OPAI AI Use Case Work Stream – Survey Results

December 19th Update

Preliminary Results

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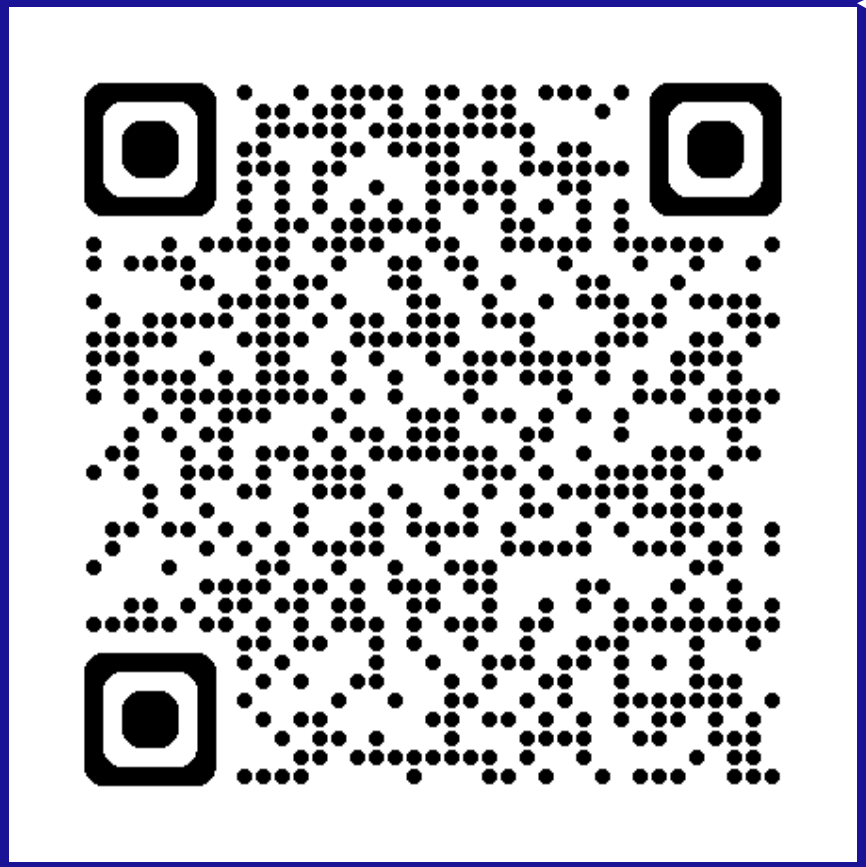
OPAI Use Case Survey Links – Remains Open Indefinitely

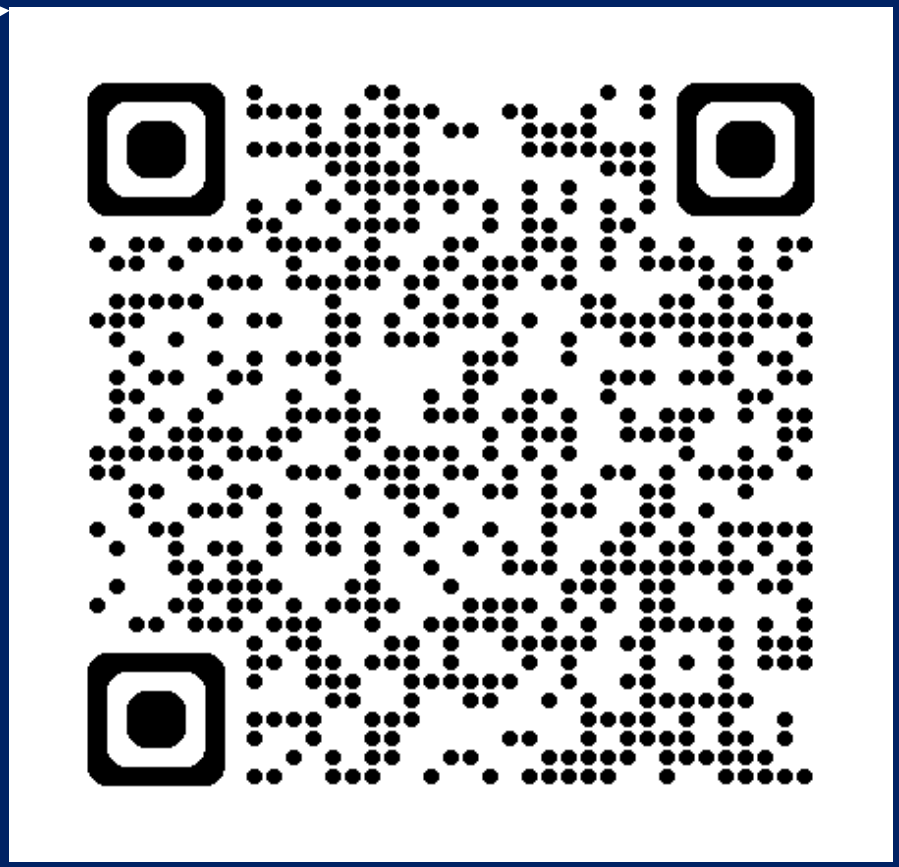
Energy Utility Survey



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

Click or Scan

Technology Provider Survey



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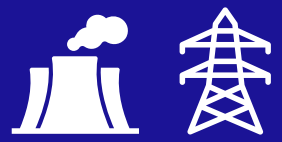
Use Case Survey By the Numbers – So Far!



Utilities		Technology Providers
53	*75+ Entities Submitted at Least 1 Response*	22
261	*Use Cases Evaluated by at Least 1 Person*	150
289	*338+ People Evaluated*	49
10875	*11258+ Data Entries (Evaluation, Maturity or Comment)*	383

Assuming ~20 Seconds Entry – Cumulative Total of ~62 hours of data entry

Thank You!

Key Takeaways from OPAI Use Case Survey Results – So Far!

Grid based use cases have the most responses relative to generation use cases. 6 of the top 10

A nuclear plant application (Real time automated visual inspection) scores the highest (with >5 Responses)

Grid asset management use cases scored 4 of the top 10, with grid and asset data high speed recording insights scoring highest. There are two grid operations use cases in the top 10.

2 cyber detection use cases and a distribution AMI data validation use cases are the remaining 3 in the top 10 overall.

Most functions have viable top 5 or 10 use cases. 132 out of 261 have > 5 respondents. 5 is an initial arbitrary cut off for viability – this may increase or decrease with further analysis.

Thermal, Renewable, Nuclear generation use case evaluation had mostly small sample sizes, but some high scoring potential use cases.

Next Steps: Continue data evaluation, parse text comments, share contributing company scores, different comparison modes for data, agreement on top use cases for co-development

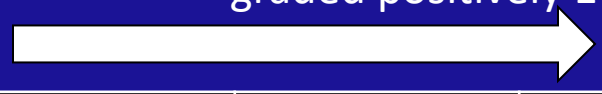
Survey Data Next Steps

Use Case Functional Prioritisation	• Top 5 10 Asset Management • Top 5-10 Operations • Top 5-10 Markets, Planning….etc
Use Case Assessment Criteria Prioritization	• Top 5-10 Reliability and Resilience • Easiest to implement • Least risky…etc
Use Case to Technology Matching	• Map high priority use cases to medium to high technology solution maturity
Use Case Co-Development	• OPAI will bring forward the highest priority use cases for co-development • Potential data availability identified in survey, utilities with highest need may provide
Utility and Industry Demo Spotlights	• May reference and spotlight utility or technology use case implementations
Company Benchmarks	• Utilities that fill in the survey will receive their individual company results, relative to industry averages
Tech Provider Call to Action	• Are there gaps in industry that your technology can address
Regular Updates	• Survey can be rerun regularly to assess state of the industry

Methodology for the Utility Evaluation Survey

- Only utilities who were distinguishable by their name and who added at least one data entry were included
- Each use case was evaluated by OPAI members, according to the use case name, and description for how a data / AI based solution solution might work. The evaluation was parameterized 1-5.

Impact scores for: reliability, resiliency, security, safety, and cost + Data availability were graded positively 1-5



Minimal	Limited	Moderate	Significant	Extensive
1	2	3	4	5

Scores for Implementation Complexity and Risk of Mis Operation Were Graded Negatively from 5-1

- Only use cases with at least 5 response were considered - to eliminate small sample size bias, and to measure interest in the topic
- The average score was collated for each use case evaluation and the averages of the scores was calculated
- Example: If a use case was graded as Significant (4/5) for impacts and data availability + Limited (2/5) on implementation complexity and risk of misoperation.
  - (4+4+4+4+2+2) / 6 = 4 out of 5
- If 5 different respondents graded the same use cases as: 4, 3, 4, 2, 2 - then the use case score is the average: 15/5 = 3

Methodology – Technology Providers

Utilities

- Only technology providers who were distinguishable by their name and who added at least one data entry were included
- Each use case was evaluated by OPAI members, according to the use case name, and description for how a data / AI based solution might be addressed by an existing technology solution.

Technology Providers were asked to graded their technology based on TRL 1-9 for the same use cases

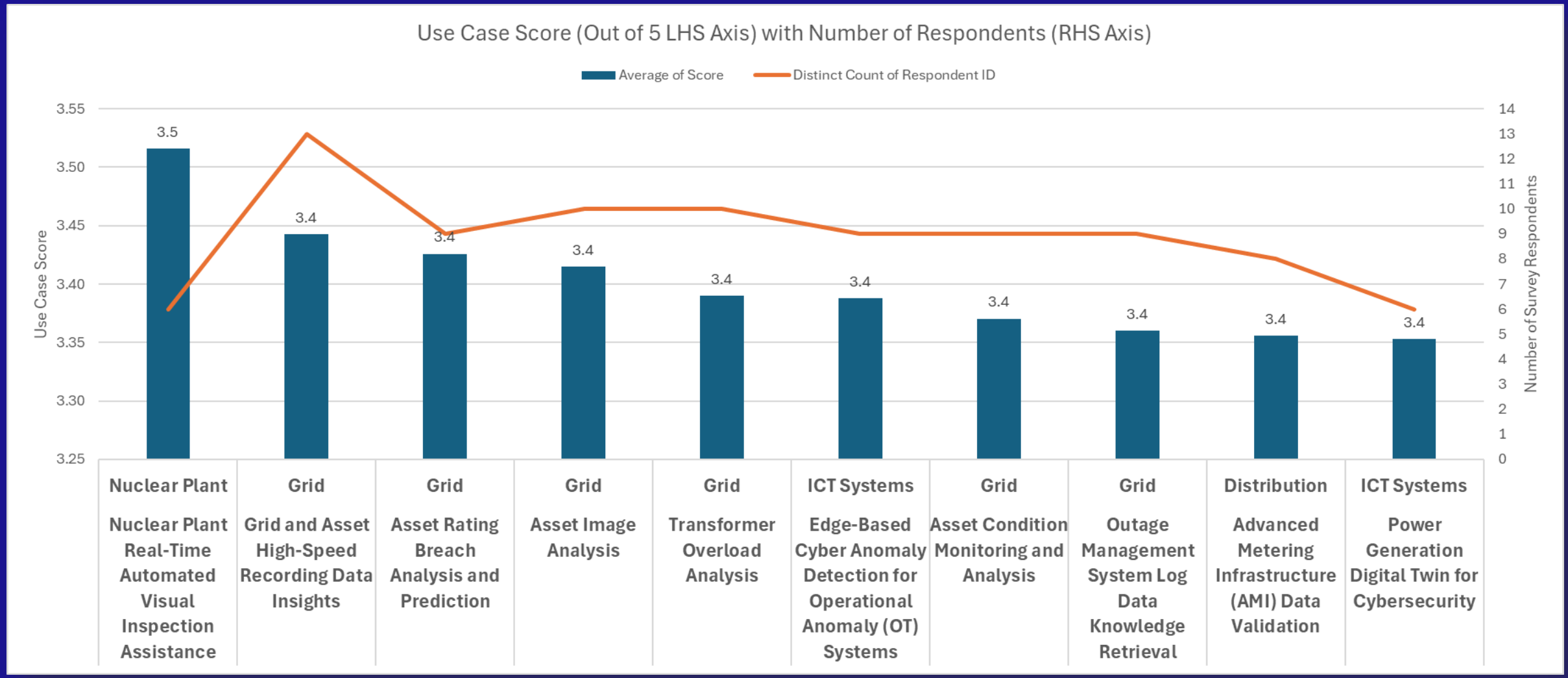
TRL	TRL	TRL	TRL	TRL	TRL	TRL	TRL	TRL
1	2	3	4	5	6	7	8	9

- Use Cases technology solution maturity were averaged – but it's a small sample size for most use cases.

Preliminary Use Case Survey Results

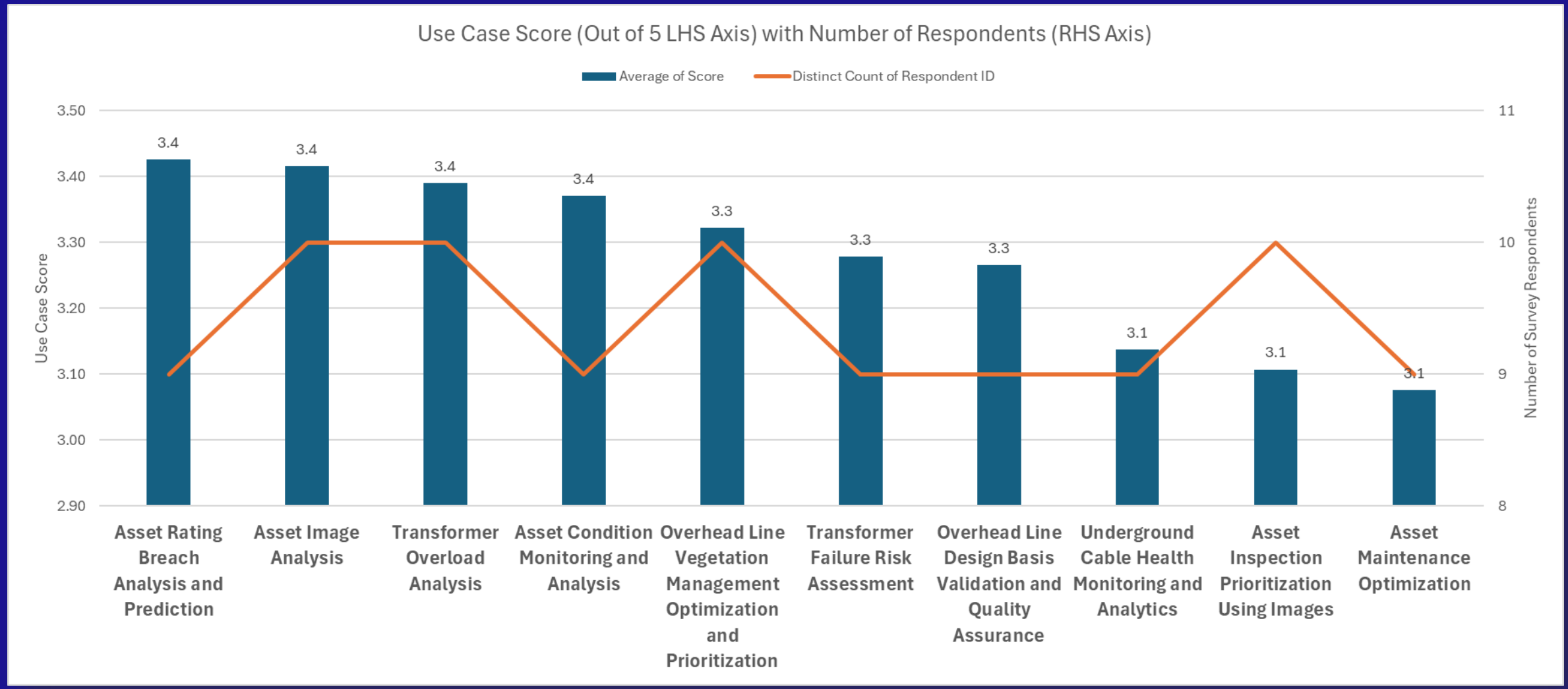
Top 10 Use Cases – All Functions (<5 Respondents)

Nuclear use cases is top identified but grid use cases are 6 of top 10. ICT cyber and distribution AMI data use cases are the remaining top 10.



Grid Asset and Infrastructure Management, Performance Top 10 Use Cases

Asset Image Analysis Dominates. Asset Data is a Rich Source of AI/ML Applications



Top 3 Assets Use Cases – Concept Descriptions

Asset Image Analysis

AI-powered computer vision systems analyze images from various sources including drone inspections, thermal cameras, and ground-based photography to assess equipment condition and identify maintenance needs. Machine learning models detect visual anomalies such as corrosion, mechanical damage, vegetation encroachment, and thermal hotspots across diverse asset types including transmission lines, substations, and generation equipment. The system uses deep learning techniques to classify defect types, assess severity levels, and track condition changes over time through comparative image analysis. Advanced image processing algorithms extract quantitative measurements from visual data including conductor sag, insulator contamination levels, and structural deformation to support engineering assessments and maintenance planning.

Asset Rating Breach Analysis and Prediction

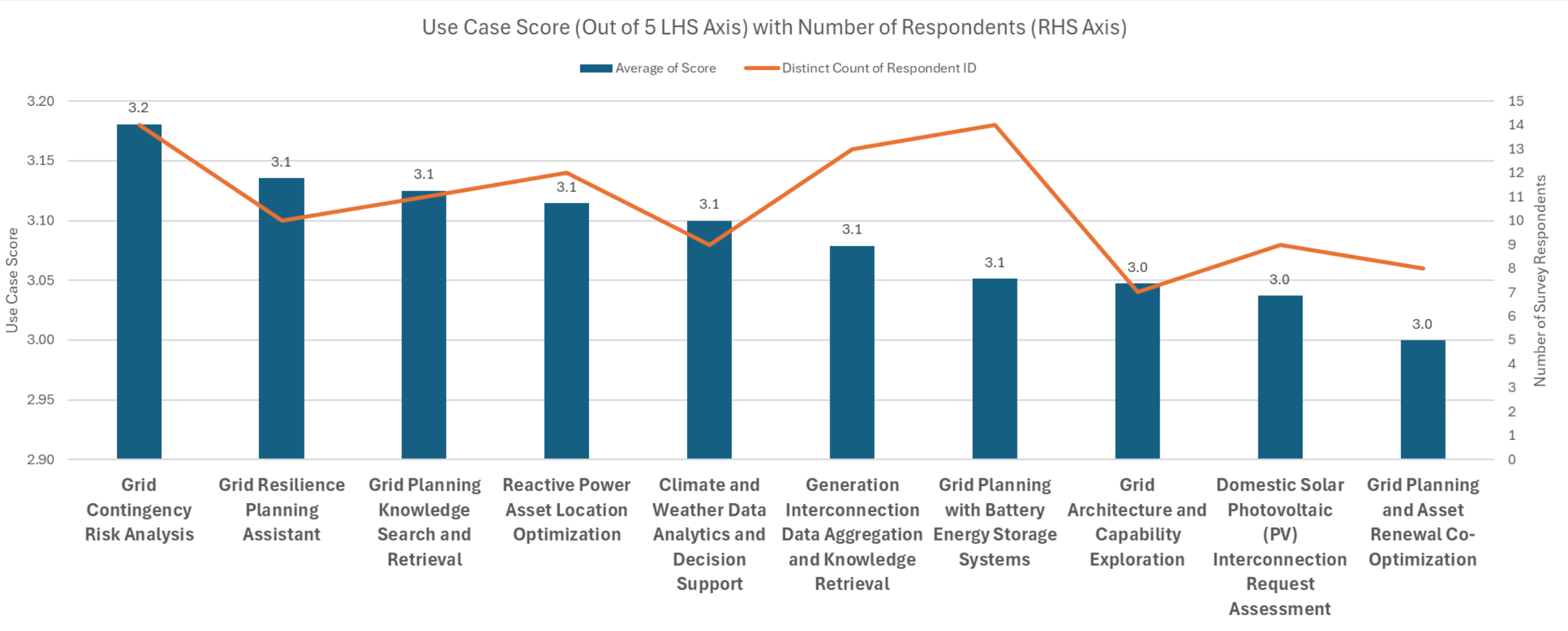
Using thermal models, weather forecasts, and load data, AI predicts potential asset overloading events such as transformer or line thermal breaches. Historical trends and asset condition data are integrated to assess residual lifespan impact. Early warnings are issued with recommended curtailment or re-routing strategies. This helps avoid emergency outages and supports dynamic line rating applications.

Overhead Line Vegetation Management Optimization and Prioritization

AI algorithms continuously monitor transformer loading conditions using real-time measurements, ambient temperature data, and thermal models to assess overload risks and remaining capacity margins. Machine learning models predict transformer thermal behavior under various loading scenarios considering factors such as cooling system performance, ambient conditions, and historical thermal cycling effects. The system provides early warning alerts for potential overload conditions and recommends load transfer strategies or operational adjustments to prevent equipment damage. Advanced analytics integrate transformer aging models with loading analysis to assess the impact of overload events on insulation life and long-term reliability performance.

Grid Planning Top 10 Use Cases

Good Combination of Text and Knowledge Based And Numerical Applications



For Context - Top 3 Planning Use Cases – Concept Descriptions

Grid Contingency Risk Analysis

AI models simulate a wide range of contingency scenarios such as equipment failures or extreme weather events on the transmission network. Machine learning quantifies the probability and impact of each contingency, prioritizing risks based on severity and likelihood. Automated risk assessment tools recommend mitigation measures and investment priorities. This ensures grid resilience and regulatory compliance.

Grid Planning Knowledge Search and Retrieval

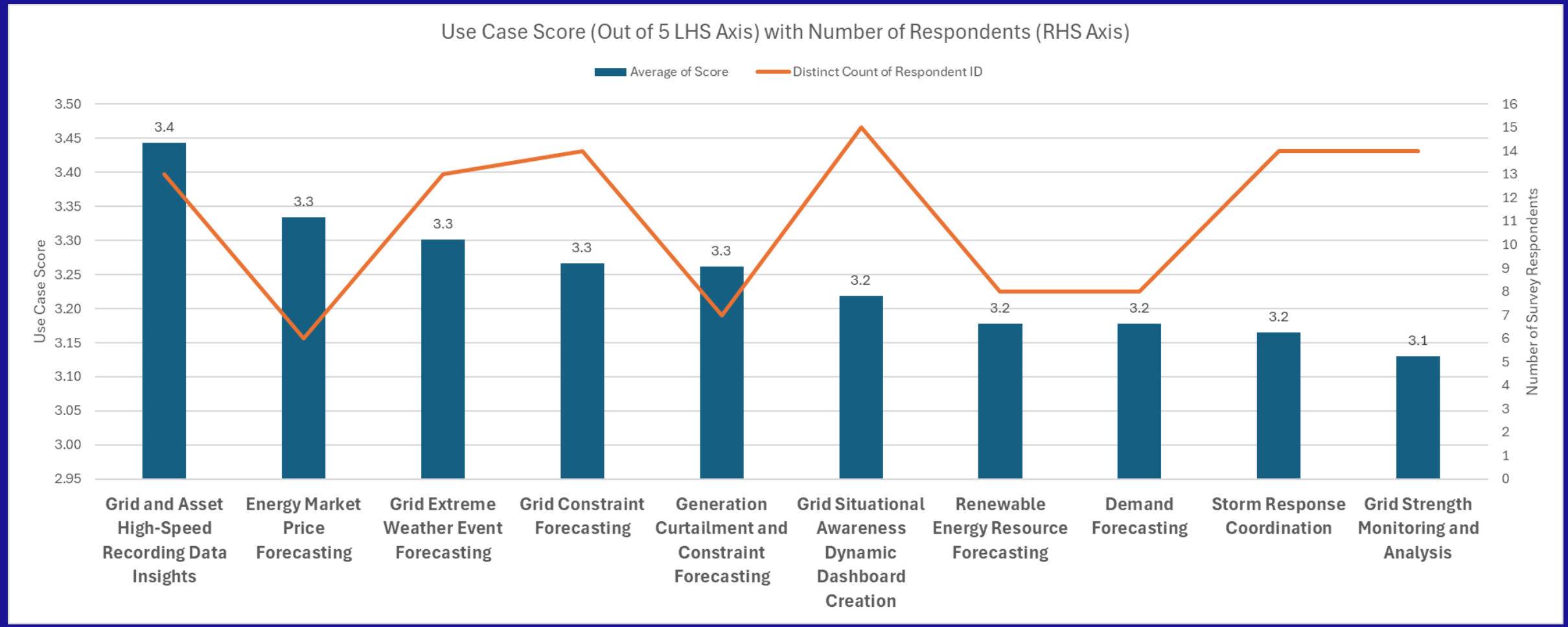
Domain-specific Large Language Model (LLM) trained on electric utility distribution planning data—including planning criteria, software manuals, historical planning study reports—serves as an intelligent assistant for distribution planners. This AI model enables real-time, conversational access to decades of institutional knowledge, streamlining planning studies and providing support for junior planners. Planners can ask natural language questions such as “What measures are needed to connect this load/DER connection request?” or “What risks and mitigation solutions are identified for a given distribution feeder?” and receive accurate, context-aware responses grounded in utility-specific practices. The LLM also assists with onboarding new personnel by accelerating knowledge transfer, a critical need as experienced planners retire at increasing rates, and staff increasingly rapidly rotate in and out of planning departments. By embedding planning expertise into an accessible AI interface, utilities preserve institutional memory, reduce training time, and enhance planning consistency.

Reactive Power Asset Location Optimization

AI streamlines distribution resilience planning studies assessing current system resilience and resilience improvement strategies across the utility distribution service area. AI pulls GIS and other data from utility and public data sources summarizing the data identifying vulnerable system locations, where risks are, best strategies to mitigate the risks, etc..

Grid Operations, Markets and Balancing Top 10 Use Cases

Grid – Is applicable to T&D. Strong Interest in Big Data Insights from high speed recording



For Context - Top 3 Grid Operations Use Cases – Concept Descriptions

Energy Market Price Forecasting

Machine learning models predict day-ahead and real-time market prices using inputs such as demand forecasts, generation availability, weather conditions, and historical price patterns. AI adapts to market rule changes and real-time events. Outputs are used by utilities, traders, and aggregators to optimize bidding strategies. Forecast confidence intervals help assess market risks.

Grid and Asset High-Speed Recording Data Insights

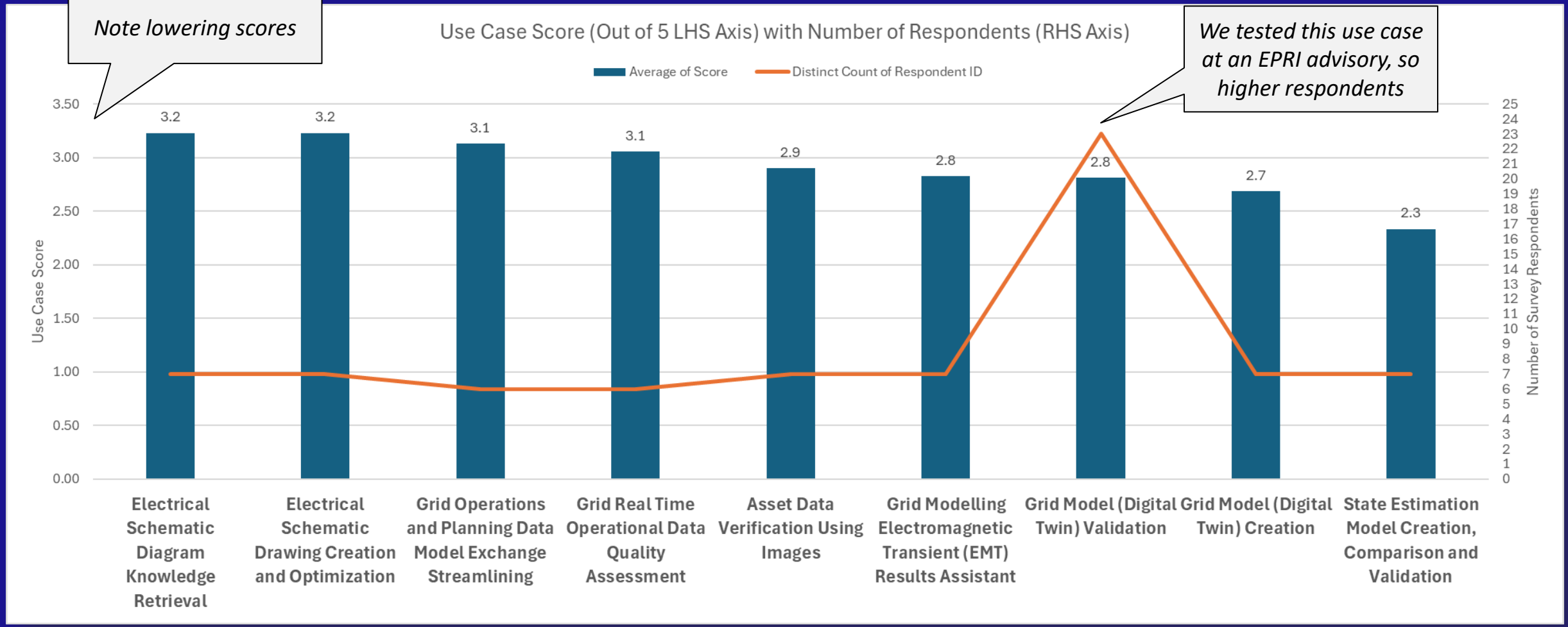
High-frequency data from Digital Fault Recorders (DFRs) and transient recorders is analyzed using deep learning to detect sub-cycle events and transient disturbances. AI models can automatically classify fault types, identify affected components, and reconstruct event timelines. These insights support root cause analysis and post-event reporting. Integration with asset condition monitoring enhances predictive maintenance strategies.

Demand Forecasting

AI uses weather models, satellite data, and historical grid impact records to forecast extreme weather risks such as hurricanes, wildfires, and heatwaves. Classification models assess potential grid impacts by region and severity. Utilities receive early warnings to prepare contingency plans and harden infrastructure. Forecast outputs are updated in near real time.

Grid Data and Model Management Top 10 Use Cases

The top 2 use cases involve interaction with images



For Context - Top 3 Data Model Use Cases – Concept Descriptions

Electrical Schematic Diagram Knowledge Retrieval

AI-powered systems use computer vision and natural language processing to extract information from electrical schematic diagrams, one-line drawings, and technical documentation for intelligent knowledge retrieval. Machine learning models recognize electrical symbols, component ratings, and connection patterns to create searchable databases of electrical system configurations and equipment specifications. The system enables semantic search capabilities that allow engineers to find similar circuit designs, equipment applications, and protection schemes across large document repositories. Optical character recognition and image analysis techniques digitize legacy schematic drawings and integrate them with modern asset management systems for improved accessibility and knowledge preservation.

Electrical Schematic Drawing Creation and Optimization

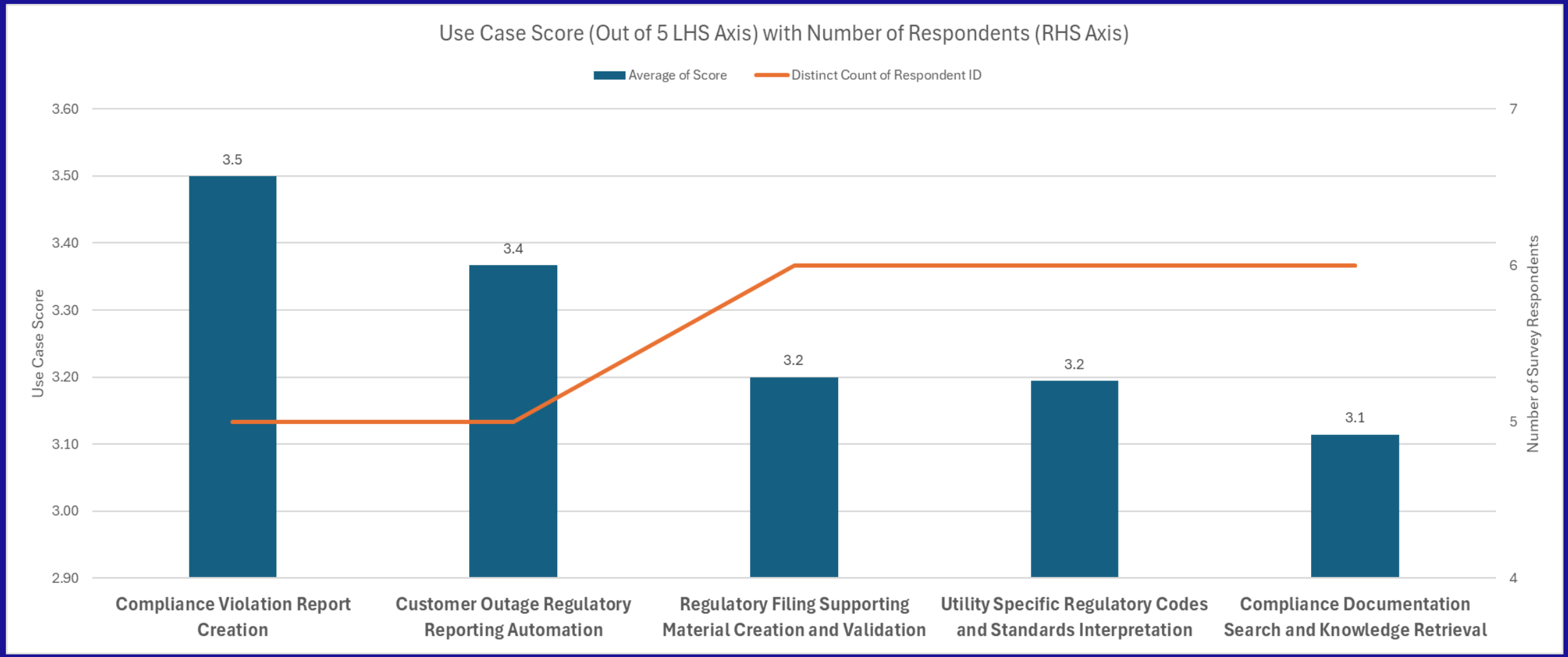
AI algorithms automatically generate electrical schematic diagrams based on system requirements, equipment specifications, and design standards using rule-based engines and generative models. Machine learning systems optimize circuit layouts, component placement, and wiring paths to minimize costs, improve reliability, and meet electrical codes and engineering standards. The system incorporates design constraints such as voltage drop calculations, short-circuit analysis, and protection coordination requirements to ensure technical accuracy and safety compliance. Natural language processing interprets design specifications and engineering requirements to automatically populate schematic symbols, ratings, and annotations while maintaining consistency with company drafting standards.

Grid Operations and Planning Data Model Exchange Streamlining

AI facilitates seamless data exchange between grid operations and planning systems by standardizing data models and automating data transformation processes. NLP and schema-matching algorithms resolve data format discrepancies and ensure semantic consistency. Automated validation checks maintain data integrity during transfers. This streamlines collaboration across departments and enhances decision-making speed and accuracy.

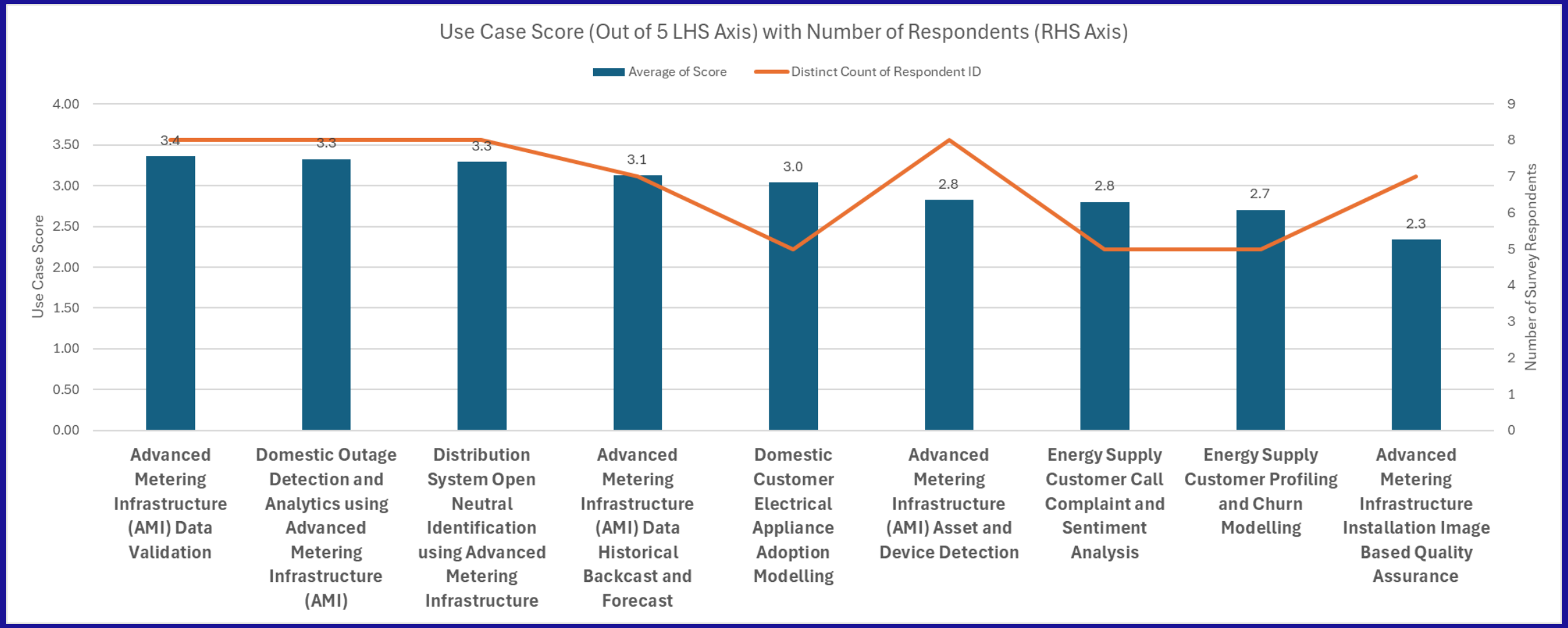
Grid Regulation and Compliance Top 5 Use Cases

Compliance Reporting Automation is a High Priority for Obvious Reasons



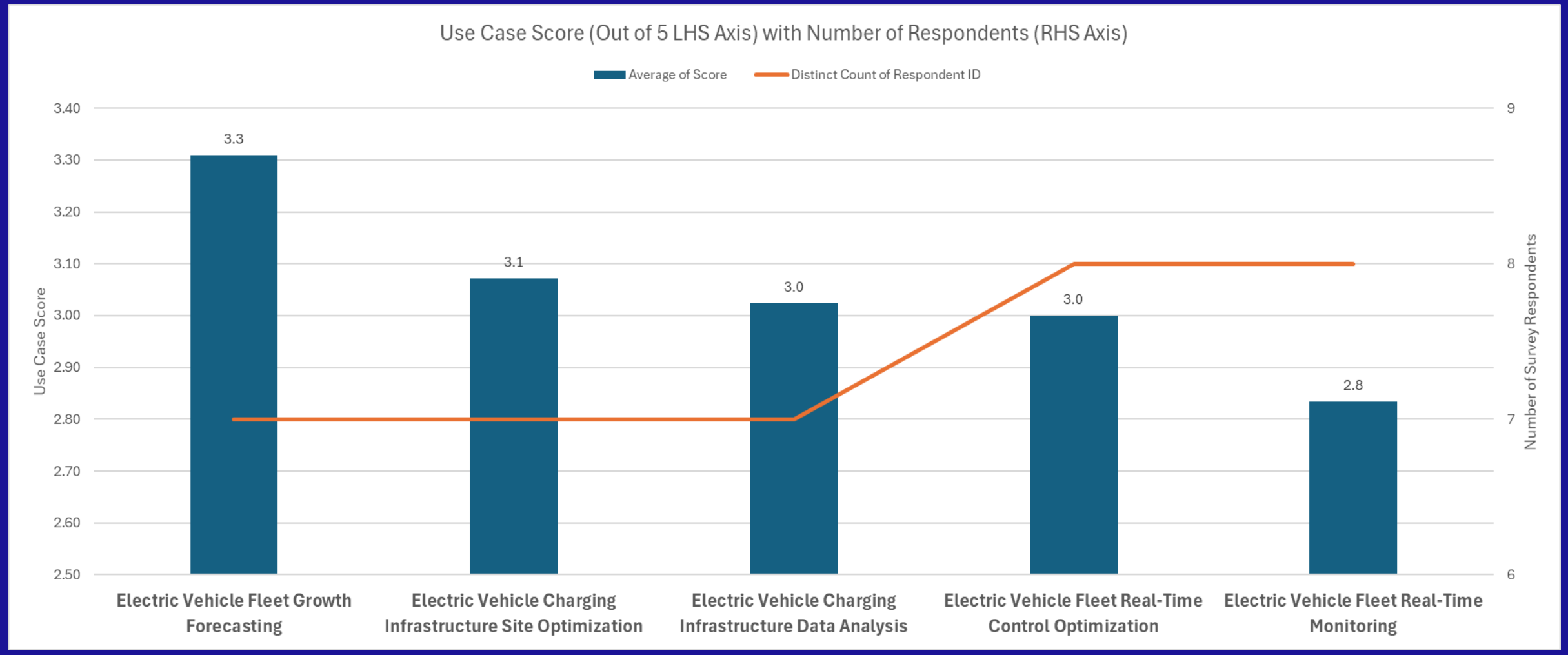
Distribution Top 9 Use Cases (Response threshold adjusted to >4)

Strong interest in Distribution AMI related use cases, lot of data many use cases



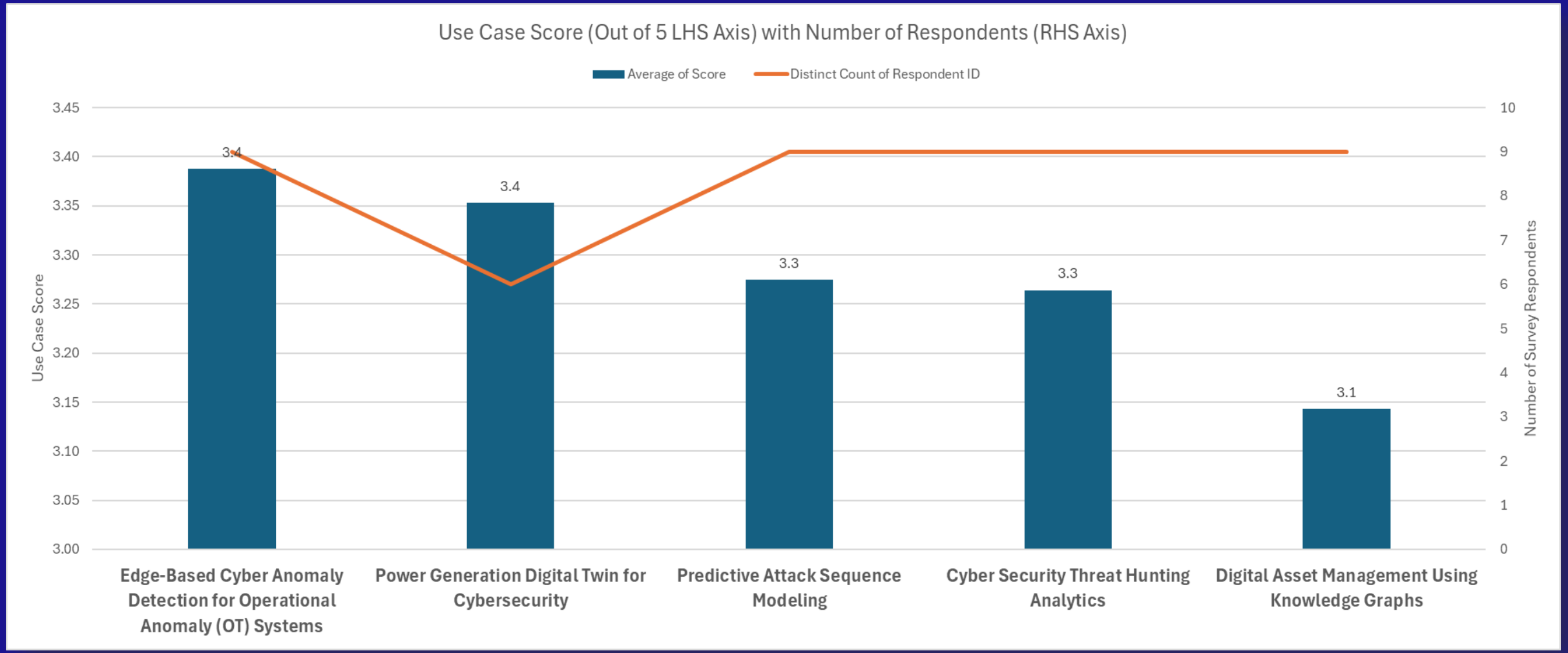
Electric Transportation Top 5 Use Cases

EV Fleet Growth Forecasting Scores high But Generally Lower than the T&D grid related use cases



ICT Systems Top 5 Use Cases

Critical topic in energy sector, data rich with valuable use cases. Ongoing research across utilities



Top 3 ICT Systems Use Cases – Concept Descriptions

Predictive Attack Sequence Modeling

Leverage LLMs and AI to benchmark and predict subsequent attacker tactics using threat intelligence, enabling proactive response and recovery

Power Generation Digital Twin for Cybersecurity

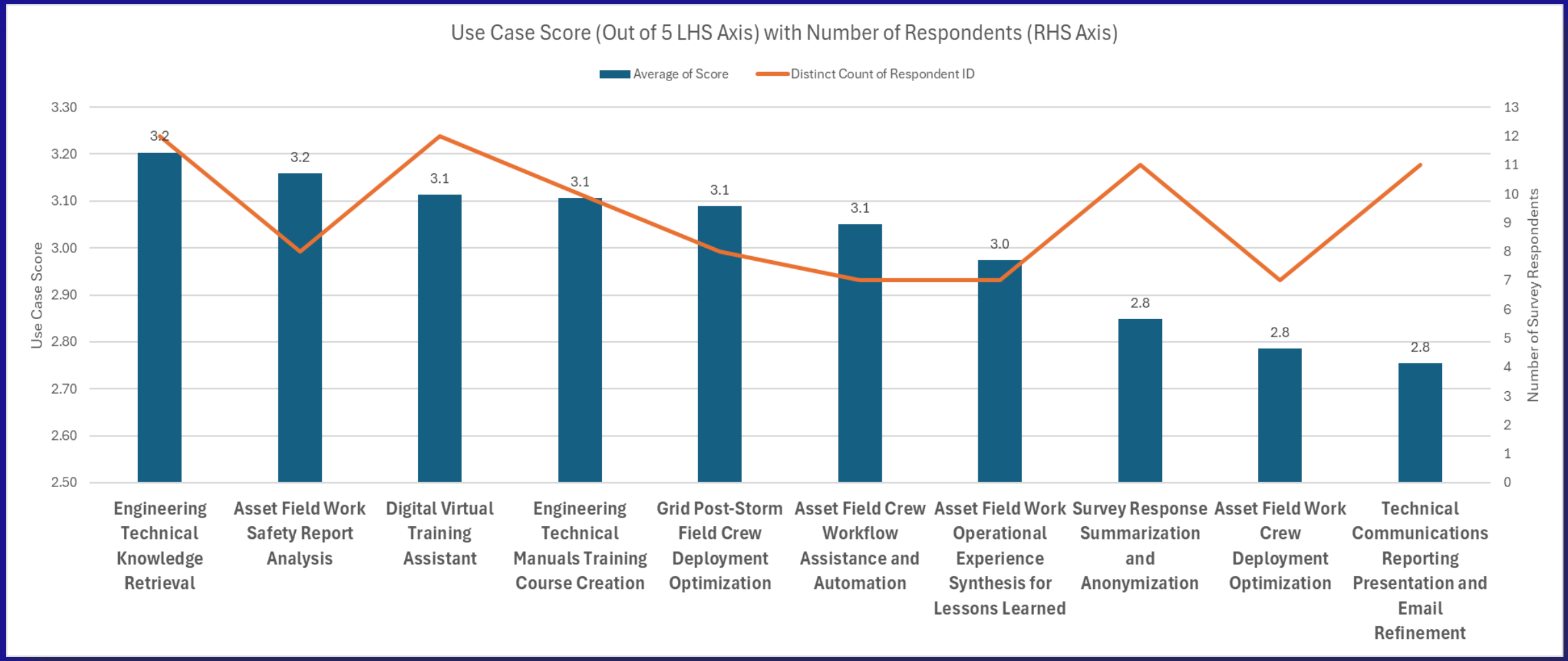
Utilize digital twins of power plant physical and control systems to provide a realistic, physics-based reference for detecting cyber anomalies and reducing false positives.

Edge-Based Cyber Anomaly Detection for Operational Anomaly (OT) Systems

A solution that leverages edge computing hardware and AI analytics to monitor operational technology networks for anomalous activities, reducing false positives and providing rapid detection of cyber threats.

People (Workforce and Training) Top 10 Use Cases

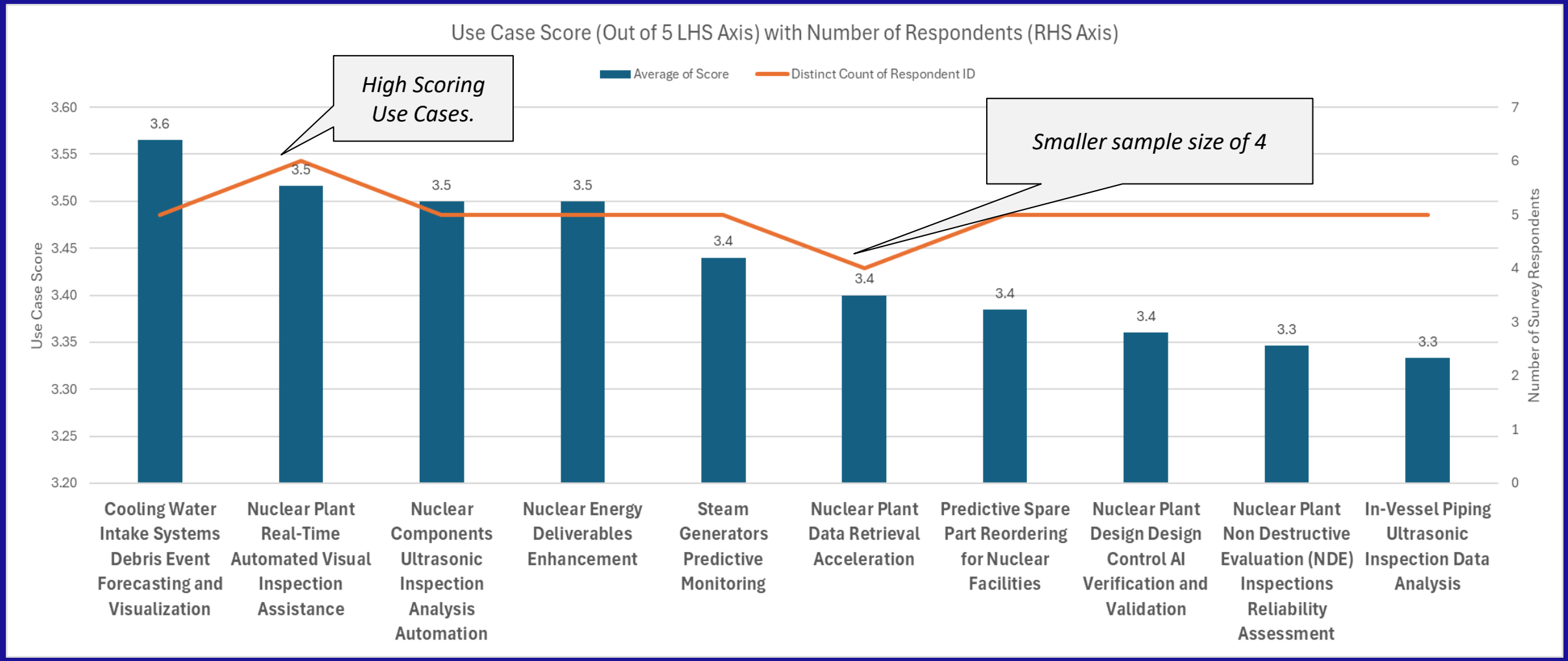
Lower scores but good response rates for these use cases. Mostly, text and language based



Generation Use Cases

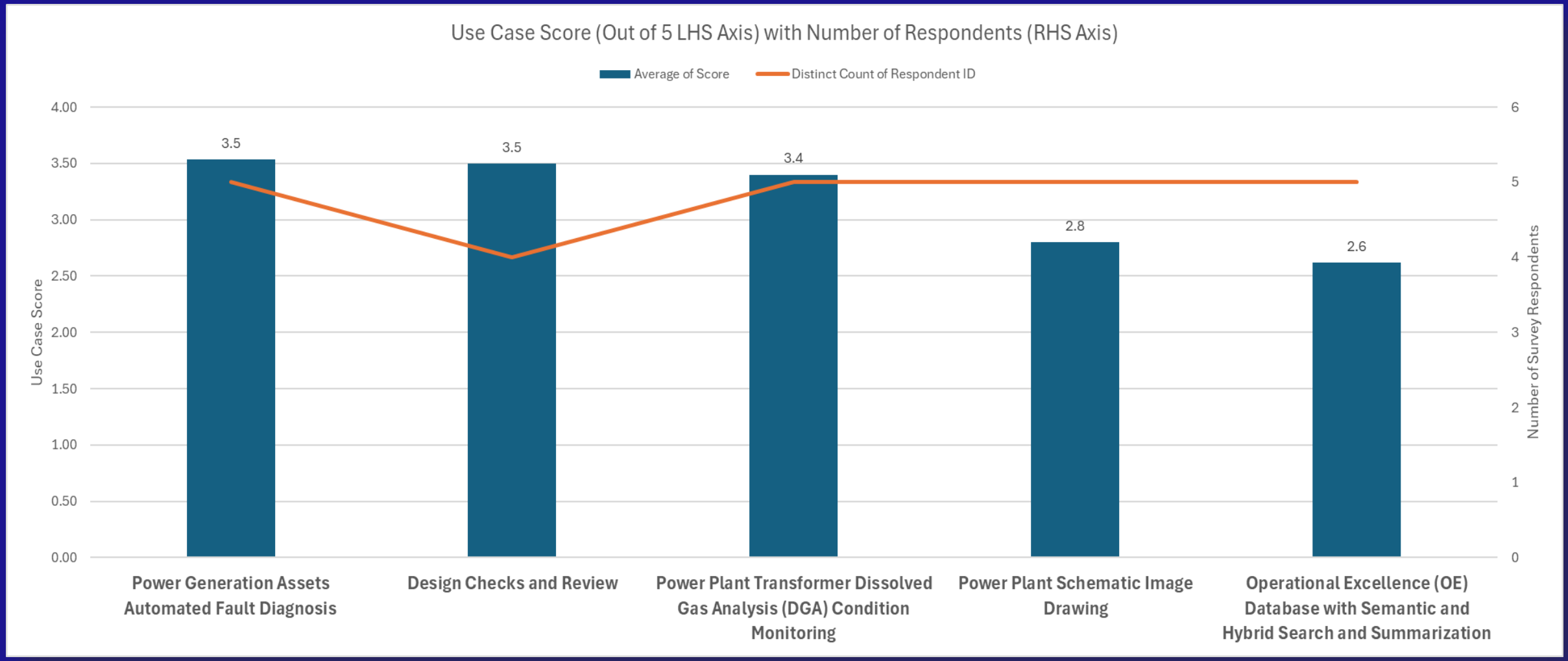
Nuclear Top 10 Use Cases

Higher scores than average compared to other use cases but very small sample sizes



Power Plant (Gas, Hydrogen, Power Plants Generally) Top 5 Use Cases

High scores for top 3 with lower sample size for some use cases



Top 3 Power Plant Generation Use Cases – Concept Descriptions

Design Checks and Review

Enable engineers and stakeholders to perform real-time, AI-driven design validation and optimization of complex components, integrating with 3D CAD for visualization and facilitating iterative checks throughout the project lifecycle.

Power Generation Assets Automated Fault Diagnosis

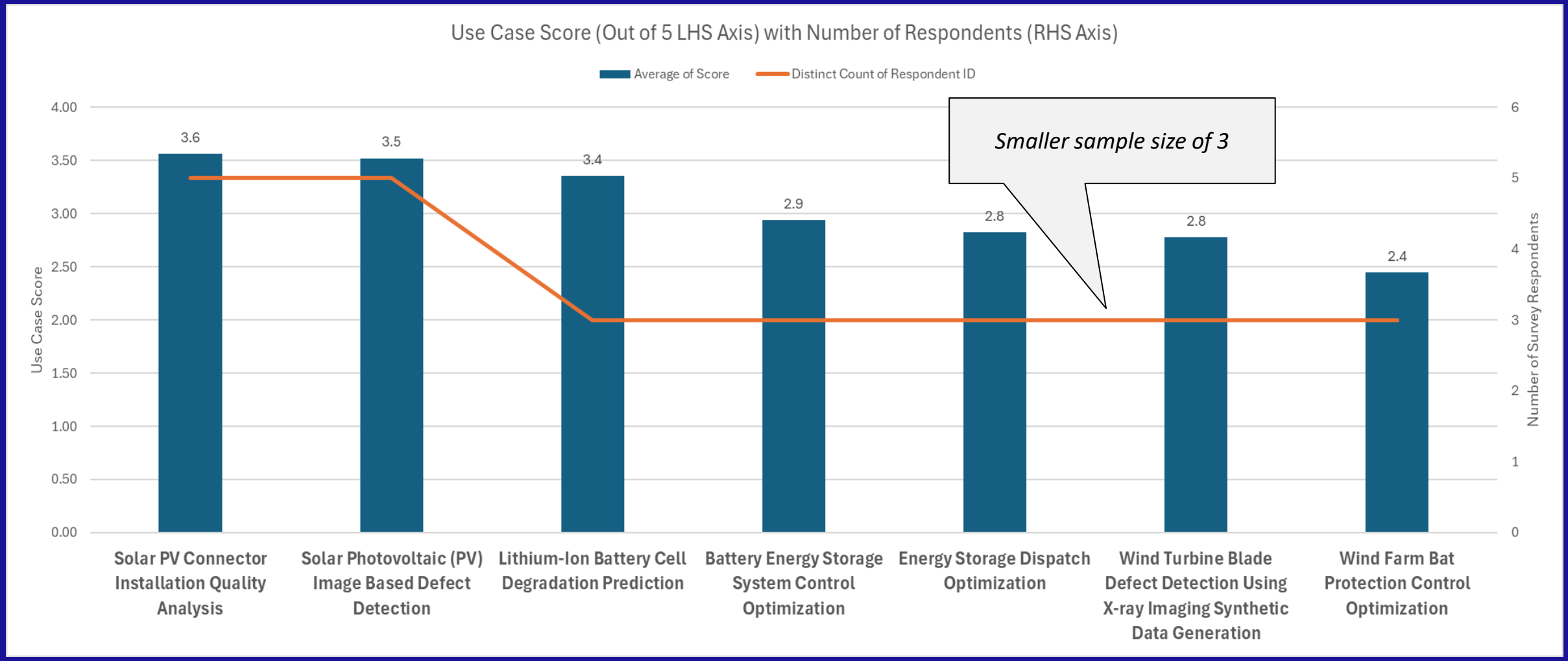
Leverage data-driven fault signature libraries to enable rapid automated detection and diagnosis of equipment failures across all generation technologies, improving reliability and reducing downtime

Power Plant Transformer Dissolved Gas Analysis (DGA) Condition Monitoring

Continuously analyze transformer oil gas composition along with temperature and pressure data to detect abnormal patterns and predict internal faults

Solar, Wind, BESS Top Use Cases (Response rate threshold lowered to >2)

Solar Top 2 have a reasonably high average scores with 5 samples Wind, BESS have a lower sample size



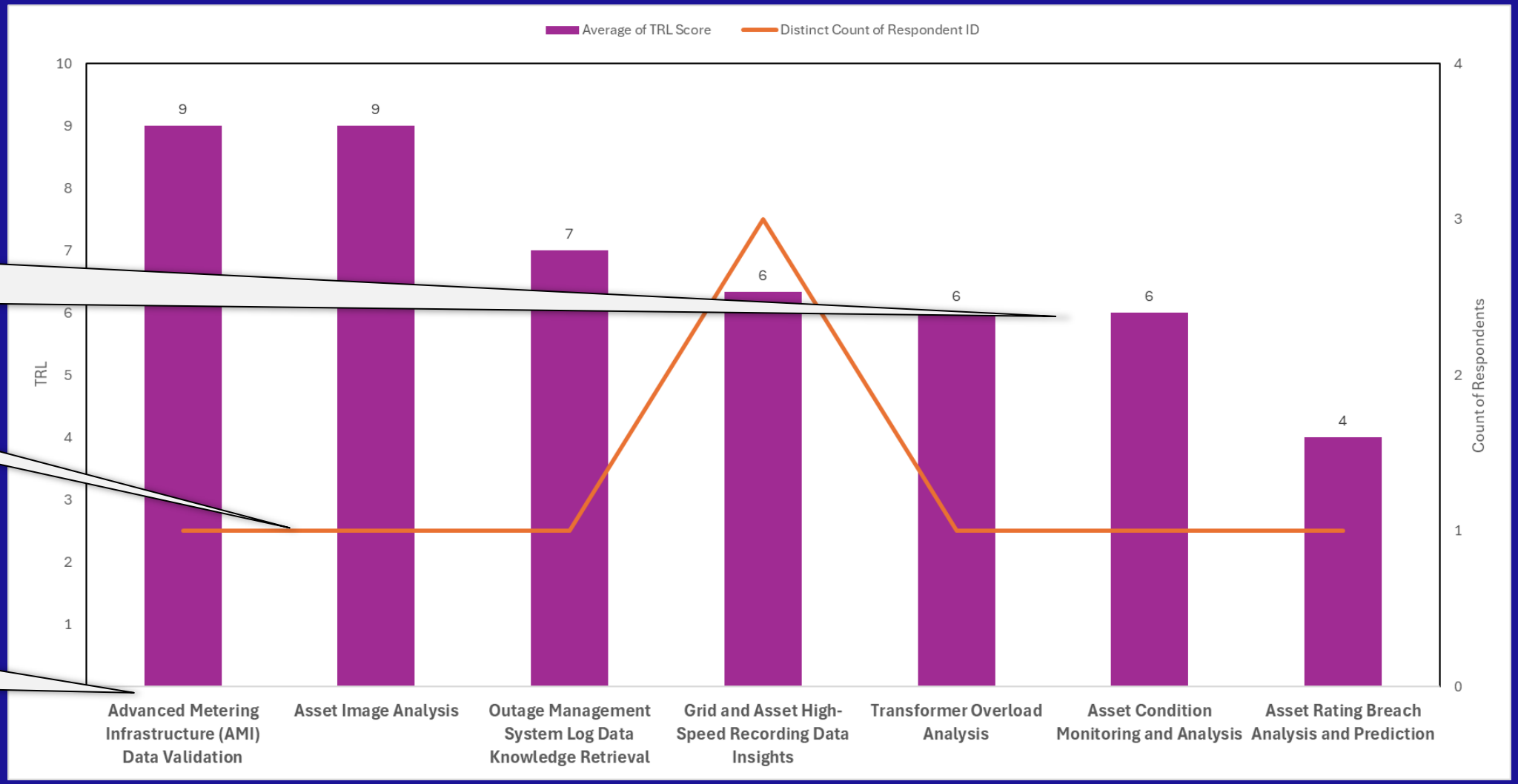
Technology Providers Survey Results

Matching the Top 10 With Technology Provider Input

TRL Between 4-6 Are Interesting as potential to co-develop

Low Sample Size of Tech Providers

Only 7 / Top 10 have tech provider response



Most of the Value from Technology Providers Response is in Text Commentary on Use Cases

yes, in other categories
Asset Condition Monitoring and Analysis
Yes. Real time, on prem monitoring of critical electrical assets. The ecosystem permits to structure data and make it available for egress to existing OT solutions. It pro
Asset Equipment Sensor Data Fault Detection
The ecosystem provides the tools to manage time series data for further analysis with possibility to adjust frequency of data. In addition, AI models can be orchestrate
Asset Failure Synthetic Data Creation and Failure Prediction
This is part of the road plan.
Asset Field Crew Workflow Assistance and Automation
No but we are currently developing a mobile-version of our web App that provided the flexibility and mobility requirements for field staff while maintaining a lot of the p
Asset Field Work Crew Deployment Optimization
Not with a utility but with a consultancy firm serving utilities. We have a platform that allows users to create own assistants , connect to different data sources and le
Asset Field Work Operational Experience Synthesis for Lessons Learned
Not with a utility but with a consultancy firm serving utilities. We have a voice-enabled platform that allows users to extract and analyze as well as search knowledge
Asset Field Work Safety Report Analysis
No
Asset Rating Breach Analysis and Prediction
This is part of the road plan.
Behind the Meter Solar Photo Voltaic and Battery Control Optimization
No
Design Checks and Review
No
We are promoting our solution to various utilities.
Distributed Energy Resources Management System (DER MS) Optimization
Photometrics AI is not deployed through a utility as street lighting load, while often unmetered is considered behind the meter.

We do not currently integrate with Phoenix Architect API, but I do not see any reason why Photometrics AI wouldn't. Photometrics AI cu
Power Generation Assets Automated Fault Diagnosis
No
We are able to deliver a data sharing and a collaboration workspace solution to a utility at the current time. This collaboration space
Power Plant Schematic Image Drawing
No
Part of our domain specific software model includes digital twin mapping, and our strategic development plan is to include language
Power Plant Transformer Dissolved Gas Analysis (DGA) Condition Monitoring
No
Our focus is on steam surface condensers but part of the analysis includes how other production equipment impacts condenser effic
Reactive Power Asset Location Optimization
No
Software Procurement Process Data Collation and Knowledge Search and Retrieval
This use case doesn't seem relevant to Photometrics AI.
Solar Photovoltaic (PV) Image Based Defect Detection
I just returned this weekend from Lisbon where I presented Circular Solar Wind at Wind Europe's EOLis 2025 conference. This is proba
No, we are not, yet. We have been waiting to be used as a use-case by Epri, first. Additionally, this project is not only to increase solar
Solar PV Connector Installation Quality Analysis
If you mean, if the remote offgrid minigrid prototype has used AI-driven image recognition of solar connectors with FLIR camera AI vid
Transformer Failure Risk Assessment
This is part of the road plan.
Transformer Overload Analysis
The ecosystem provides dashboards with single pane of view for monitoring transformers with all internal and external sensor data
Underground Cable Health Monitoring and Analytics
The ecosystem provides to enable and run advance algorithms for different electrical events.

We will parse the text – linking high evaluated use cases to solution providers

Other Ideas or Concepts for Use Cases

Other Possible Use Cases we Missed – Utilities

- Task automation between departments
- Using AI to create presentations for Document Control
- Contract Lifecycle Obligation system. GEN AI powered solution able to consolidate into the same tool contractual and business document to provide business intelligence to drive business decisions based on documentation content.
- We need AI that can predict attack methods requiring short-term vigilance based on signs of cyberattacks worldwide.
- Stability prediction based on network configuration and weather conditions
- We are currently exploring AI for use in energy storage dispatch as well as load and demand forecasting.
- We are looking at the use of AI to automatically generate closed captions for internal training resources.
- Machine learning disaggregates AMI data to identify appliance-level usage patterns, enabling targeted energy efficiency programs.
- All use cases that involving using AMI data is of significant interest to our member cooperatives
- Resource portfolio planning. Comparing renewable projects with cost and value. Budget forecasting.
- Gen AI outage planner for generating assets
- I want to be speak into a LLM and explain what the job is today. It should give me a custom pre-job brief that takes into account this task being done today with this crew. (for example - we're performing a lift of an 800 lb. square container outside with Crew 2. The PJN should note the weather conditions (does wind potential change parameters for the lift), who is certified to run the job, what events have happened on similar lifts in our company and around the world; etc)
- Drones to help identify emerging issues on Inverters that can't be identified from existing data points.
- 1. Make it easy to use LLM to query local data historians. Up front work is significant now - how can we make this simpler 2. LLM for engineering blueprints/plant drawings. Make it easy to ask questions about a plant design.

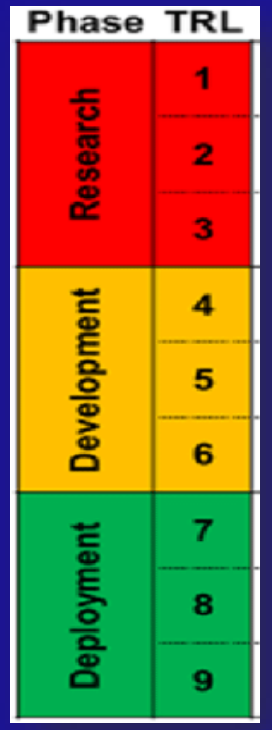
Other Possible Use Cases we Missed – Tech Providers

- Demand Response Aggregation
- Generative AI assisted work planning and execution, asset deficiency (image analysis) detection, asset and human performance analysis, etc.
- Identification of relevant regulatory orders and compliance standards that apply to engineering designs.
- One of the applications in which my company has expertise is in using expert and AI algorithms to identify the root cause and source of power system disturbances that are detected as waveform anomalies. This can be used to help grid operators determine the source of a disturbance (generation, transmission, distribution, electric customer, connected inverter-based resources, etc.).
- One use case not covered in the survey is the application of expert-fallback mechanisms integrated into GenAI decision-support workflows for utility operations. Use Case Description When an AI system encounters low confidence, conflicting signals, or a safety-critical query, the platform automatically escalates the question to a pre-approved utility expert (retiree SME, supervisor, or engineering specialist). The expert provides validated guidance via text, audio, or live remote support and the system:
- Resilience
- There are other use cases we are working on captured in other categories.
- This has been tested by electro magnetic frequency interruption from rail noise and current through the water:
- We are integrating condenser related data sets captured from specialized sensors into data based stored on the Cloud and then running analysis on those data sets. Over time, we will increase capacity to analyze more data sets and run more data analysis to locate steam surface condenser efficiency drift and intervene in the best manner possible to correct it.
- We are working on Use cases related to Solar farm drone Scans for both greenfield and brownfield projects coupled with Robotic inspections to minimize manual inspections. We have also developed a Radiation protection monitoring and Heat Map solution based on remote monitors to deliver situational awareness and worker debrief based on historical trend data and real time to minimize exposure.
- Well, I use IR, thermal camera imaging, for many years now, where I made a basic prototype to test an IR camera mounted to the stern solar panel on OCTOPUS to act as additional security to minigrids. But this isn't anything breakthrough worthy.
- Working on decarbonization optimization for multi-energy systems and the use of AI to interpret data.

Next Steps

Use Case Maturity Assessments

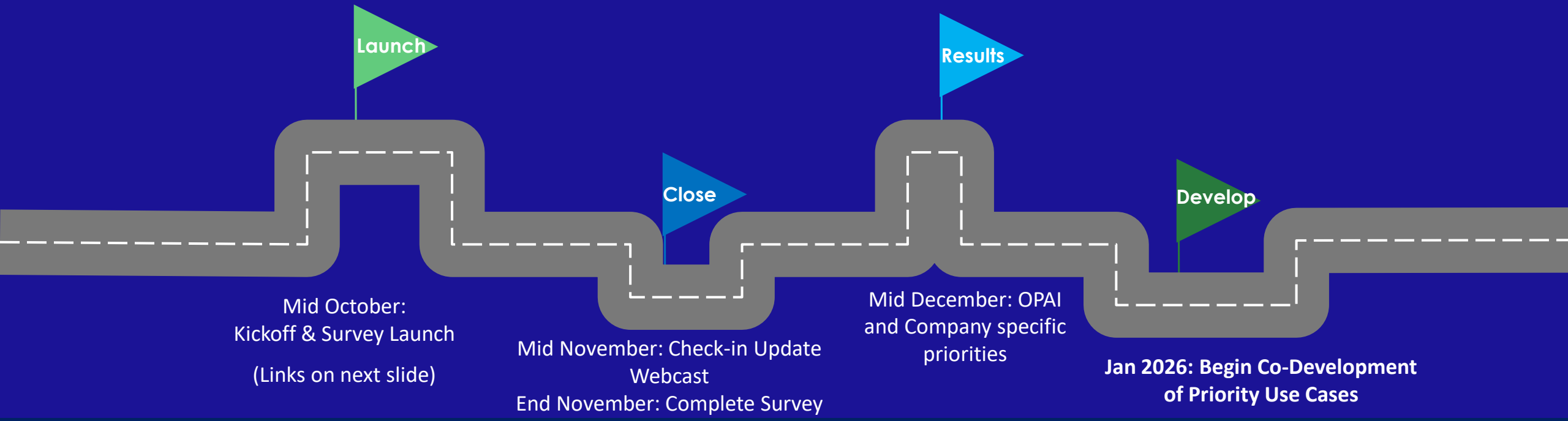
Matrix Evaluations → **Use Case ←→ Technology Matching** → **Co-Development of Use Cases**



- Virtual Co-Development Space 1
- Virtual Co-Development Space 2
- Virtual Co-Development Space 3
- Virtual Co-Development Space 4
- ....

Use Case Workstream

- Kickoff Webcast October 15-16.
- Collated 260 use case titles and descriptions across the energy sector
- Need OPAI members 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**



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