



Ahmad Al Rashdan Ph.D.

Plant Modernization Pathway Lead

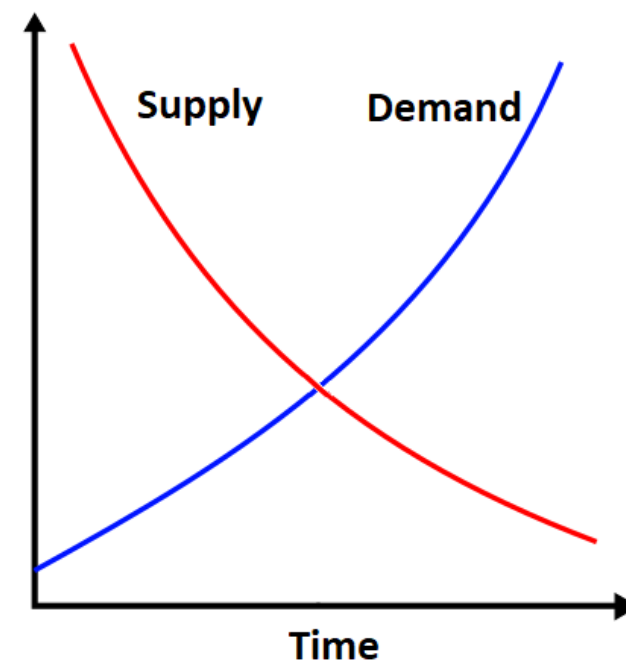
April 29, 2025

Plant Modernization Pathway Overview



Industry Challenges

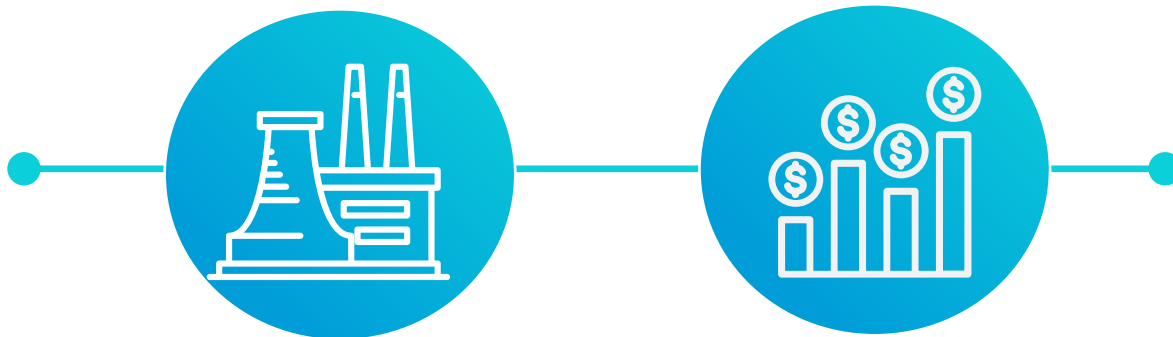
- Operating a nuclear power plant at a specific power level requires over ten times the workforce needed to operate a fossil fuel plant.
 - Over 70% of the cost of operating a nuclear power plant is attributed to workforce.
- Over the past ten years, labor costs have increased more significantly than energy prices, further straining the financial viability of these plants
- More recently, new challenges have emerged:
 - Retiring skilled staff
 - Increased competition for skilled staff replacements
 - Increased competition for craft workers across the US industries, not just in the nuclear sector
 - Increased workforce demand to support new reactors.



The nuclear power industry's need for skilled workers is expected to increase, while it is anticipated that the supply of skilled workers will continue decreasing

Pathway Objective

- Extend life and improve performance of existing fleet through **modern technologies** and **improved processes** for plant operation and power generation.

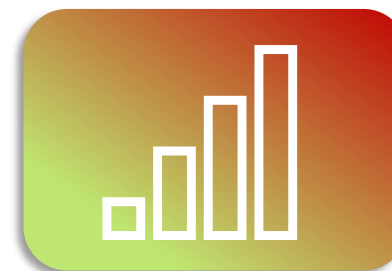


**Long-Term Management
of Plant Systems**

License extension for
60, 80, or 100 years

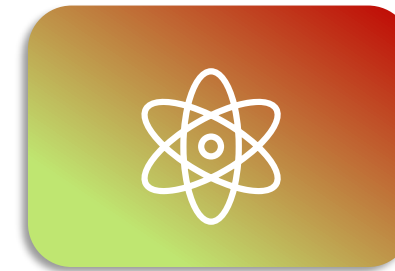
**Nuclear Cost
Competitiveness**

Cost pressures from
other generation sources

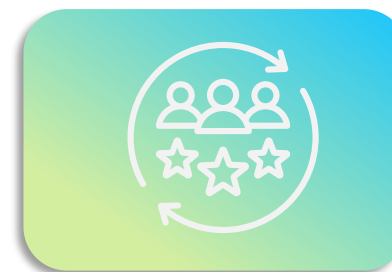


Improve
Efficiency

+



Enhance Energy Output
(increase availability and
capacity factors, and
reduce outages)



Workforce Optimization

+

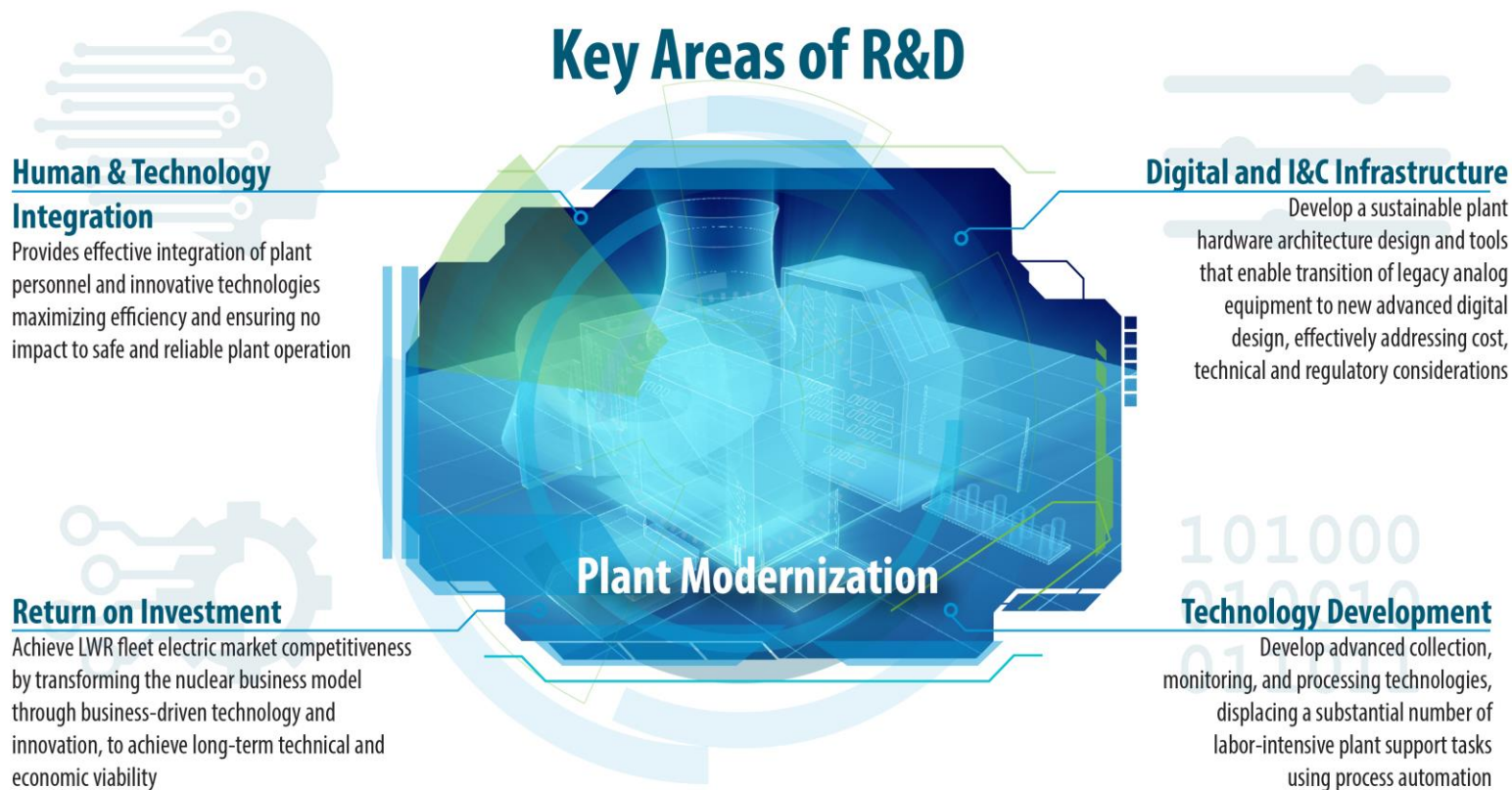


Modernization and
Automation

*We need to move from a labor-centric model to a
technology-centric model.*

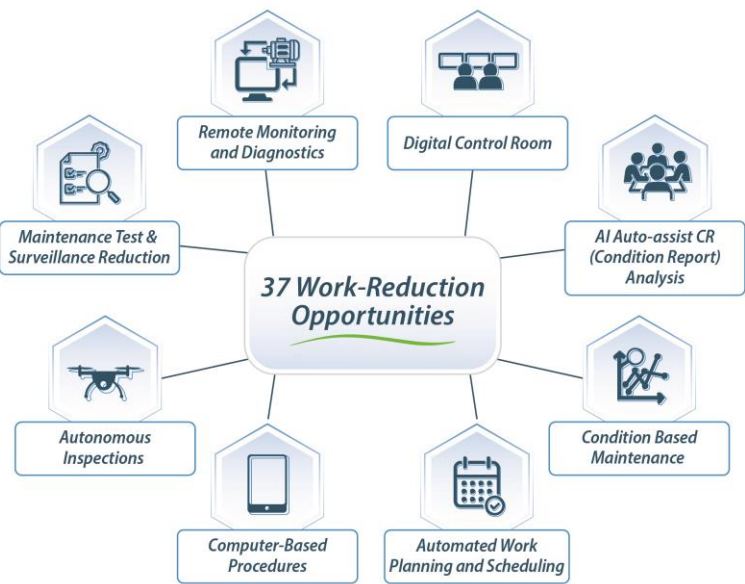
Focus Areas

- Develop a systematic modernization strategy driven by the business case for each technology.
- Create the necessary technologies to facilitate modernization.
- Develop infrastructure for modernization.
- Optimize the process for integrating technology with the human element.

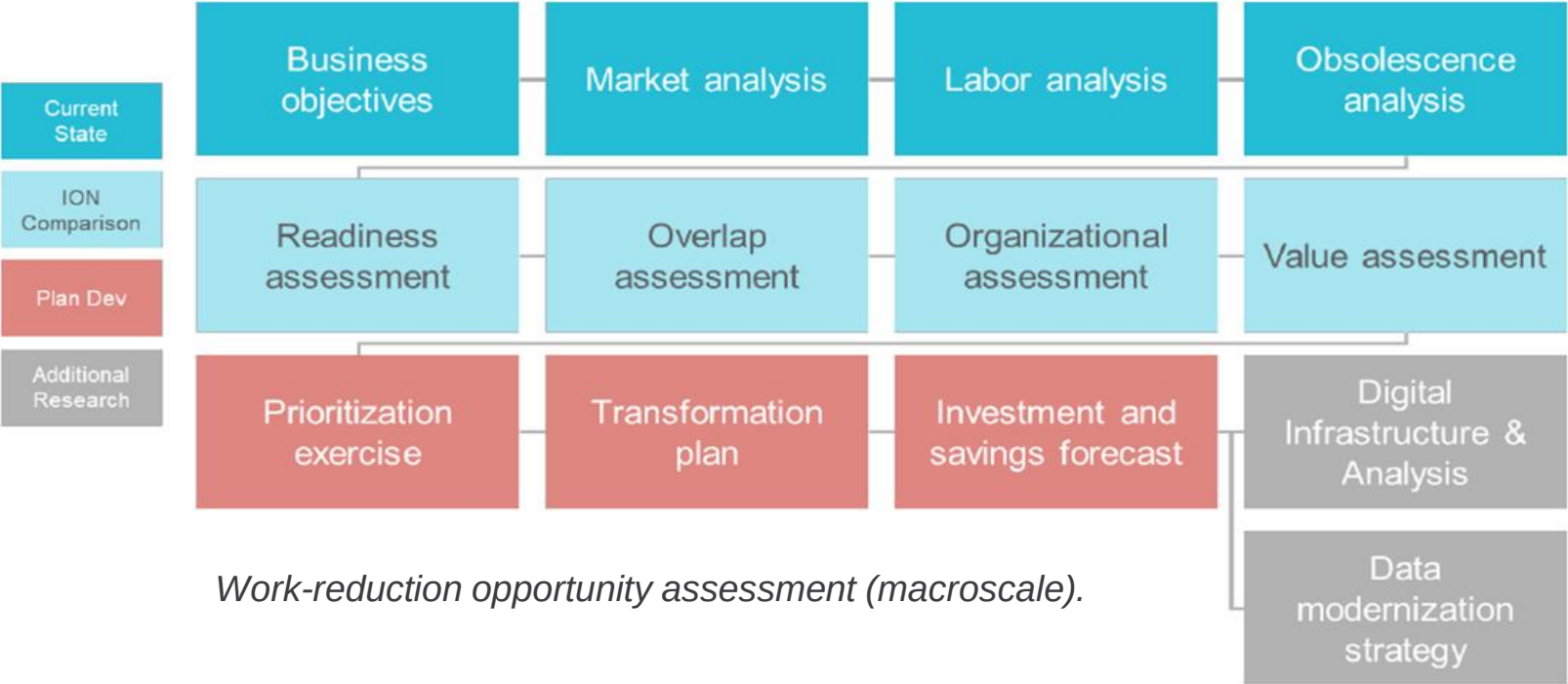


Strategic Approach to Innovation

Challenge: Lack of a process or roadmap for the digital transformation of plants, or business cases for work-reduction opportunities to foster plant modernization and sustainability.



Identify work-reduction opportunities

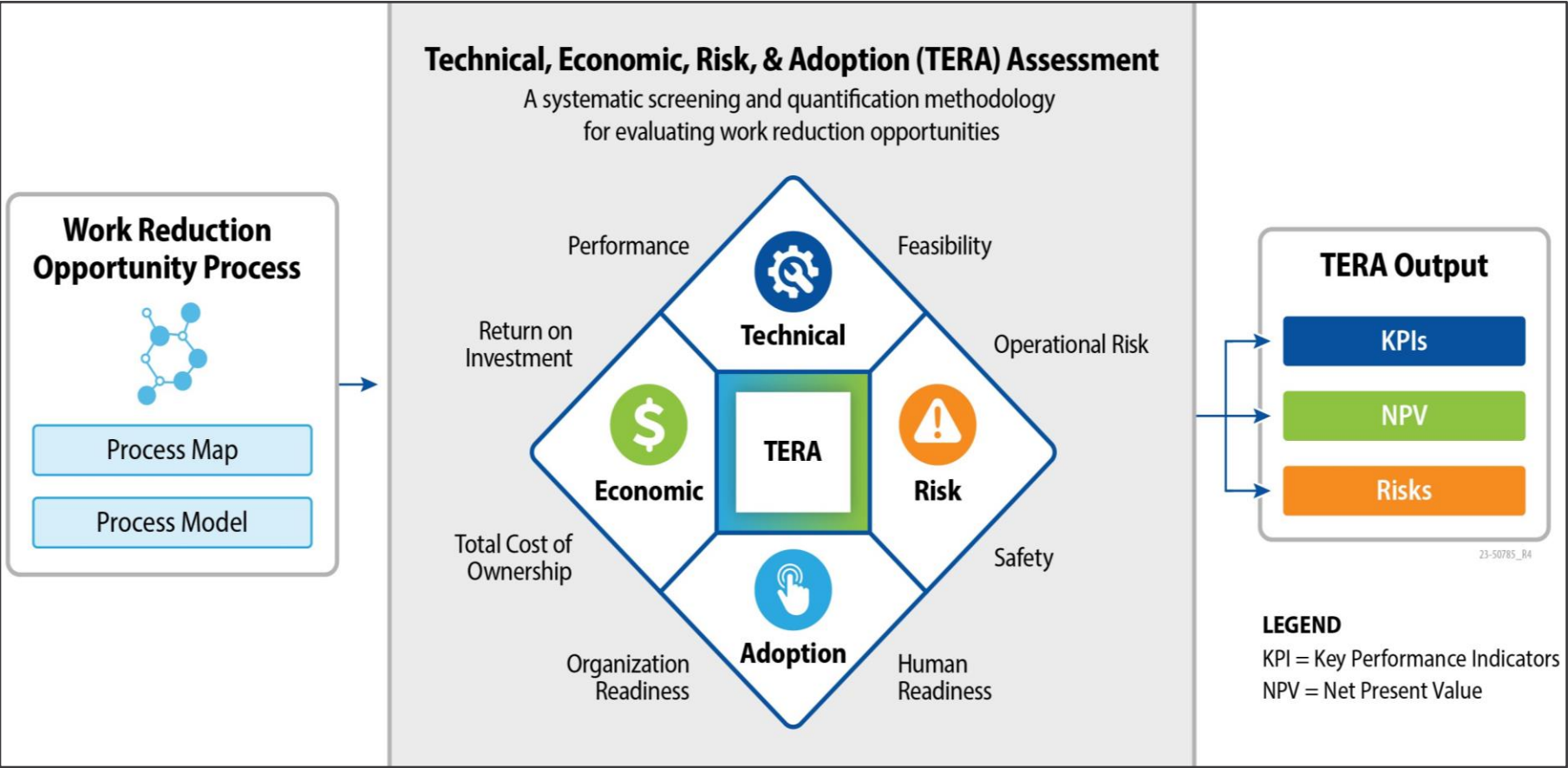


Work-reduction opportunity assessment (macroscale).

Strategic Approach to Innovation

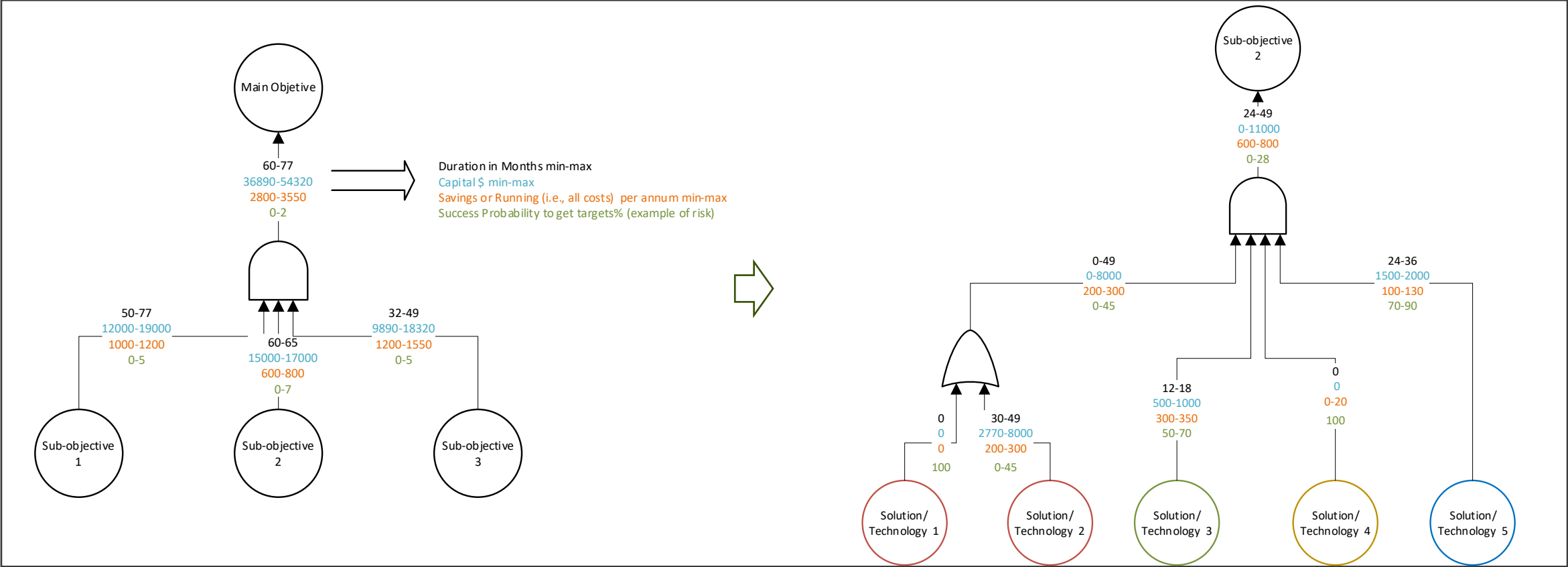
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Work-reduction
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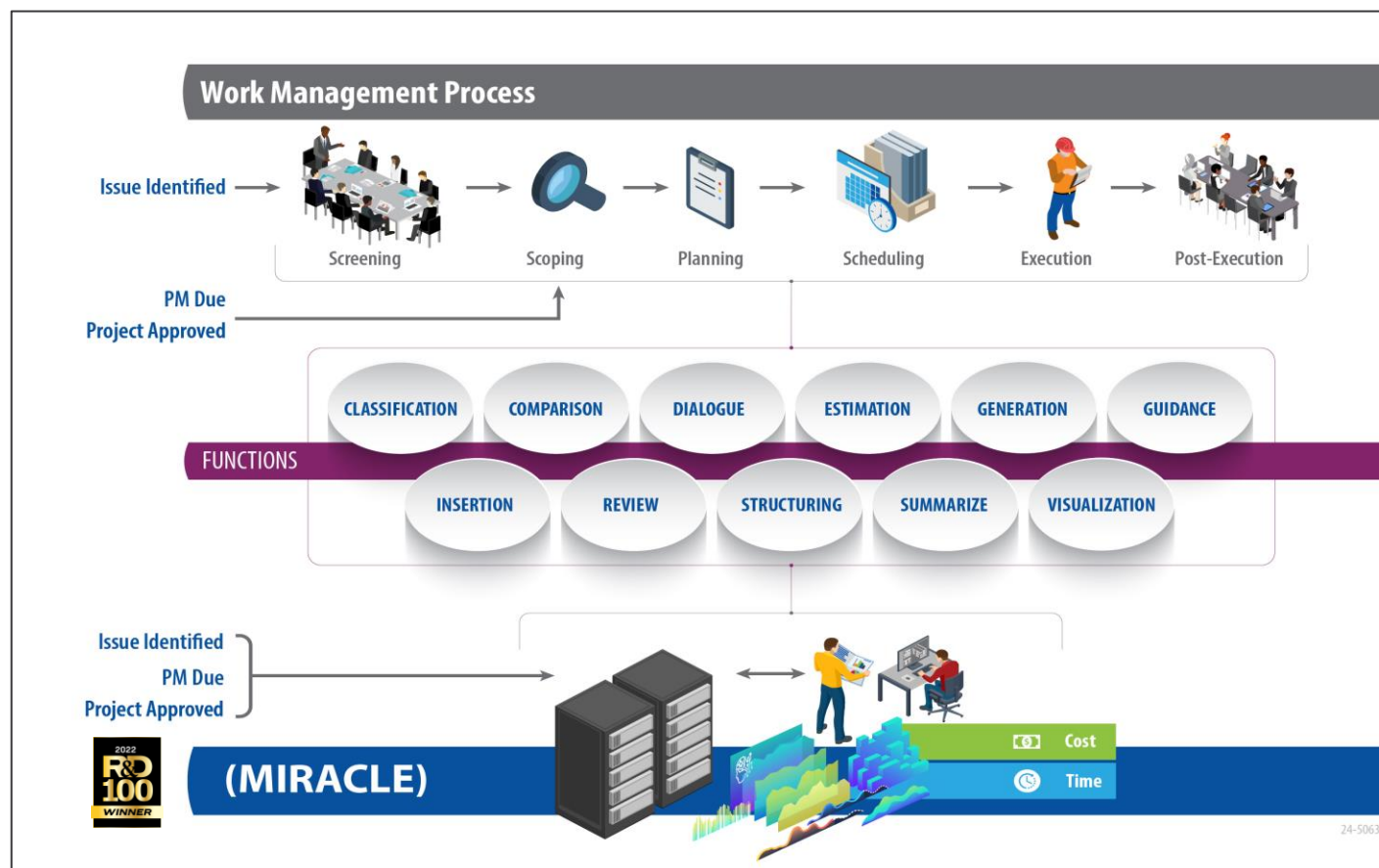


Strategic and systematic planning.

Operational Efficiency Enhancement

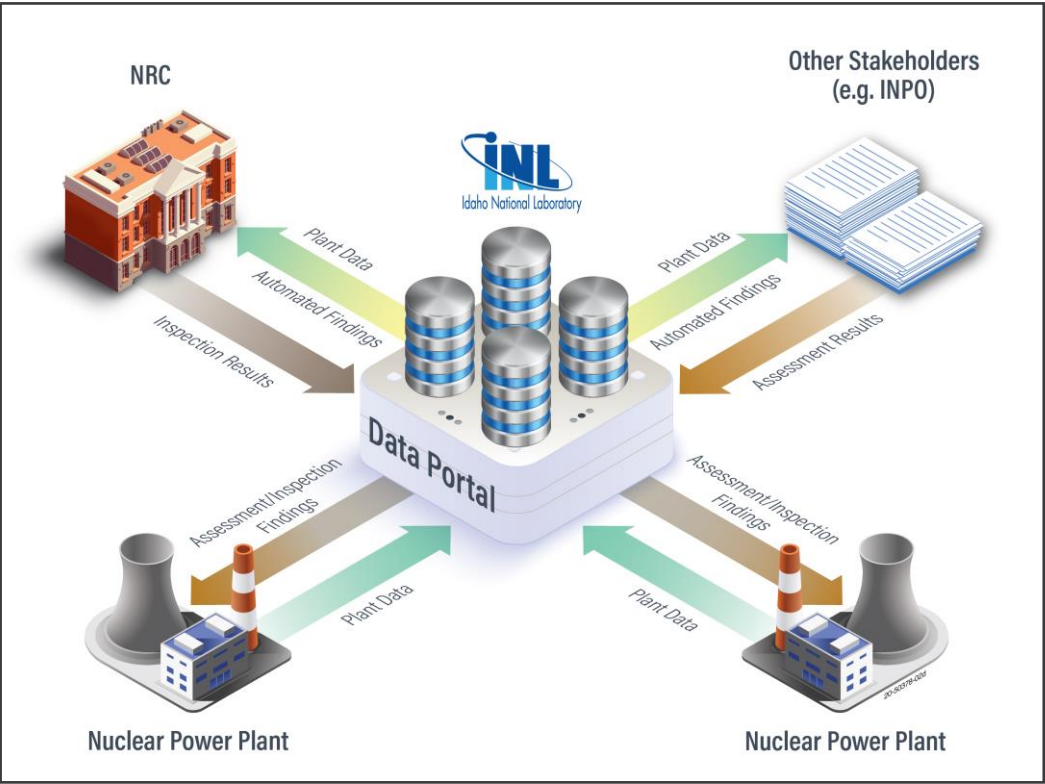
Challenge: The analysis of documents for various programs and processes in the plant relies on human and manual efforts and these efforts represent most of the plant staff's activities

Work management automation.

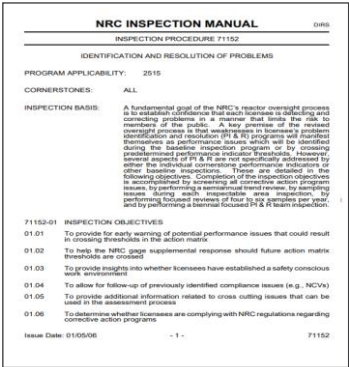


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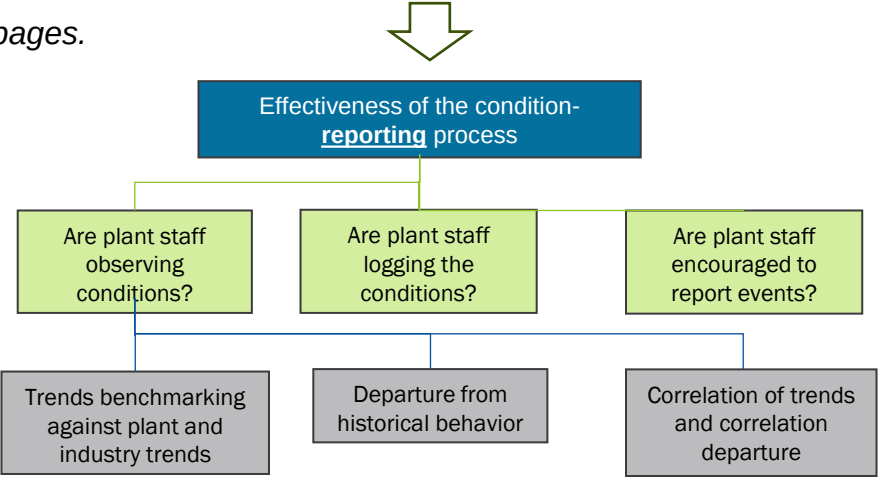


Inspections.



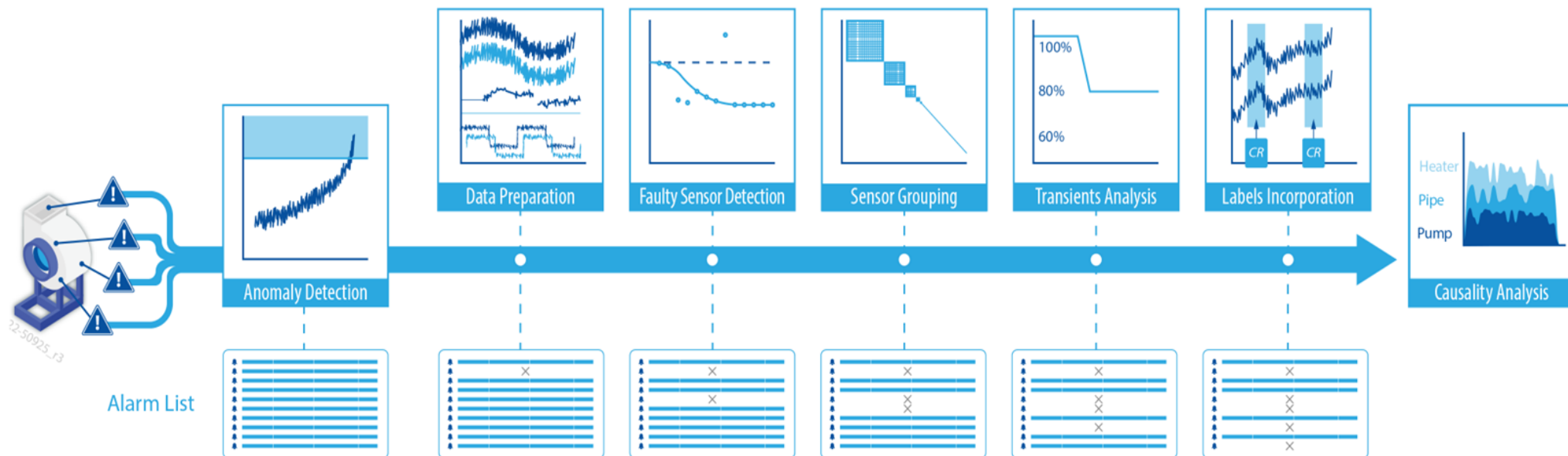
15 pages.

- Effectiveness of the condition-reporting process
- Effectiveness of the reports-screening process
- Effectiveness of the issues-tracking process
- Effectiveness of the issues-resolution process



Advanced Remote Monitoring

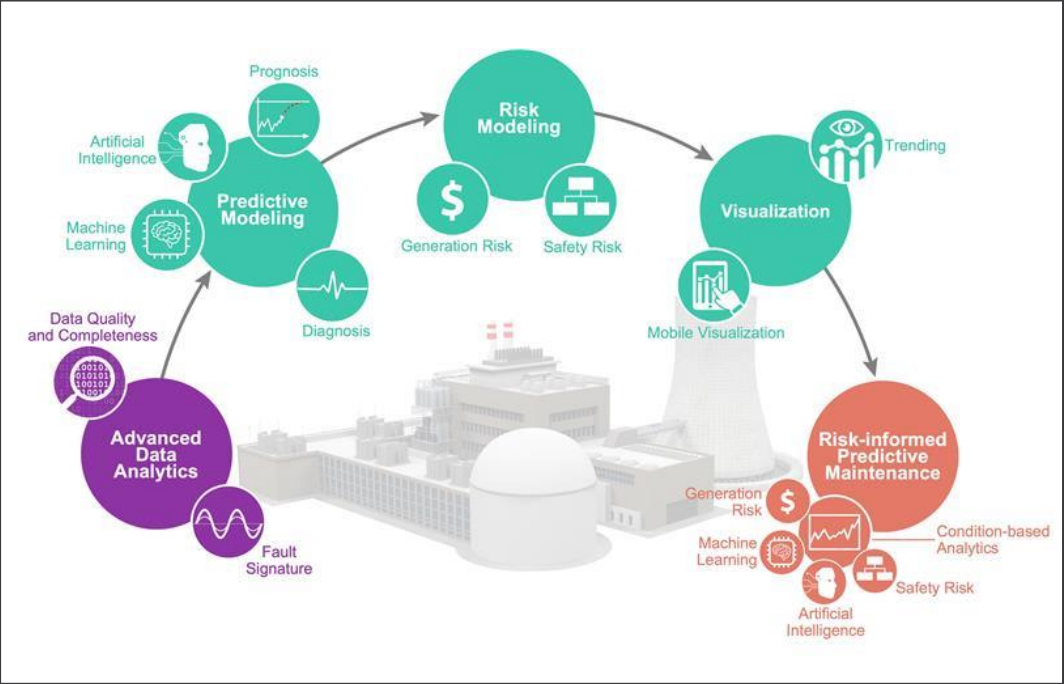
Challenge: Condition monitoring of plant equipment primarily relies on legacy tools and manual trending, which cannot accurately diagnose and predict equipment conditions. This process is also time-consuming, dependent on manual efforts, and prone to human error.



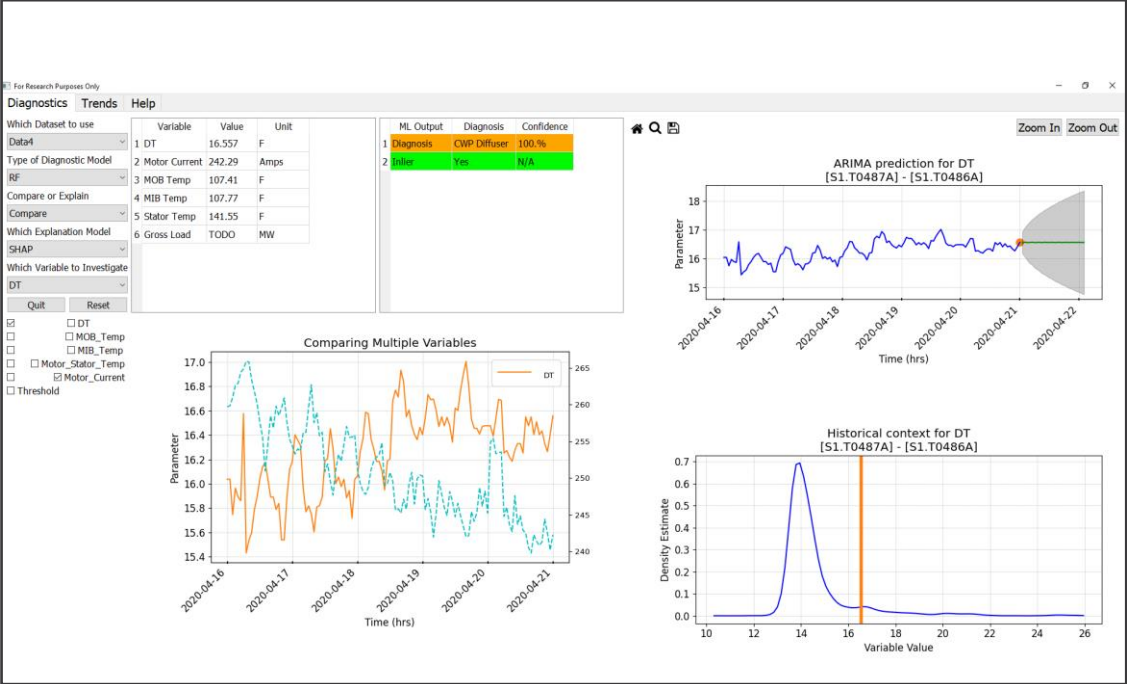
Monitoring and diagnosis.

Advanced Remote Monitoring

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Risk-Informed predictive maintenance.



Explainable prognostics.

Advanced Remote Monitoring

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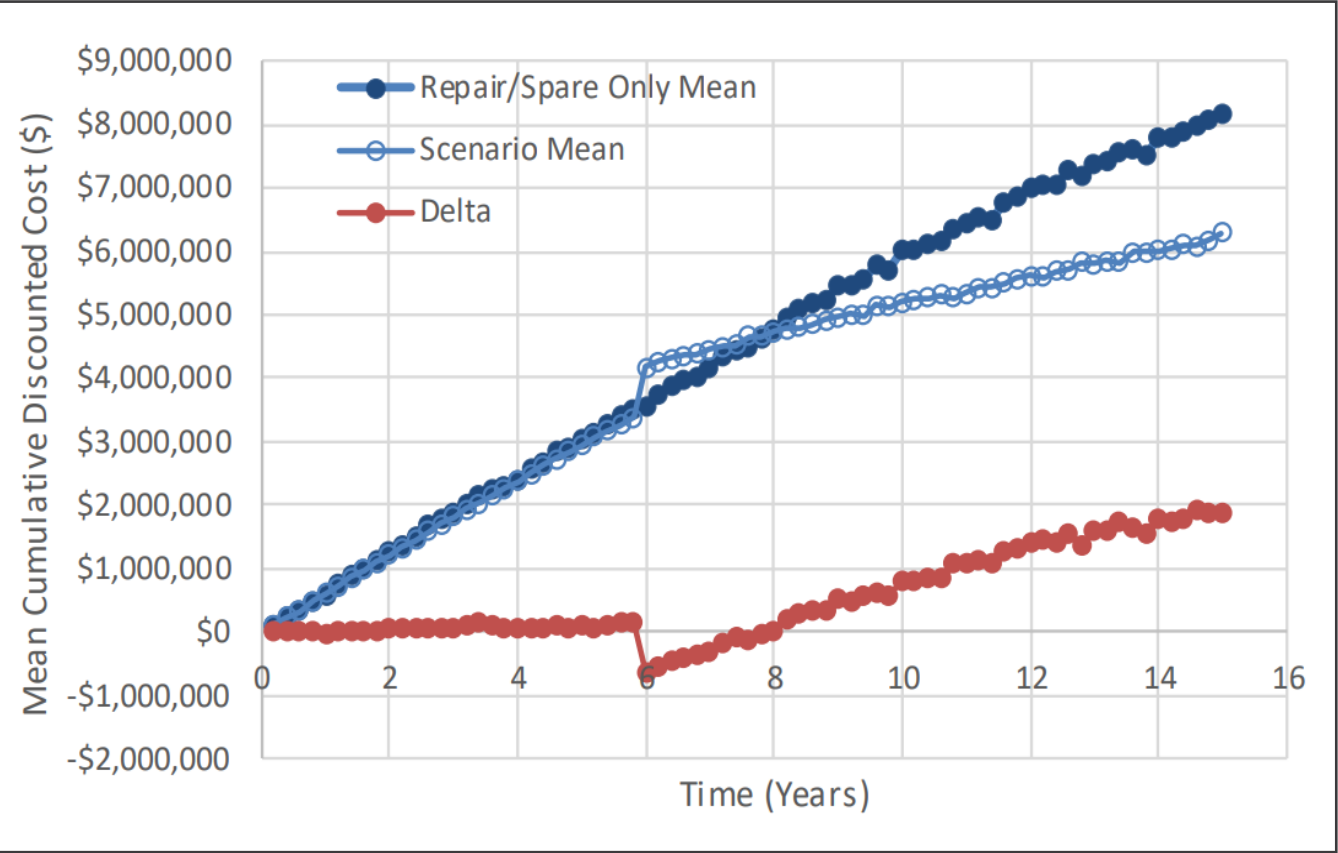
Maintenance inspections.



Instrumentation and Control Infrastructure Modernization

Challenge: The current instrumentation and control (I&C) infrastructure is based on outdated analog technologies. It does not support modernization plans or innovative technologies. Utilities are hesitant to upgrade their existing I&C or data infrastructure.

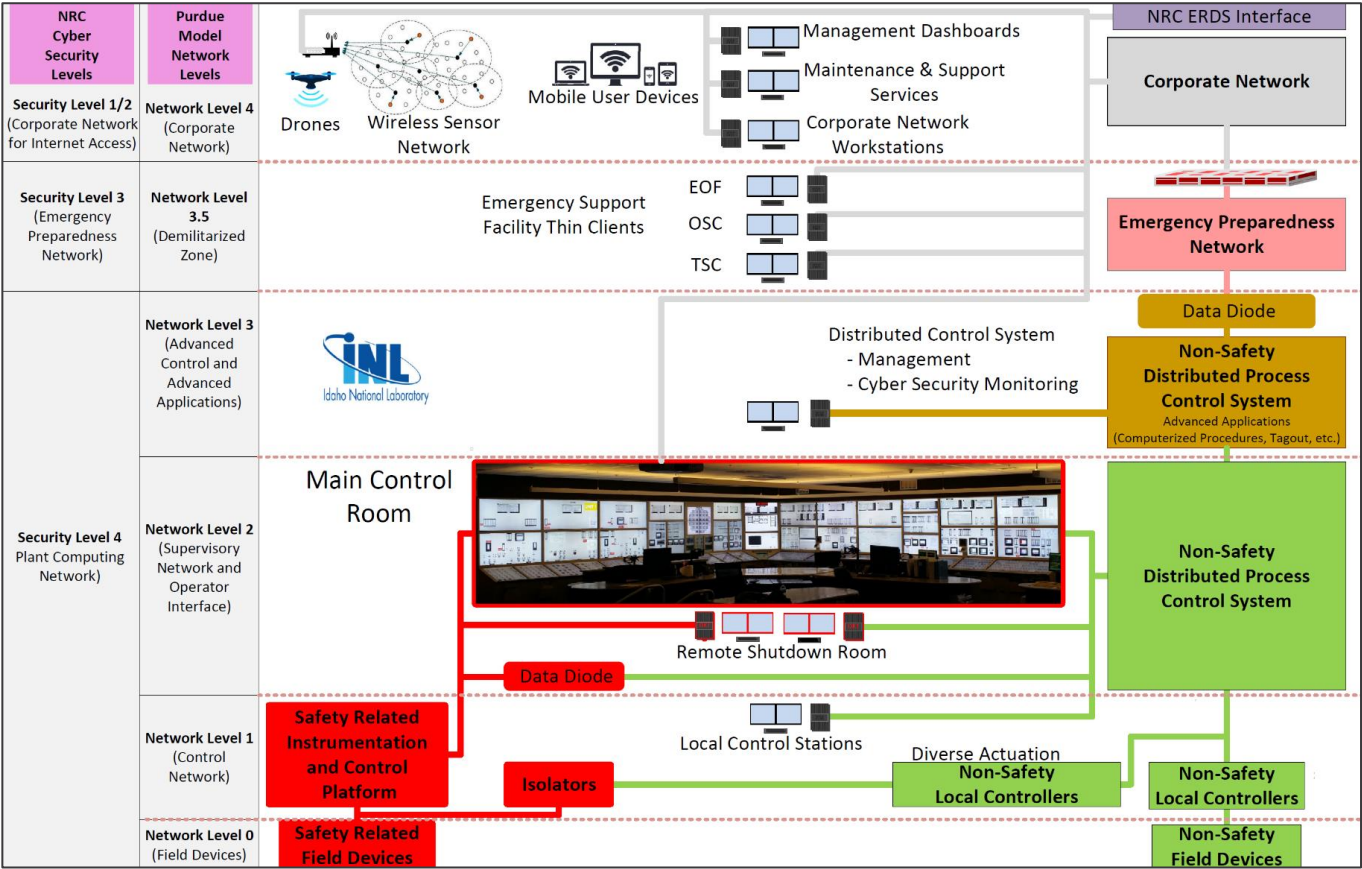
Obsolescence analysis.



Instrumentation and Control Infrastructure Modernization

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Infrastructure modernization.



Human-System Integration

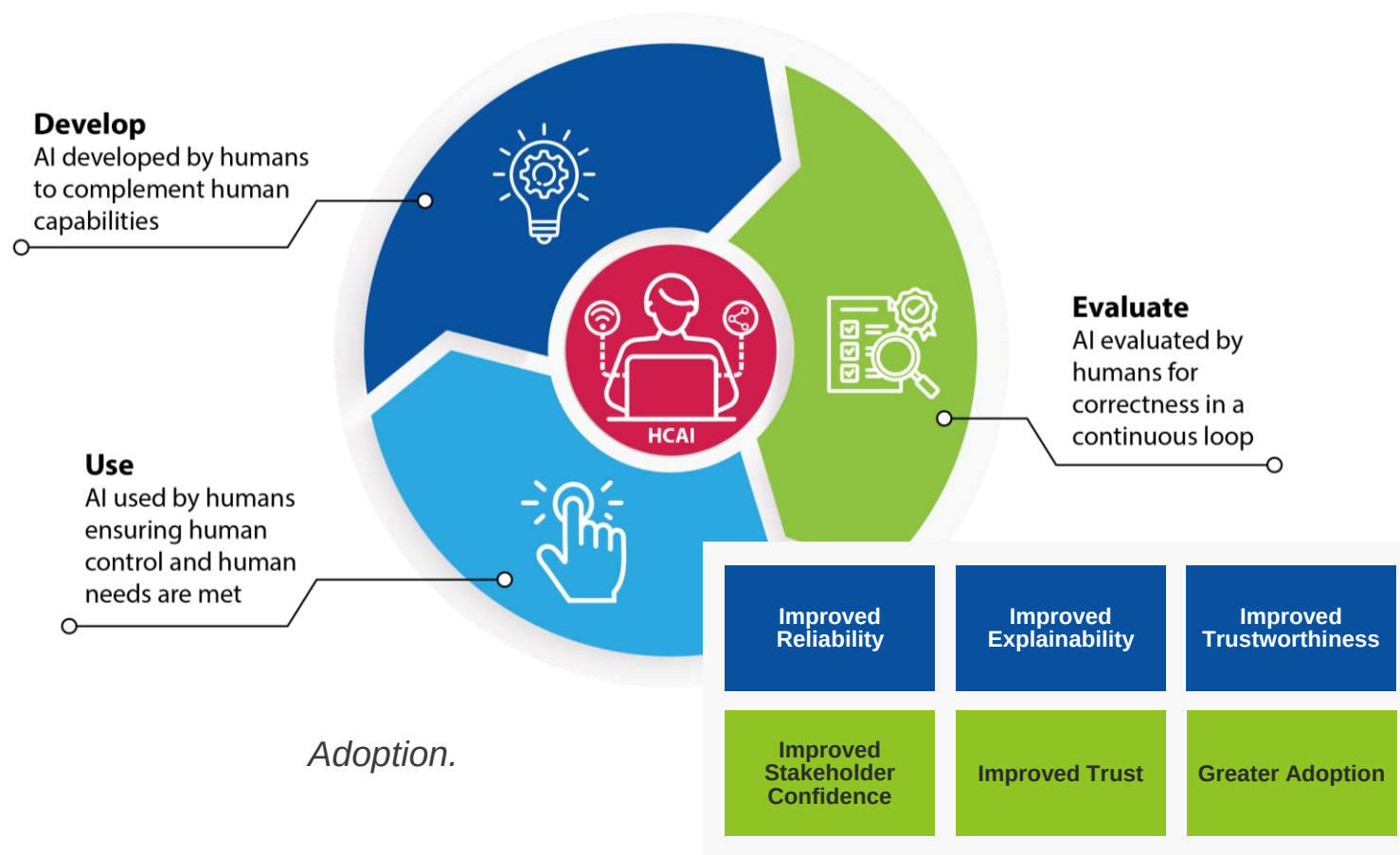
Challenge: Modernization efforts often result in successful pilots that do not necessarily scale up to full implementation in the plant, primarily due to human factors.

	N	Frequency	Total	Duration	Digital	Workload	Reliability	Effective
Plant Database Management	4	6.00		2.75	4.50	2.75	2.75	2.50
Security Rounds	3	6.00		4.67	2.33	3.33	3.00	2.67
Operator Rounds, Log Keeping	2	6.00		3.50	4.50	3.50	2.50	2.50
Security Equipment and Zone	2	6.00		5.00	4.00	3.00	3.00	2.50
Dose Recording and Reporting	1	6.00		3.00	5.00	1.00	2.00	1.00
Testing Process	1	6.00		4.00	5.00	2.00	1.00	2.00
Plant and Department Meetings	21	5.95		3.62	3.67	2.86	2.75	2.52
Action Items Tracking	134	5.37		2.47	4.42	3.04	2.86	2.62
Lesson Plan Creation	6	5.33		4.33	4.00	3.00	2.83	3.00
Plant Radiological Surveys	3	5.33		3.33	4.00	3.33	3.00	3.00
Sampling and Monitoring	3	5.33		4.00	3.67	3.00	3.00	2.67
Plant Access Processing	4	5.25		3.50	3.50	3.25	3.00	3.00
Regulatory Interface/Commitment	4	5.25		2.50	4.00	3.00	2.75	2.50
CAP Program Administration	16	5.19		2.75	4.63	3.13	3.00	2.69
Job Briefings	13	5.08		2.31	2.54	3.31	2.92	2.69
Rad Shipping	4	5.00		4.00	4.25	3.25	3.00	3.00
Simulation	4	5.00		4.00	3.75	2.33	2.33	2.67
Employee Observation and Coach	46	4.78		2.67	4.28	3.09	2.82	2.36
Plant Drawings and References	21	4.76		2.76	4.14	2.95	2.75	2.60
Work Schedule Use and Update	47	4.55		2.92	4.40	3.04	2.83	2.60
Remote Monitoring and Sampling	4	4.50		3.50	2.75	3.00	2.50	2.50
Investigation and Evaluation	2	4.50		3.50	4.50	2.00	2.50	2.50

Assessment.

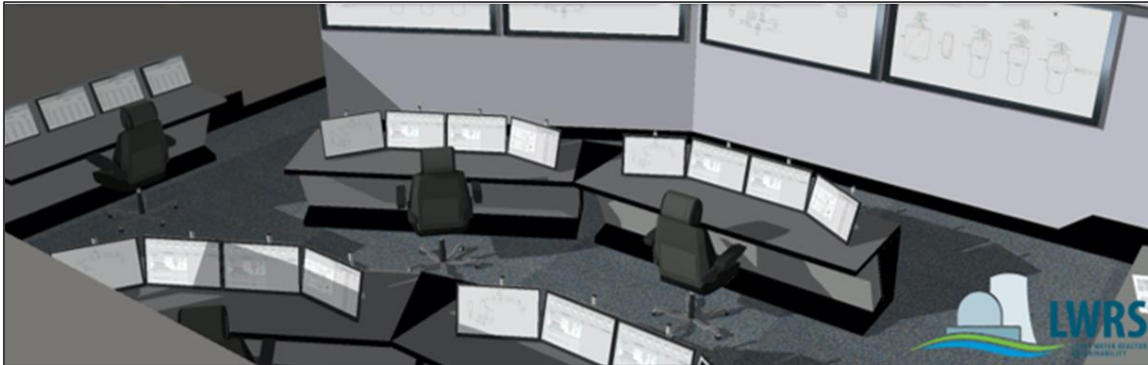
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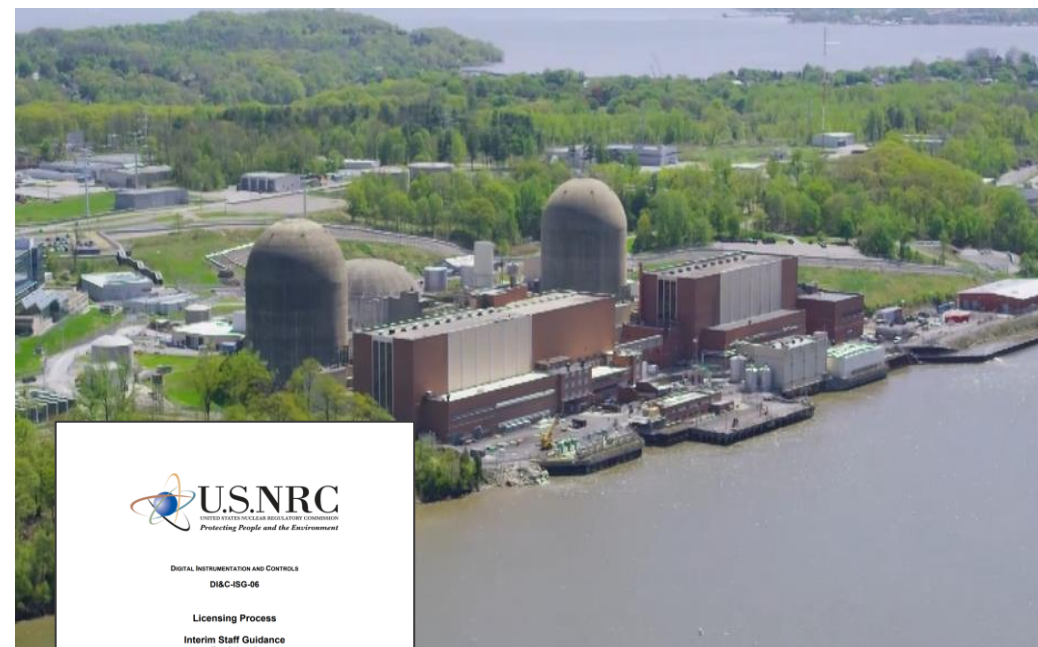


Optimization.



Recent Efforts Example: Streamline the Licensing Process

- Accelerate modernization by streamlining the revision process for plant license documents and technical specifications, and by assisting in the preparation of license amendment requests (LARs).
- This research aims to:
 - Develop a dedicated large language model (LLM) capable of understanding technical specifications and LARs.
 - Enable the model to check LARs for completion, review plant LARs, and eventually generate LARs.
 - Expand model use to license renewal.



DIGITAL INSTRUMENTATION AND CONTROLS
DI&C-ISG-06

Licensing Process
Interim Staff Guidance
Revision 2
December 2018

The AI Research Portfolio



AI to Screen
Plant
Conditions



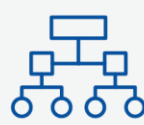
AI to Automate
the Work
Process



AI to Augment
Inspections



AI to Improve
Plant
Performance



AI to Inform Risk
from Plant Logs



AI to Optimize
Outage
Planning



AI for Plant
Licensing



AI for
Knowledge
Management



AI in Nuclear
Standards



AI Adoption
Barriers



AI to Read
Analog
Gauges



AI to Detect
Fire and
Smoke



AI for Image
Change
Detection



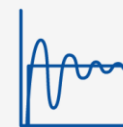
AI for Robotics
Maintenance



AI to Enable
Autonomous
Navigation
of Drones



AI for Anomaly
Detection



AI for
Autonomous
Control



AI for Predictive
Maintenance



AI for Cable
Diagnosis



AI for Acoustics
Change
Detection

Collaborations with Stakeholders





Sustaining National Nuclear Assets

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