Introba

TECHNOLOGY

SMART Facility Transformation: Driving Efficiency, Safety, and Sustainability

October 24, 2025

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Learning Objectives

Smart Building Facility Operations - Transformation

Shift from Reactive to Proactive Lab Management – Recognize the benefits of proactive lab management and how advanced SMART technologies mitigate risks, improve safety, and minimize unplanned disruptions.

Explore AI and ML Applications in Lab Operations – Understand how Artificial Intelligence (AI) and Machine Learning (ML) can transform traditional research labs into high-performing, proactive environments.

Identify Key Impacts of AI and ML – Learn how AI and ML enhance decision-making, sustainability, predictive maintenance, operational efficiency, resource optimization, safety and compliance, and knowledge retention.

Implement SMART Transformation Strategies – Discover how to develop strategic roadmaps, foster an asset management culture, and integrate a robust technology framework to align with industry standards and drive long-term efficiency.

SMART Facility Transformation: Driving Efficiency, Safety, and Sustainability

Executive Summary

Today's labs face rising costs, staffing shortages, and operational risks. This session explores how SMART facility strategies—powered by AI, Machine Learning, IoT, and Digital Twin technologies—shift operations from reactive to proactive.

You'll see real-world examples of how these tools improve energy use, system reliability, safety, and compliance. The session also outlines a step-by-step roadmap for implementing SMART transformation, aligning people, process, and technology to drive long-term performance and resilience.

AI, ML, and SMART building technologies

Definitions

Artificial Intelligence is the use of computer systems to perform tasks that normally require human intelligence — such as reasoning, learning, decision-making, and problem-solving — by processing large volumes of data and identifying patterns or insights.

Machine Learning is a subset of AI that enables systems to learn from data, improve performance over time, and make predictions or classifications without being explicitly programmed for each task.

Smart Building Facility technology integrates building systems (HVAC, lighting, ventilation, security, energy management) with IoT sensors, automation, and analytics to create an adaptive, efficient, and safe environment for laboratory operations.

The Internet of Things (IoT) refers to a network of physical objects embedded with sensors, software, and connectivity that enables them to collect and exchange data with other devices and systems over the internet.

Smart Facility Transformation – The Why?

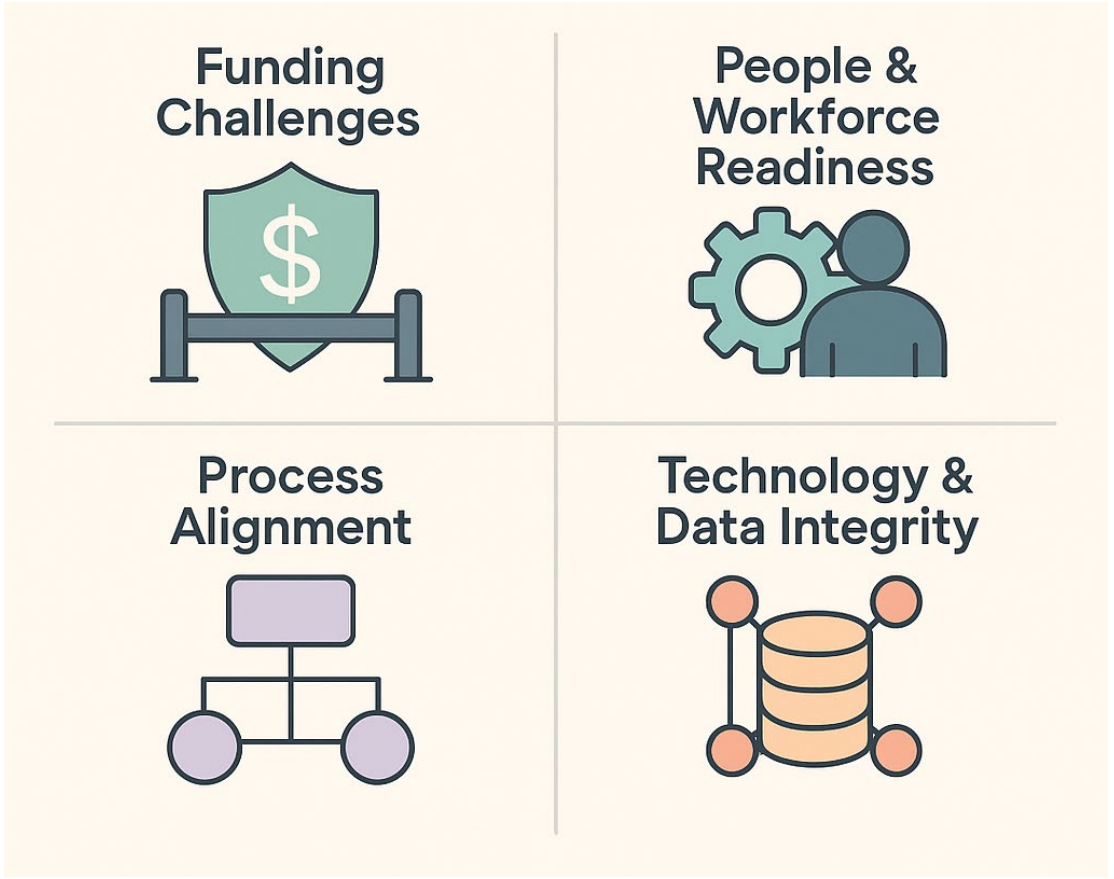
The Why - Adopting Digital Twin, AI, ML and advanced technology is increasingly critical for labs to remain operationally efficient, financially sustainable, and competitive.

Funding Challenges – Challenges due to rising operational costs, financial models, and increasing customer demands, making cost reduction and improved capital planning essential.

People & Workforce Readiness – Facilities operations face a growing skilled labor shortage, with demand exceeding workforce availability while critical knowledge is lost as experienced staff leave.

Process Alignment – Facilities management processes rely heavily on inefficient manual interactions, increasing the risk of human error and operational inefficiencies.

Technology & Data Integrity – Without data-driven, consistent decision-making, facilities suffer from inefficiencies, increased costs, compliance risks, and unpredictable outcomes.



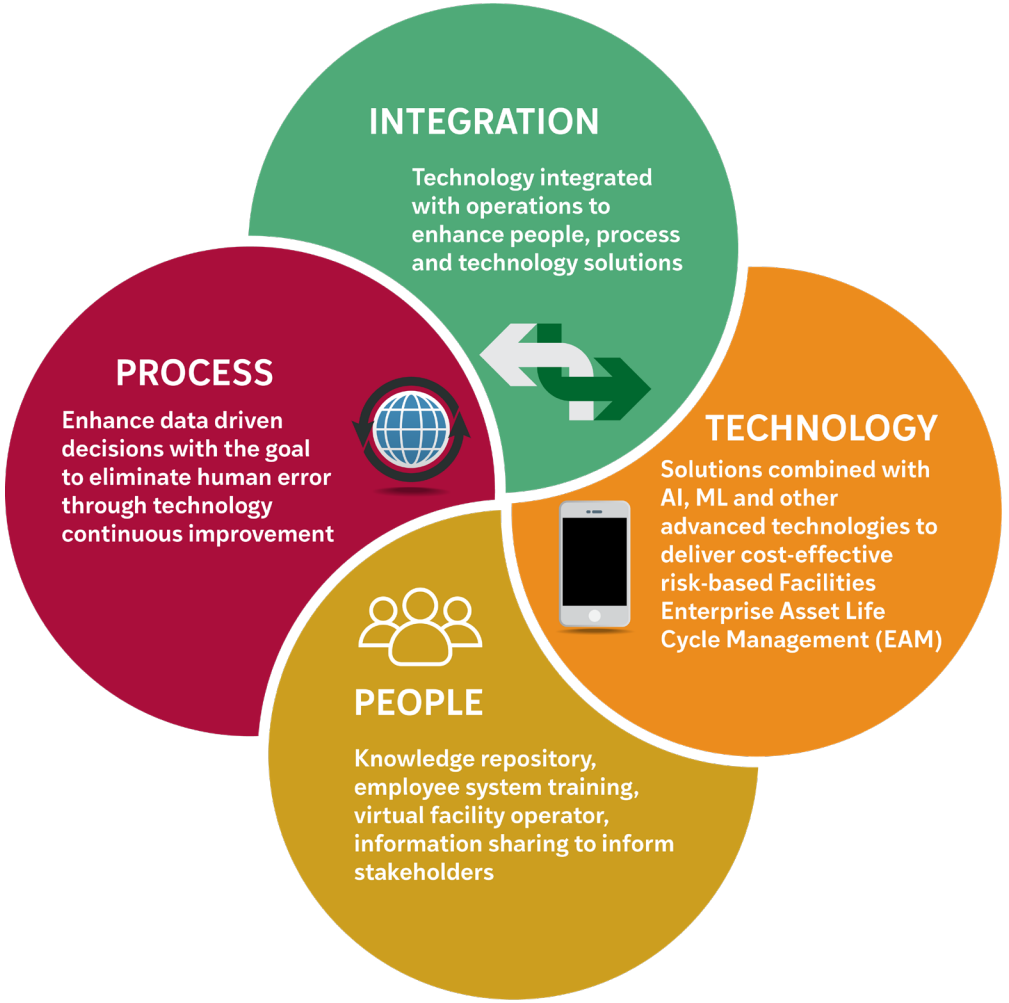
Key Impacts of AI and ML

Benefits of Digital Twin, ML, AI-driven solutions, and advanced technologies to maximize desired outcomes and overall impact aligned with funding plan.

People & Workforce Readiness – AI-driven automation enhances knowledge retention, staff guidance, efficiency, customer experience, and data-driven decision-making while strengthening cross-functional collaboration.

Process Alignment – AI reduces manual optimizes predictive maintenance, regulatory compliance, space utilization, and emergency response for streamlined lab operations.

Technology & Data Integrity – AI-powered analytics, IoT integration, digital twin simulations, and advanced security systems drive intelligent facility management.



Shift from Reactive to Proactive Lab Management - Transformation

Use Cases & Associated Key Performance Indicators (KPIs) – Top 5 Suggestions

- ✓ Special Environment Monitoring (Time out of range)
- ✓ Business Continuity (Uptime & downtime)
- ✓ Safety & Regulatory Compliance (Prevent incidents)

- ✓ Continuous Commissioning (Usage & cost)
- ✓ Mass Balance (Loss & waste)
- ✓ Peak Load Management (Utility cost & Revenue)

- ✓ AI-Driven System Efficiency (Cost avoidance)
- ✓ AI Virtual Operations (FTE reduction)
- ✓ Knowledge Retention & Training (Track accuracy & skillsets)

- ✓ Advanced Fault Detection Monitoring (Accuracy)
- ✓ Predictive & Preventive Maintenance (On-time & downtime)
- ✓ Corrective Actions & Continuous Improvement (Reoccurrence)

- ✓ Infrastructure Failure Planning (Contingency accuracy)
- ✓ Table-top Scenario Training (Readiness)
- ✓ Emergency Management Support Services (Response time)

Explore AI and ML Applications in Lab Operations

Traditional Methods – Building Facility Operations & Maintenance

Slow Process – People Intensive Portfolio-wide Assessment

Identify Priority Buildings For Some Insights

Poor Capital Planning & Cost Estimates, Minimal Energy Modeling

Innovation (AI & ML Based) – Building Facility Operations & Maintenance

Rapid, Low-Cost Portfolio-wide Assessment

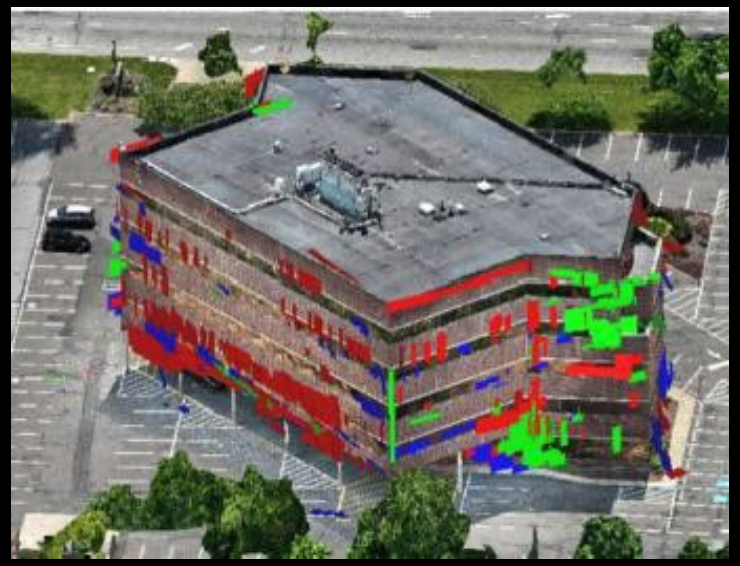
Identify Priority Buildings for Deeper Insights

Smart Capital Planning, Cost Estimates, Energy Modeling & ROI Analysis

Explore AI and ML Applications in Lab Operations

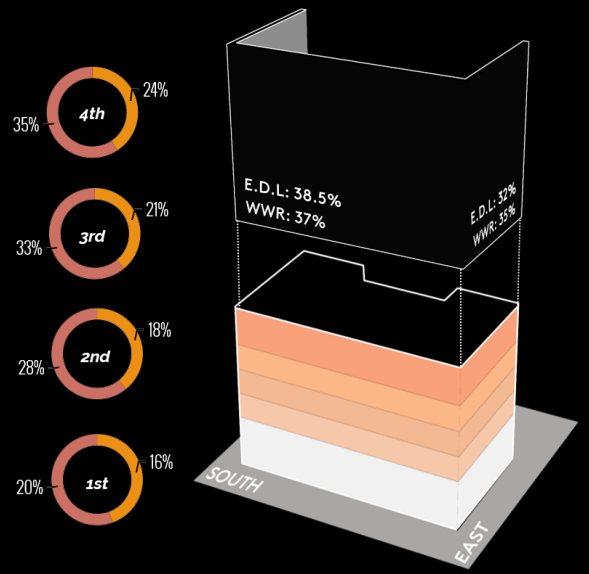
Innovation (AI & ML Based Example) – Building Facility Operations & Maintenance

DETECT (Safety & Regulatory Compliance)



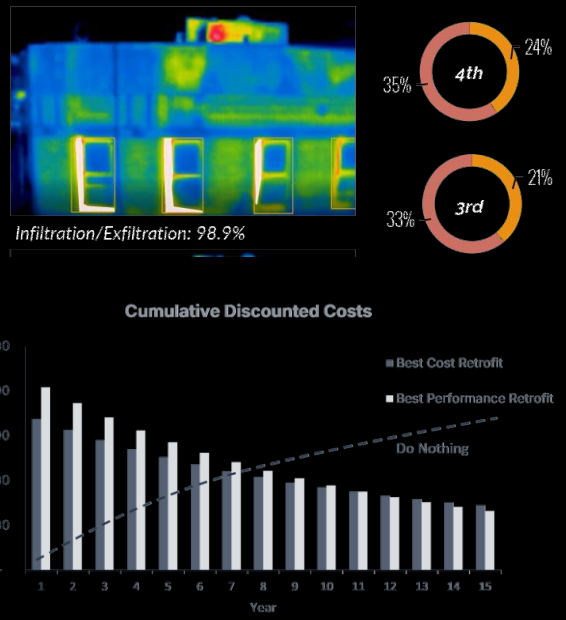
- Thermal Defects
- 3D Model w/ Defects
- Water Intrusion
- General Retrofit Suggestions
- Visual Defects

DIAGNOSE (Solutions)



- Thermal Defects
- 3D Model w/ Defects
- Water Intrusion
- Retrofit Work Plans & Costs
- Visual Defects

AUDIT (Energy)



- Thermal Defects
- 3D Model w/ Defects
- Water Intrusion
- Retrofit Work Plans & Costs
- Visual Defects
- Energy Modeling
- Infiltration & Exfiltration
- $ ROI Projections

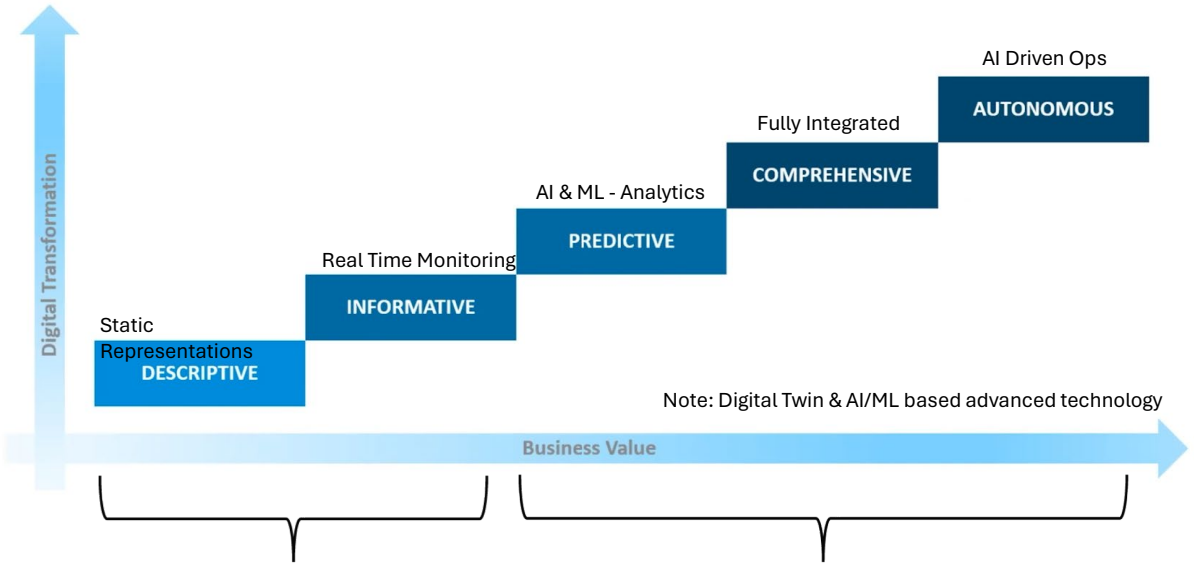
PATENTED NOVEL AI

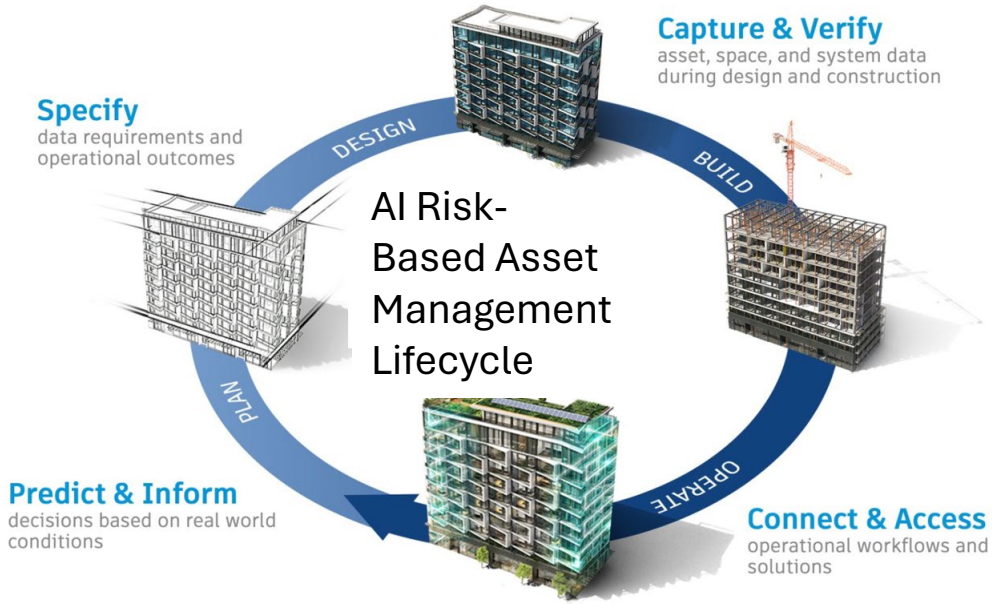
Developed through 10+ years and $3M of DOE and Other Grants

Credit Lamarr.AI

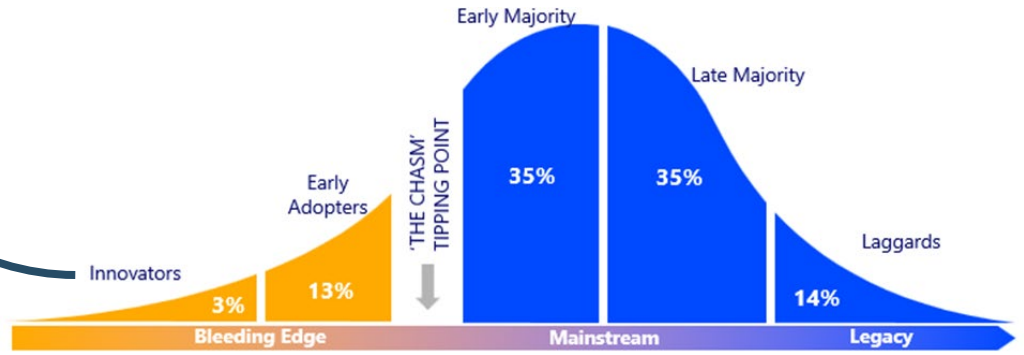
Sustainability & Safety – Key Drivers for Transformation

Identify Key Impacts of AI and ML (Example – Chiller Plant Performance: AI Virtual Operators)





Innovators

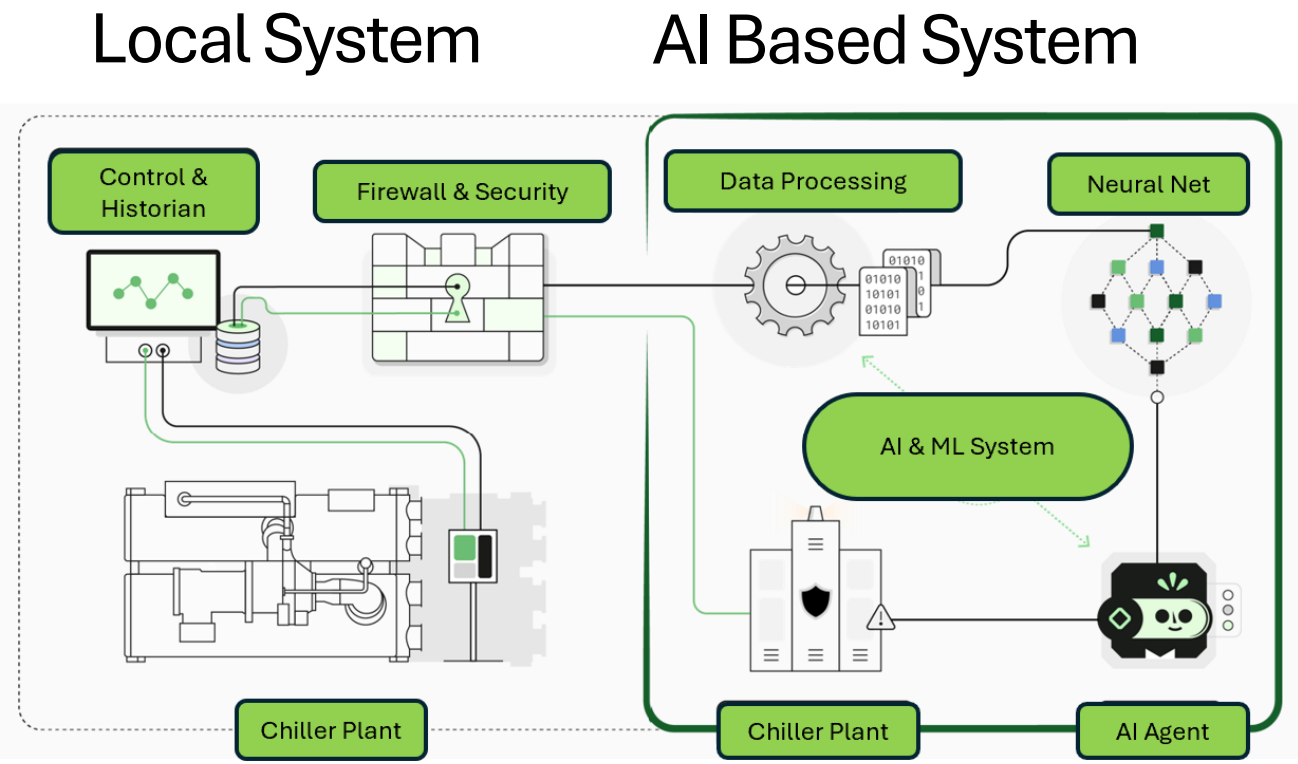


Innovation - Law of Diffusion of Innovation

Credit: AutoDesk

Sustainability & Safety – Key Drivers for Transformation

Identify Key Impacts of AI and ML (Example – Chiller Plant Performance: AI Virtual Operators)



The system uses deep reinforcement learning to autonomously control and optimize mission-critical cooling infrastructure.

Virtual Plant Operators (AI agents) layer onto existing controls to maintain thermal stability and reduce energy use by dynamically adjusting operating parameters and setpoints.

It ingests live data from the facility's BMS, evaluates billions of setpoint combinations, and selects optimal settings based on current and predicted environmental conditions.

Unlike static systems, the AI continuously learns, digitizing operator knowledge to ensure consistent performance while uncovering new strategies to boost reliability.

Over time, these efficiencies can extend equipment life and lower operating and maintenance costs.

Results

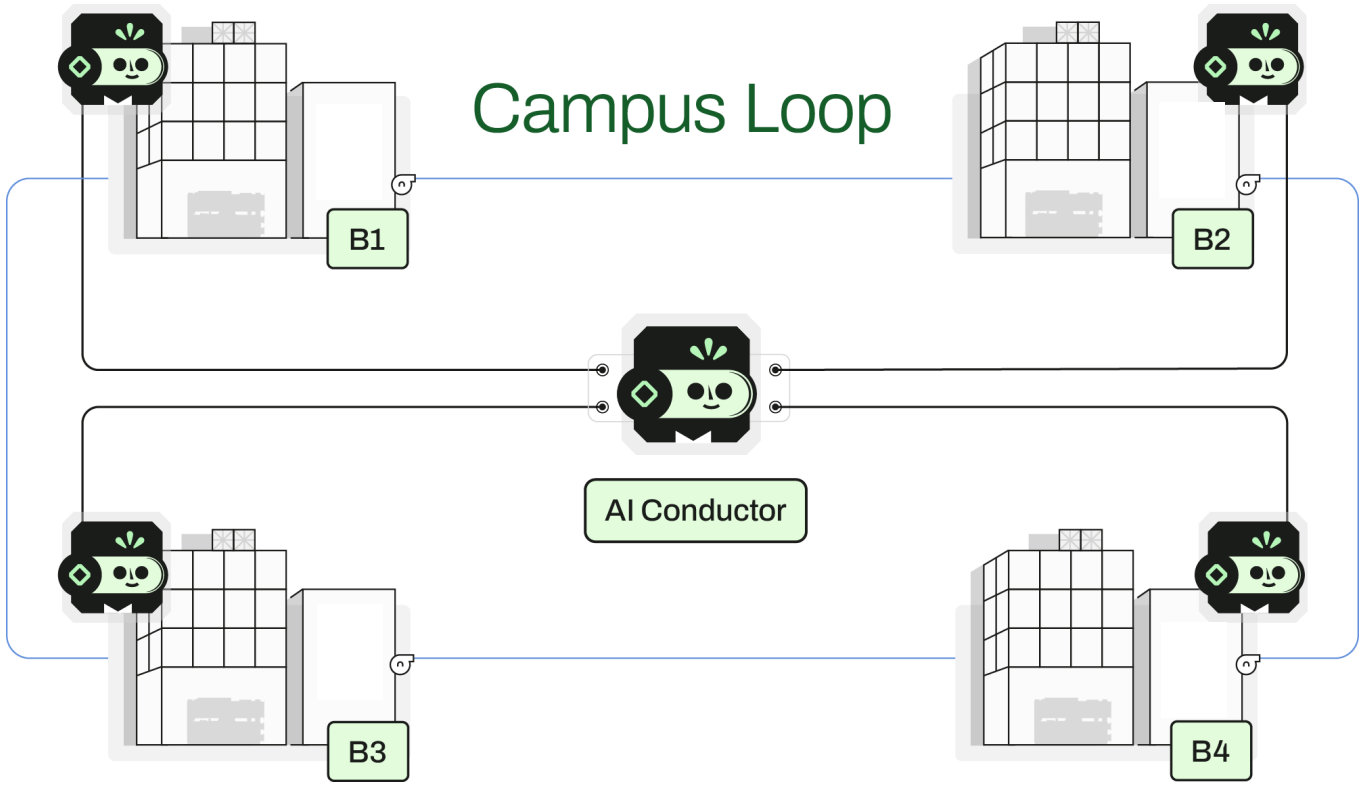
0
Service Interruptions caused by AI Control

7.7%
Improved Energy Efficiency

37.8%
Excess Capacity Reduced

Sustainability & Safety – Key Drivers for Transformation

Identify Key Impacts of AI and ML (Example – Chiller Plant Performance: AI Virtual Operators)



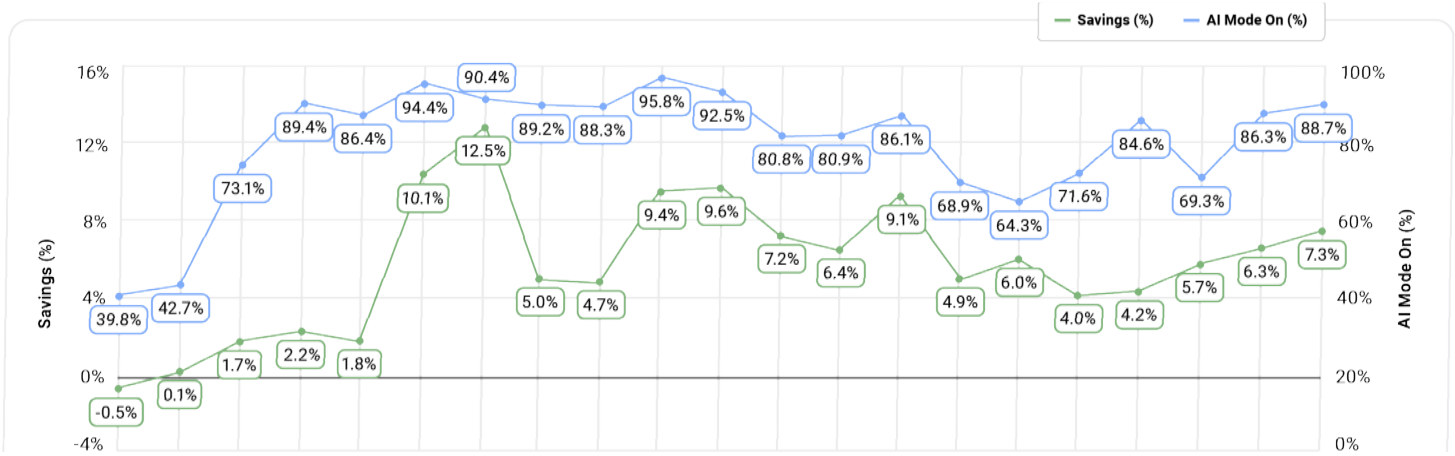
While plant-level AI agents optimize individual systems, the team introduced a fifth agent—the "AI Conductor"—to manage the campus loop connecting all plants.

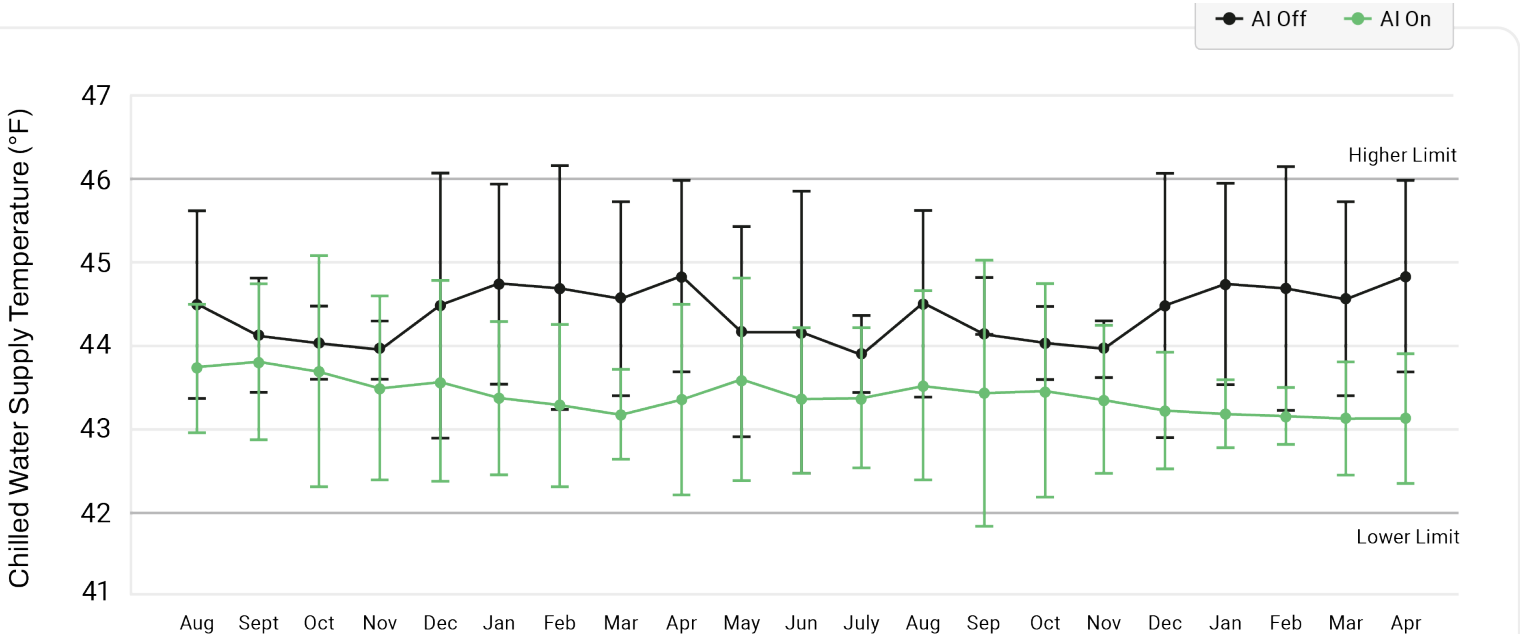
This agent coordinates chilled water production and load balancing across the network to enhance campus-wide efficiency.

Each plant agent still controls its local operations but now receives system-wide insights to operate as part of a unified whole. Since going live, the AI Conductor has further improved energy efficiency across mission-critical cooling systems

Sustainability & Safety – Key Drivers for Transformation

Identify Key Impacts of AI and ML (Example – Chiller Plant Performance: AI Virtual Operators)





Sustainability & Safety – Key Drivers for Transformation

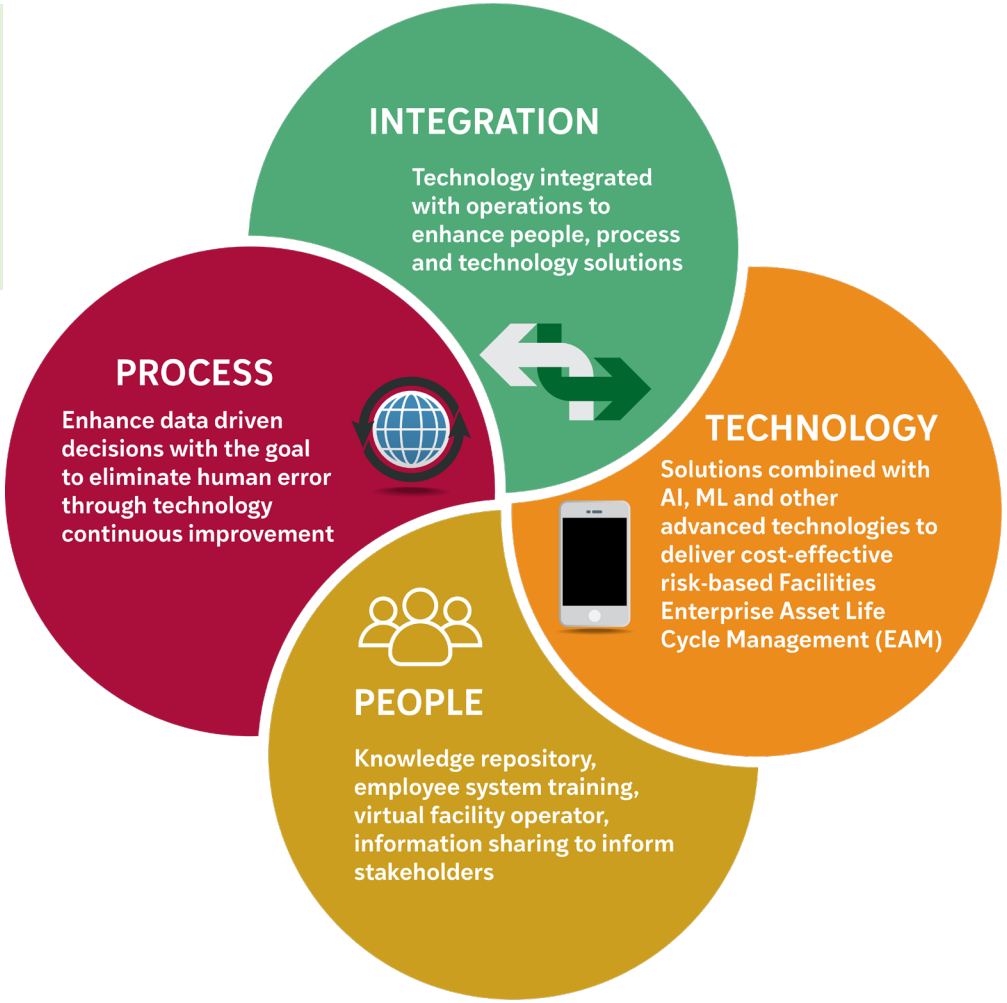
Identify Key Impacts of AI and ML (Example – Chiller Plant Performance: AI Virtual Operators)

"Early on, gaining operator buy-in was imperative as it supported more AI runtime, especially on nights and weekends when operators needed to respond more independently. As the AI continued to learn and improve, operators went from somewhat skeptical participants to active supporters."

"We have seen improvements in energy efficiency and plant stability without a single operational interruption since implementing, and Phaidra has earned the trust of our operations team. Our plant operators like having the AI Agents supporting them, especially after-hours.

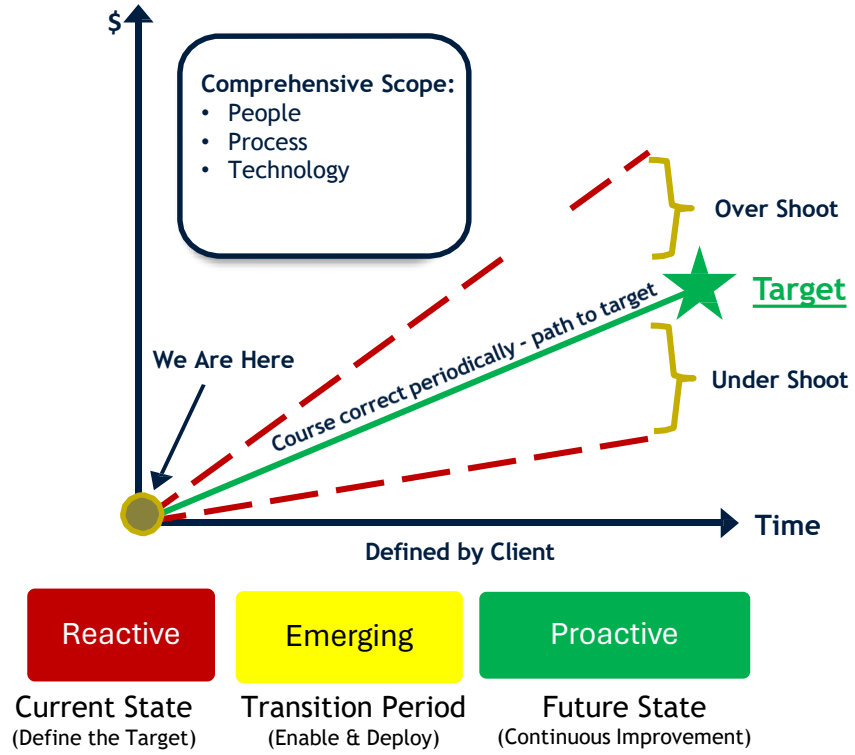
Most notably, the capability to optimize the load amongst chiller plants has been encouraging and we have only just begun to realize the full potential."

Credit: Phaidra



Implement SMART Transformation Strategies – How to Start

Approach – Leverage a proven solution to define the target, vision, and project plan for Digital Transformation, including Digital Twin, AI, ML and other advanced innovative technologies.



Over Shoot

- Excess capacity/infrastructure
- Misaligned systems
- Too much increase for staffing/ overhead/ space
- Opportunity cost vs other critical needs
- Unneeded operational & capital expense increases

On Target

- Adhering to mission-vision masterplan & facilities Management strategy
- Data driven solutions - optimized capability
- Right amount of integration, automation & people
- Develop remote/ monitoring/ control capability
- Right sized technology solutions - expense & capital
- Realize benefits

Under Shoot

- Inadequate capacity/infrastructure
- Misaligned systems
- Incorrect staffing/ overhead/ space
- Cost vs other critical needs
- Not enough operational & capital expense funding

Implement SMART Transformation Strategies – How to Start

Create a strategic roadmap by assessing the current state, identifying gaps, and defining key areas for improvement

Current State

People
Review current assessments, benchmarking and succession plans

Process
Review process outcomes such as surveys, deficiencies and corrective action plans.

Technology
Consolidate existing technology obsolescence, migration & integration plans

Transition Period

People
Facilitate focused discussion for gaps to better understand issues & priorities.

Process
Consolidate cross functional alignment for desired process improvements

Technology
Define the “art of the possible” to brainstorm integrated solutions

Desired State

People
Succession Transformation Plan

Process
SMART process improvement plan

Technology
Technology Integration and Digital Transformation Plan

Implement SMART Transformation Strategies – How to Start

Creation of a project team and project plan

1. Establish cross functional Facilities Operations governance structure (Leadership Committee, Steering Committee and Focus Group)
2. Hire consultant based on qualifications and capabilities of innovation service suppliers (Innovators and Early Adopters - Refer to Innovation - Law of Diffusion of Innovation)
3. Assess people, process and technology to define the future state, validate digital transformation use cases and identify viable systems via a risk-based assessment
4. Define user requirements, enabling projects and project plan milestones via strategy roadmap session with key stakeholders and aligned with the masterplan & budget.
5. Implement digital transformation enabling projects and phased approach for digital transformation to meet planned milestones.

Implement SMART Transformation Strategies – Challenges to Overcome

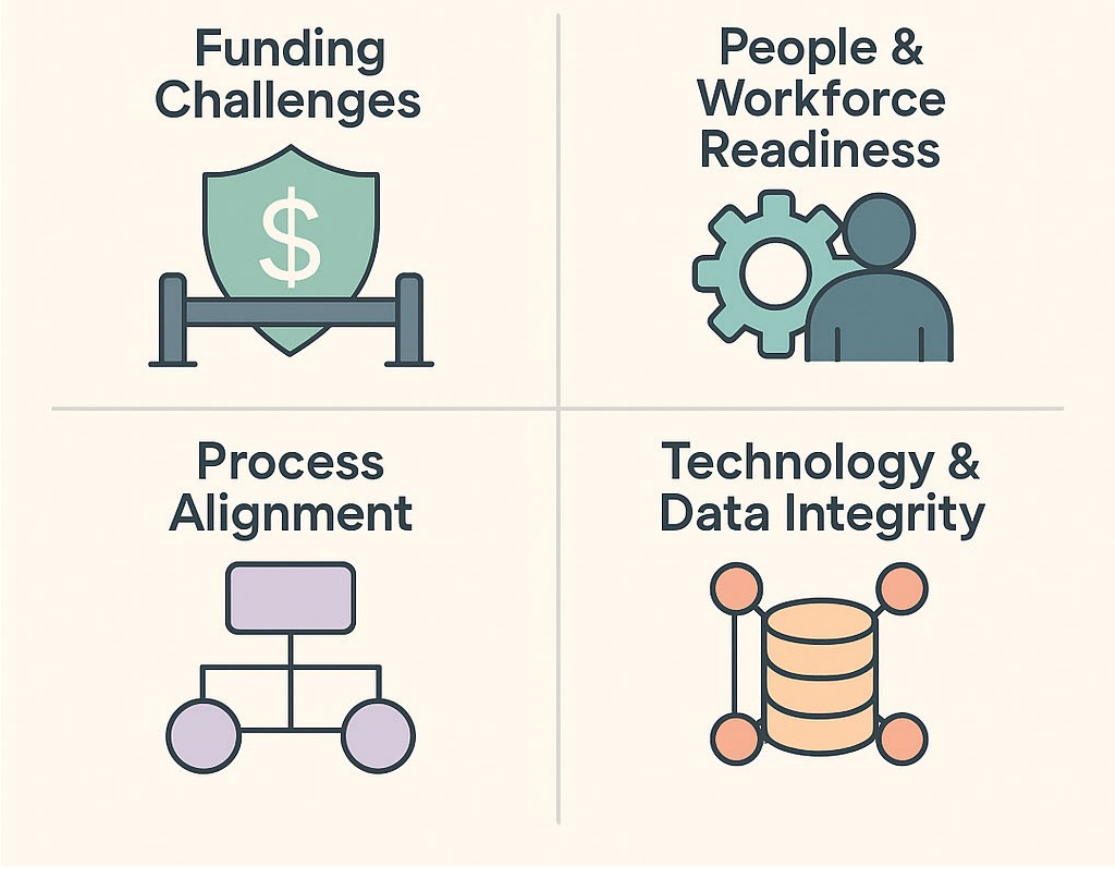
What is likely to go wrong, downside, issues to avoid

Funding Challenges – Technology descoping can separate budgets and schedules, cause misalignment and hinder progress. Early stakeholder engagement prevents costly retrofits and ensures seamless execution.

People Resistance – Manual habits and digital skill gaps cause data inaccuracies. A tech-savvy workforce is critical for sustaining performance and decision-making.

Process Misalignment – Proactive workflow integration minimizes costly late-stage changes, while stakeholder collaboration facilitates a smooth implementation. Planning for existing system obsolescence and a structured transition ensures operational continuity and efficiency.

Technology Gaps & Poor Data Integrity – Poor data quality and deferred maintenance undermine digital twins. Ongoing updates, strong infrastructure, and funding are essential for success.

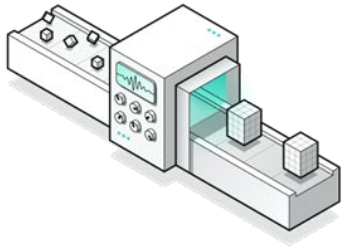


Leveraging AI for everything - Labs to admin to portfolio

Carbon Signal

01 Inputs

designed to rely on only a few key pieces of information for each building: size, location, and monthly energy use for each utility.

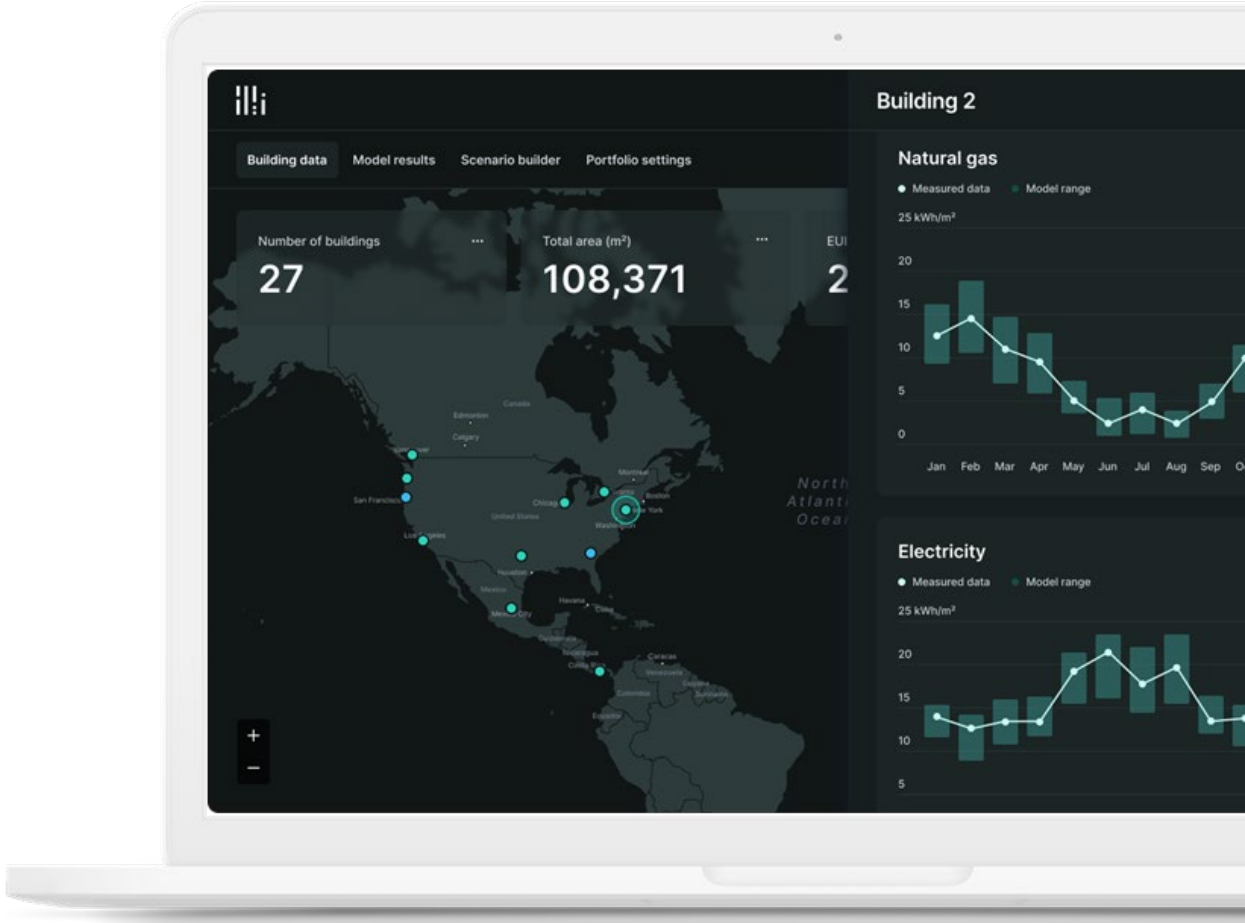


02 Calibration

uses a combination of machine learning and genetic algorithms to reverse-engineer a set of calibrated building-by-building energy models.

03 Analysis

simulates each model to generate carbon savings estimate for specific strategies in each building to identify the biggest portfolio-wide impacts.



SMART Facility Transformation: Driving Efficiency, Safety, and Sustainability

Key Take Aways

Proactive Lab Management
Transitioning from reactive to proactive facility operations mitigates risk, enhances safety, and reduces unplanned downtime.

AI & ML Applications
AI and ML technologies transform lab operations by enabling predictive maintenance, automated decision-making, and continuous optimization.

Impact Areas
Smart solutions drive measurable improvements in energy efficiency, sustainability, resource optimization, regulatory compliance, and knowledge retention.

Strategic Implementation
Successful SMART transformation requires alignment of people, processes, and technologies through structured planning, governance, and a clearly defined roadmap.

Readiness for the Future
Integrating advanced digital tools positions labs for greater resilience, operational excellence, and sustained innovation in an increasingly competitive and regulated environment.

Thank You.

Questions?