Leveraging Technology for Decision Support

Consolidated Edison

Central Engineering

Asset Management & Technology Development

Maximo Center of Excellence

Agenda

- Background

- Con Edison enterprise asset management journey

- Creating decision support capabilities

- Data analysis process improvements

- Decision support opportunities and challenges

- Strategy to achieve desired outcome – how can technology assist?
  - PM Frequency Optimization
  - AI Powered DGA
  - Capital Project Portfolio Optimization

![conEdison logo]

Commodities:
- Electric – 3.6 million customers
- Gas – 1.1 million customers
- Steam – 1,155 customers
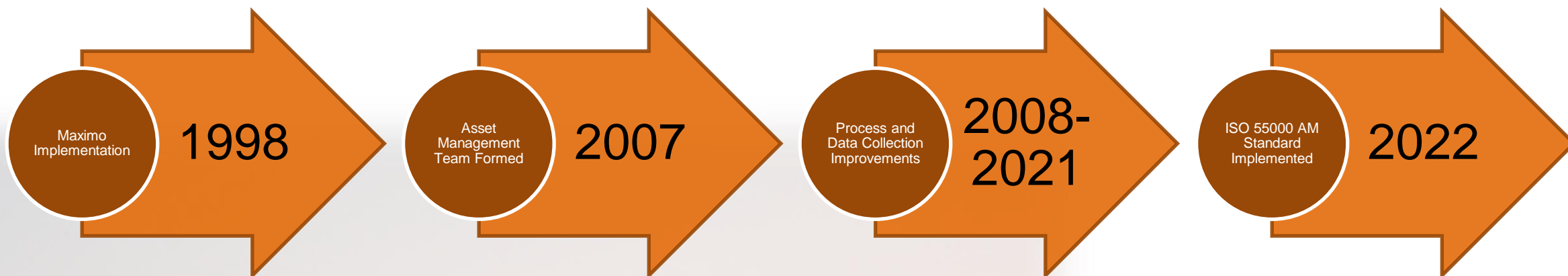
Over 10 million customers

$66 billion in assets

$15 billion in annual revenue

Central Operations:
- Electric Transmission
- Substations
- Power Generation
- Steam Distribution
- Construction

Map Extent

Consolidated Edison

Yonkers

Bronx

Manhattan

Queens

Brooklyn

Staten Island

10 Miles

Con Edison Substations Maximo Journey

1998 — Maximo Implementation

2007 — Asset Management Team Formed

2008-2021 — Process and Data Collection Improvements

2022 — ISO 55000 AM Standard Implemented

- Incomplete asset registry
  - Missing assets and asset nameplate data
- Work management process not documented
  - Ad-hoc planning and scheduling
- Lack of standardized reporting
- Inadequate data collection requirements and processes
  - Paper-based maintenance records
- Poor user interfaces
  - Minimally used by most personnel
- Few Engineering/project work management tools

AM Program Maturity Leads to a Shift in Focus

Lifecycle Delivery

Construct
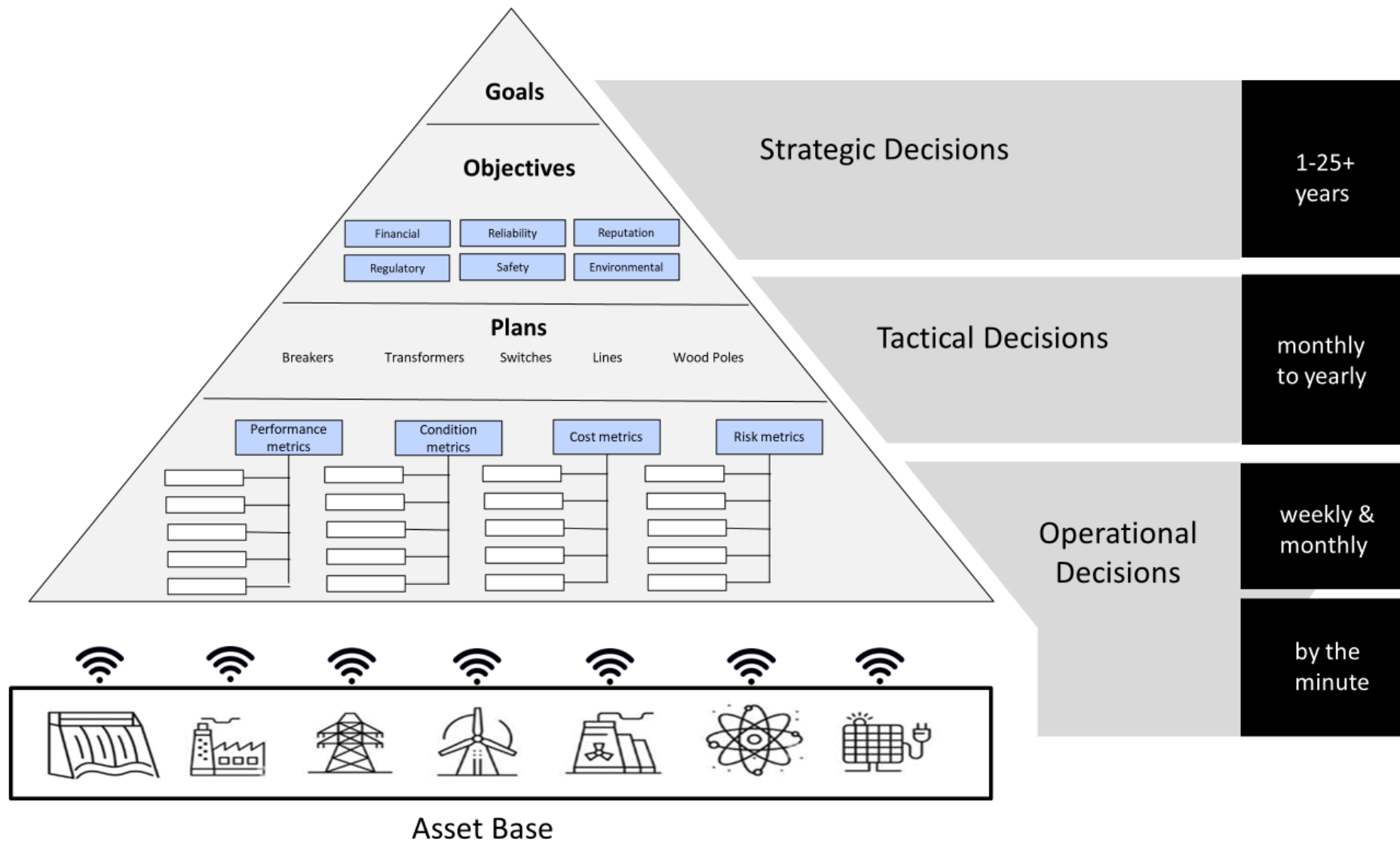
Operate

Maintain

Strategic Decision Support

Asset condition, assessment and end-of-life predictions

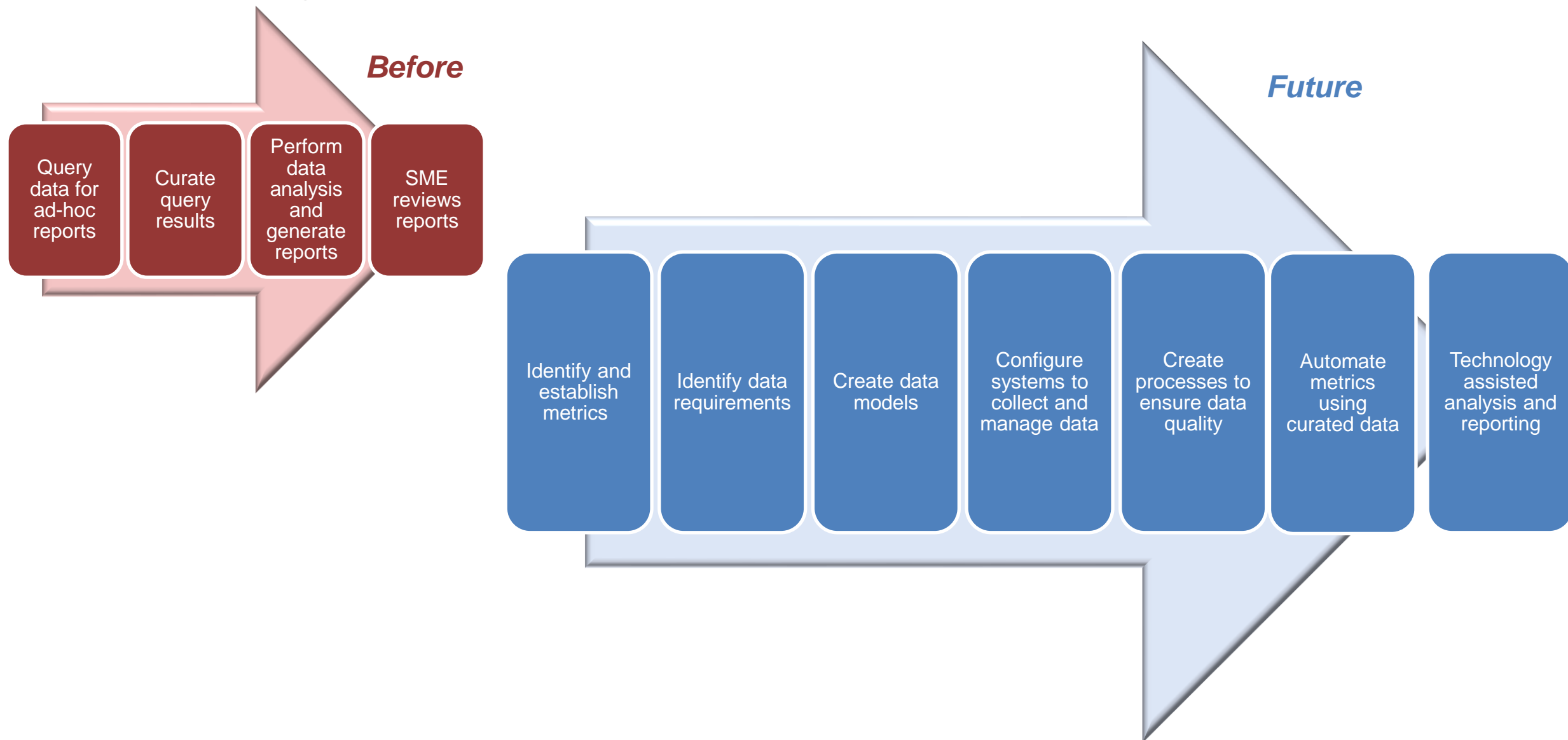Project selection and portfolio optimization

Asset level risk management
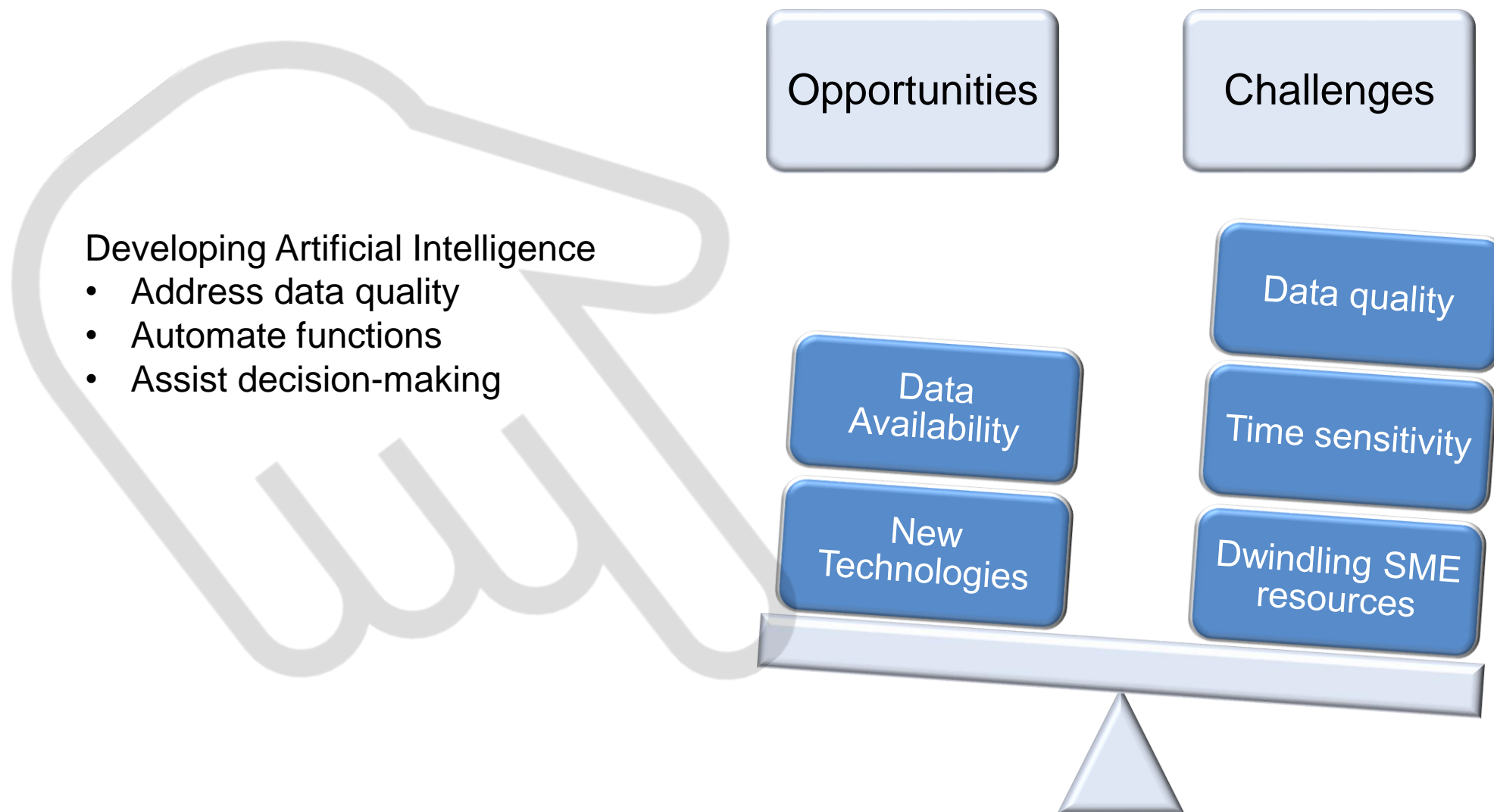
Performance metrics and associated data models

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Asset Management Decision-Making

Goals

Objectives

Financial | Reliability | Reputation
Regulatory | Safety | Environmental

Plans

Breakers | Transformers | Switches | Lines | Wood Poles

Performance metrics | Condition metrics | Cost metrics | Risk metrics

Asset Base

Strategic Decisions — 1-25+ years

Tactical Decisions — monthly to yearly

Operational Decisions — weekly & monthly

by the minute

Data Analysis Process Improvement

Before

Query data for ad-hoc reports

Curate query results

Perform data analysis and generate reports

SME reviews reports

Future

Identify and establish metrics

Identify data requirements

Create data models

Configure systems to collect and manage data

Create processes to ensure data quality

Automate metrics using curated data

Technology assisted analysis and reporting

Creating Decision Support Technology

Developing Artificial Intelligence
- Address data quality
- Automate functions
- Assist decision-making

Opportunities

Challenges

Data Availability

New Technologies

Data quality

Time sensitivity

Dwindling SME resources

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What can we do once we have good data?

Select applications of data science for asset management

AI OPPORTUNITIES FOR AM

Bold items will be discussed today

- Automated work scheduling and assignment
- **PM frequency optimization**
- Battery monitoring systems
- **Transformer gas-in-oil alarm diagnosis**
- Asset health assessment automation
- Asset Management Plan digitization
- **Capital portfolio project planning**
- Work order curation assistant
- Virtual reality and 3D scanning

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1) PM FREQUENCY OPTIMIZATION

○ Preventive Maintenance (PM) is a core part of any equipment maintenance program

- Ensures equipment is running properly
- Enables early issue detection
- Complies with standards and regulations

○ Need to find the PM "sweet spot"

- Too much PM can be a waste of resources and create additional maintenance issues
- Too little PM can lead to high corrective maintenance (CM) costs and reliability issues

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HOW DOES PM FREQUENCY OPTIMIZATION WORK?

Historical data on assets' PM and CM timing and costs

Preferences from company re. risk appetite

Company standards and regulatory constraints

Collect data from company

Predictive model of expected CM cost for an asset

Predictive model of expected asset downtime

Optimization engine to find best frequency for asset or group

Build and train analytics

Recommended PM frequency

Results

PM FREQUENCY OPTIMIZATION BENEFITS

- Lower overall costs and maintenance time

- Faster decision making

- Data-driven justification for PM scheduling

2) DISSOLVED GAS-IN-OIL DIAGNOSIS

- ○ Cooling oil is often monitored for dissolved gases, which can indicate problems

- ○ On-line transformer fleet DGA monitoring generates hundreds of alarms/day

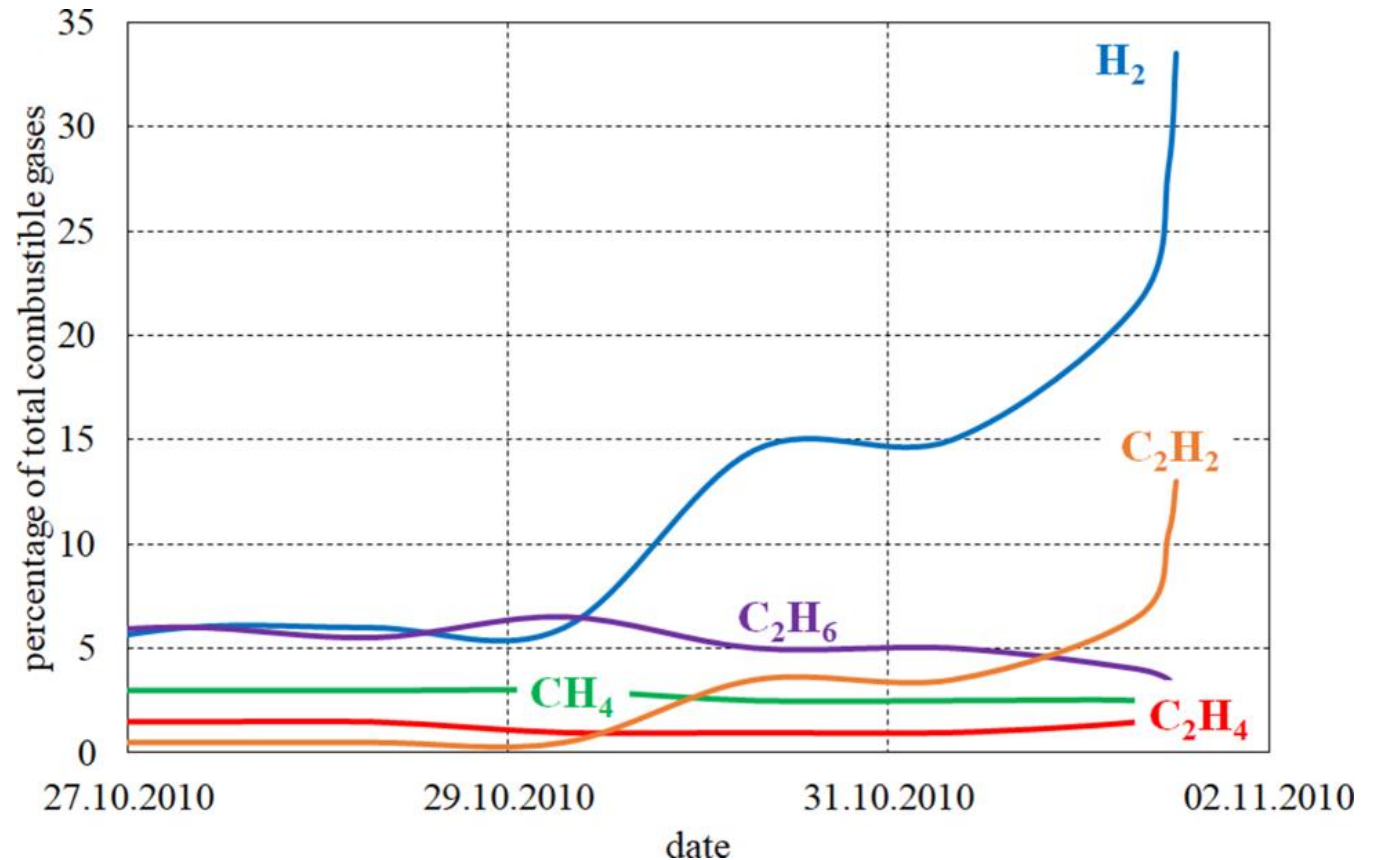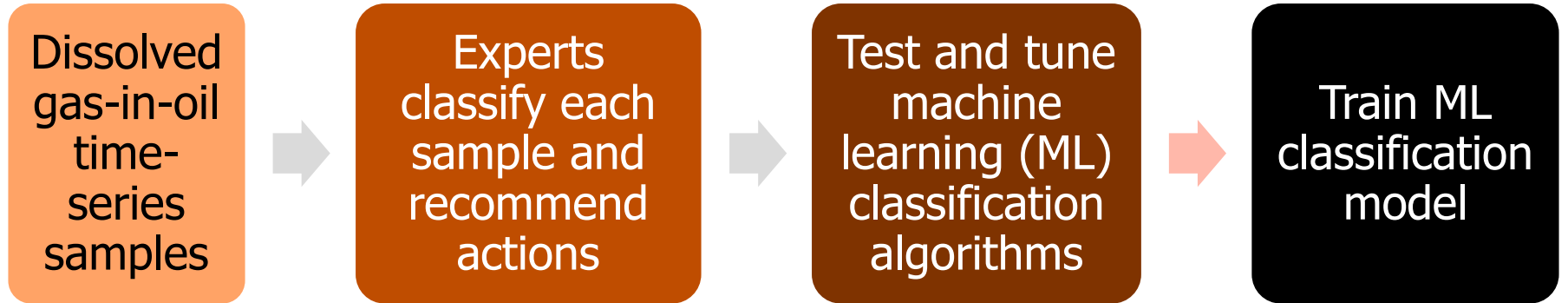- ○ Reviewing and dispensing recommendations (e.g., immediate action necessary, adjust threshold and monitor) requires human time and expertise

Image source: Riedmann, C., Schichler, U., Häusler, W. *et al.* Online dissolved gas analysis used for transformers – possibilities, experiences, and limitations. *Elektrotech. Inftech.* **139**, 88–97 (2022). https://doi.org/10.1007/s00502-022-00992-8

AI-POWERED DGA APPROACH

Training (up-front) → Dissolved gas-in-oil time-series samples → Experts classify each sample and recommend actions → Test and tune machine learning (ML) classification algorithms → Train ML classification model

Inference (operational) → Dissolved gas-in-oil time-series sample → ML classification model → Class of problematic behavior & recommended action

AI-POWERED DGA BENEFITS

○ Automated pattern recognition

- More DGA samples can be analyzed
- Important alarms flagged for immediate action
- Not reliant on expertise of an aging workforce
- More issues will be caught early!

○ Integration with AM software

- Seamlessly route issues to those responsible
- View DGA results alongside other AM insights
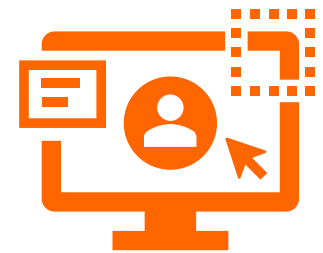
3) CAPITAL PORTFOLIO PROJECT PLANNING

○ Capital projects require resources

- Money
- Time
- Workers

○ Projects have specific requirements

- Engineering design
- Equipment procurement
- Outage scheduling
- Labor availability
- Vendor/service availability

○ How do you know which projects to do, and when?

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CAPITAL PORTFOLIO OPTIMIZATION

1. Prioritize
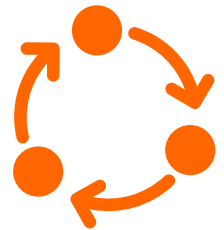   - Quantify value of projects
   - Quantify risk of deferral

2. Optimize
   - Variables represent portfolio calendar
   - Define objective to maximize
   - Define rules/constraints

3. Operationalize
   - Software writes context-specific objectives and constraints
   - Run through optimization solver (commercial or open-source)
   - Integrate with AM/AIP software

PORTFOLIO OPTIMIZATION BENEFITS

○ Faster planning that accounts for all practical constraints

○ Ability to quickly adjust (or explore "what-if" scenarios) without starting over

○ Better alignment of project work with company priorities

○ Better value for budget/resources

BOTTOM LINE

○ Modern AI can support efficient, data-driven decision making

- Data visualization tools
- Association models
- Predictive models
- Optimization engines
- Text synthesis and generation

○ However, it all starts with good data!

- Requires intentional collection and curation
- Garbage in, garbage out

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THANK YOU

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