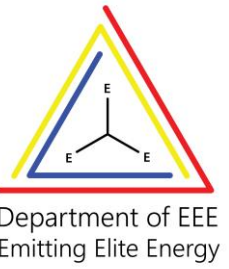




ATME
College of Engineering



MODULE-3 | ENERGY CONSERVATION AND AUDITING

ENERGY AUDITING

Systematic Approach to Energy Performance
Assessment and Conservation

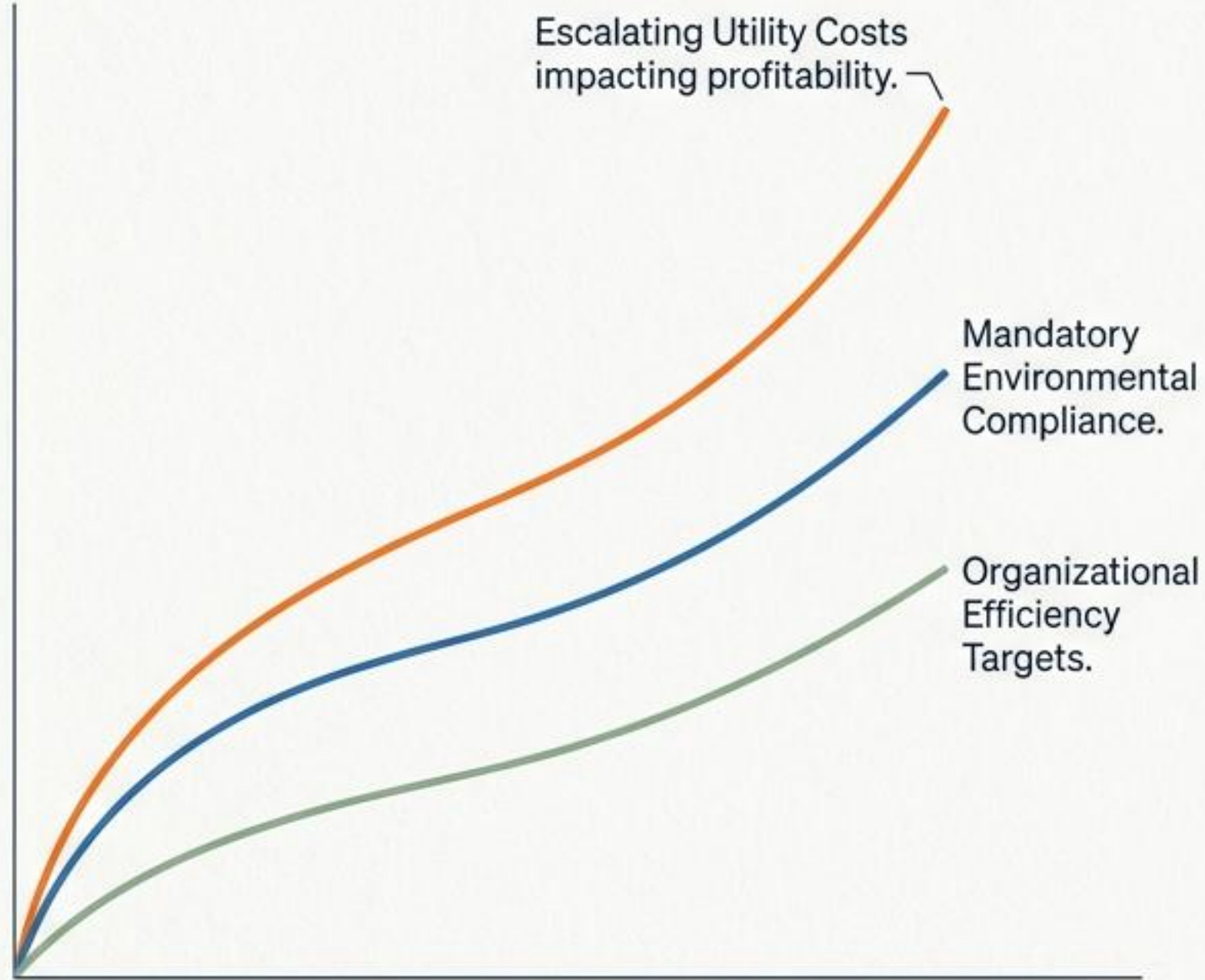
Dr. Sathish K. R.

Assistant Professor

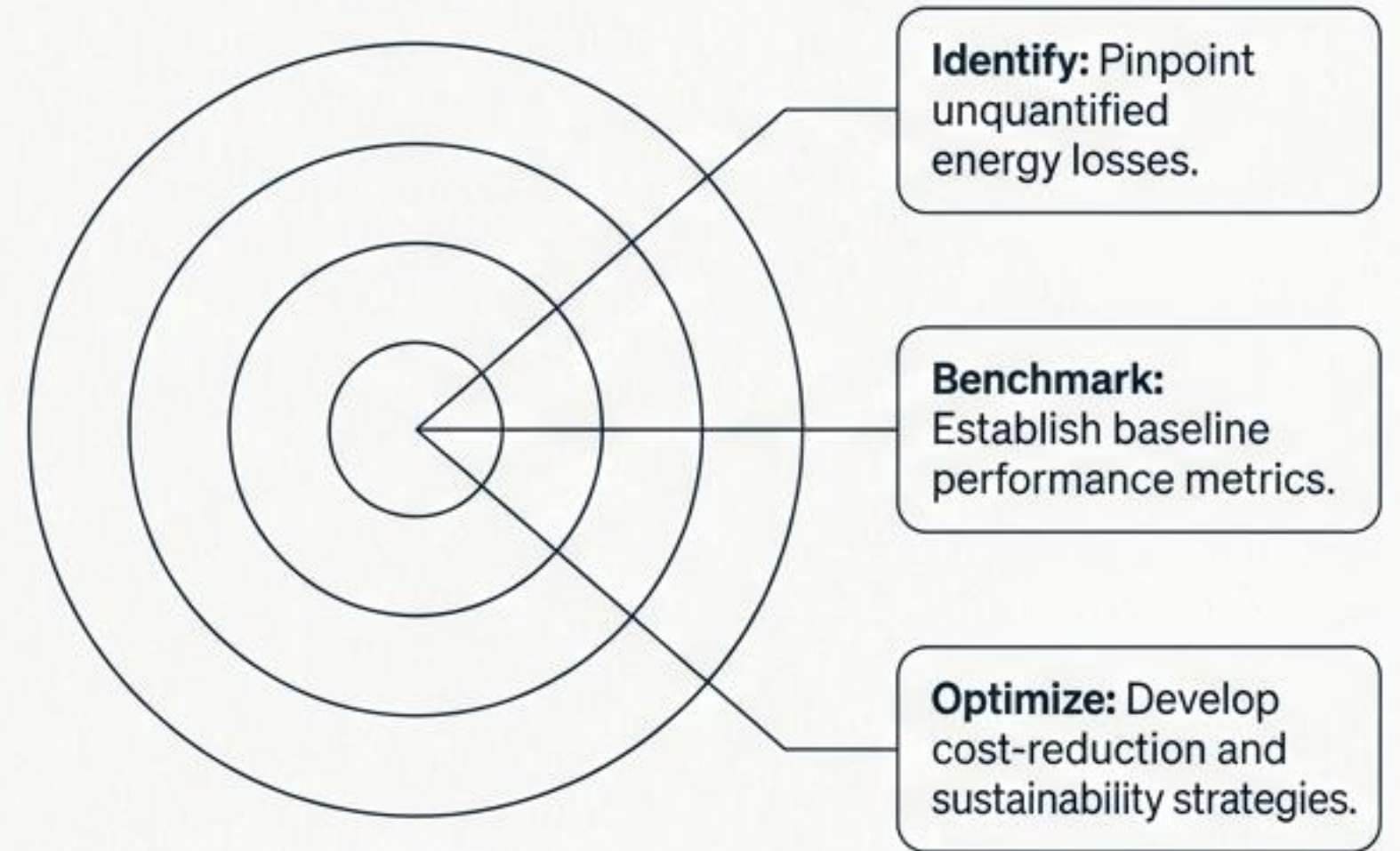
Department of Electrical and Electronics Engineering (EEE)

ATME College of Engineering

The Energy Imperative: Balancing Cost, Compliance, and Conservation



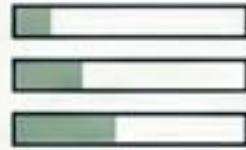
Objectives Target



The Audit Spectrum: Defining the Scope of Investigation

Preliminary (Walk-through) Audit

Time / Cost:
Low (1-3 days)



Methodology: Visual inspection, utility bill review. Identify major energy users.

Deliverables: Quick-win savings (No-cost/Low-cost), **glaring inefficiencies**.

Detailed Energy Audit

Time / Cost:
Medium to High (Weeks)



Methodology: Granular data collection, system-level measurements, energy balance calculations.

Deliverables: Comprehensive cost-benefit analysis, **detailed engineering recommendations**.

Investment Grade Audit

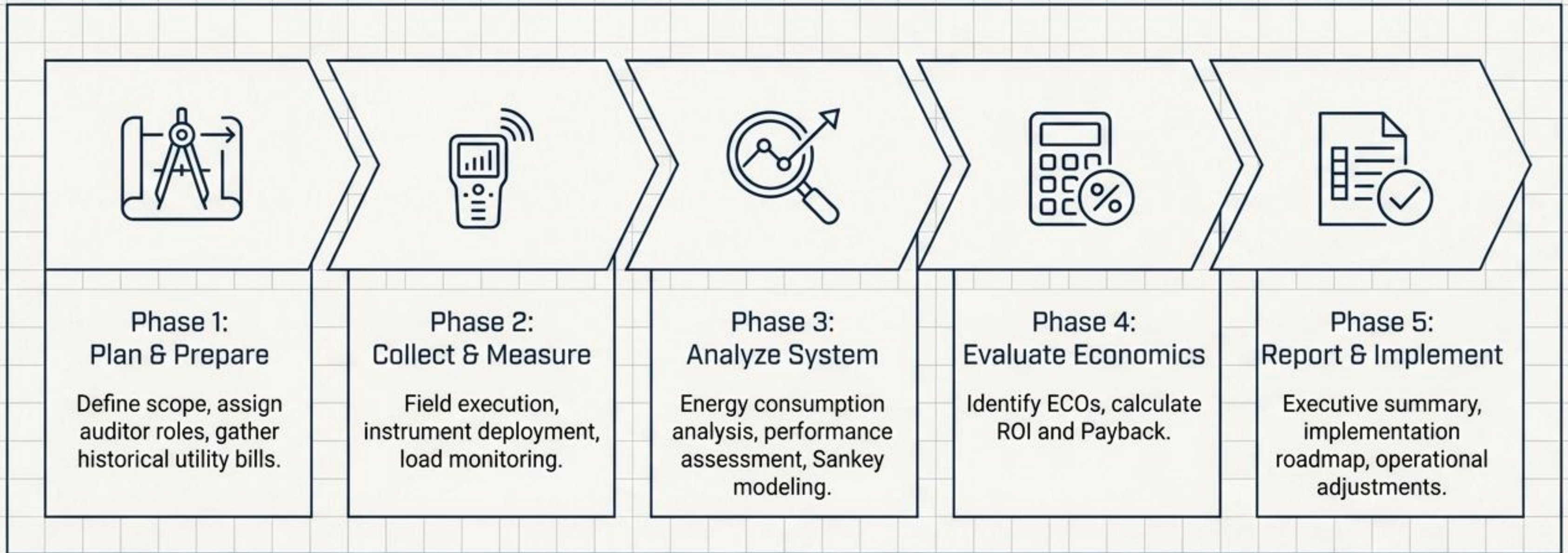
Time / Cost:
High (Months)



Methodology: Rigorous financial modeling, risk assessment, continuous logging.

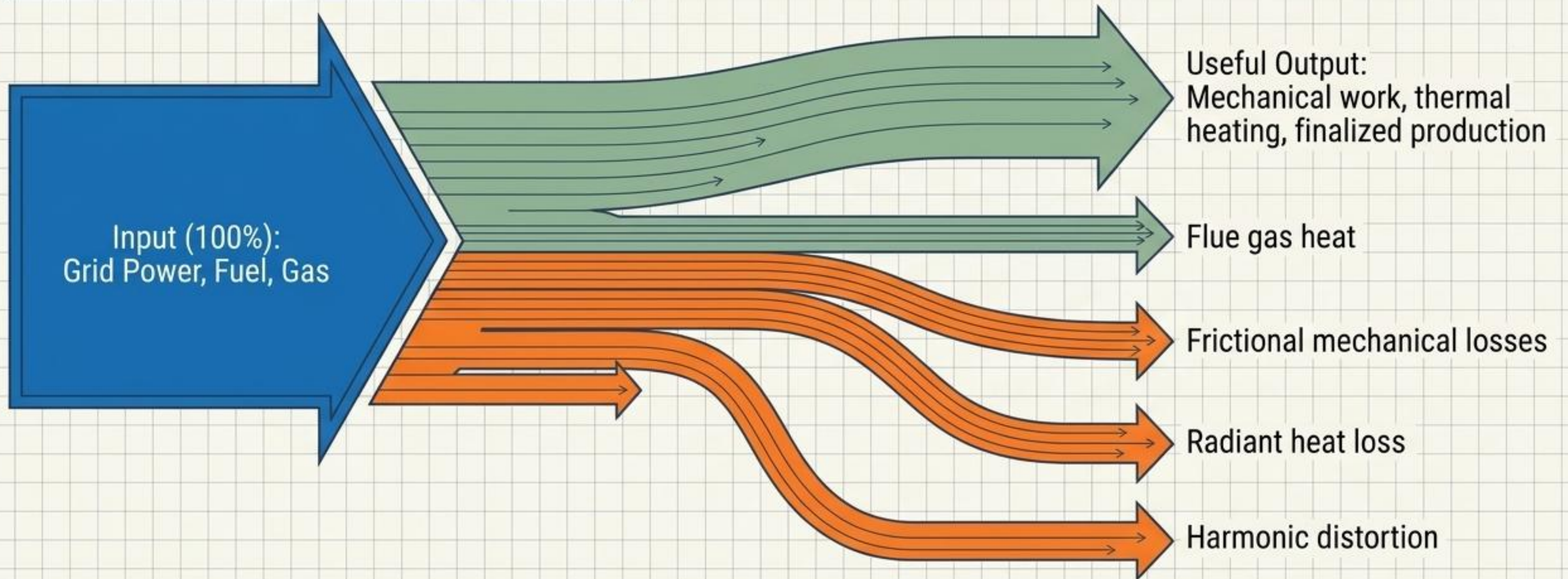
Deliverables: **Bankable ROI/IRR** analysis to secure project funding.

The Audit Lifecycle: A Systematic Engineering Process



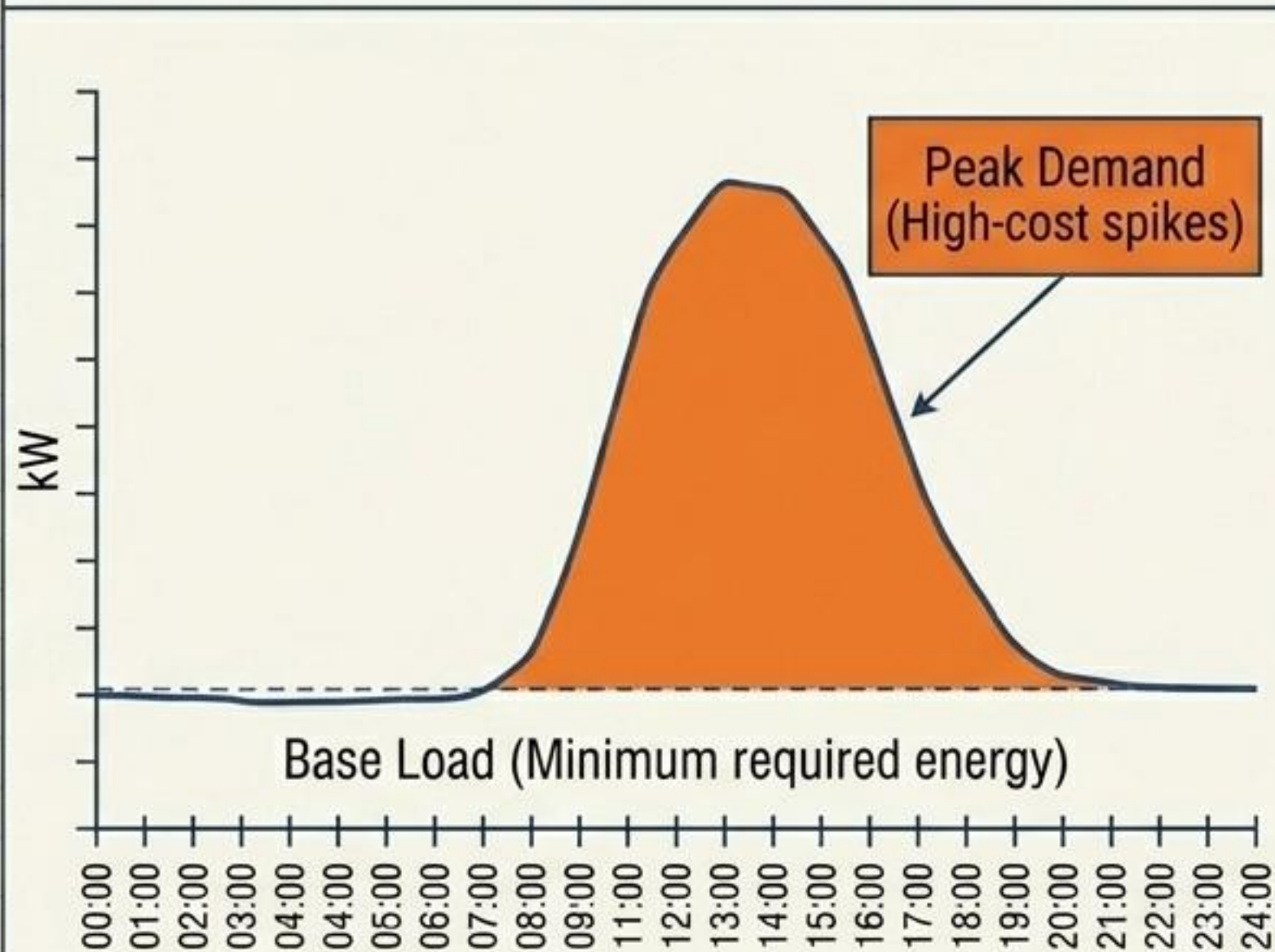
Mapping Energy Flow: The Sankey Diagram and Energy Balance

Energy Balance is an input-output analysis proving that all energy entering a facility equals the energy leaving as product, work, or waste.

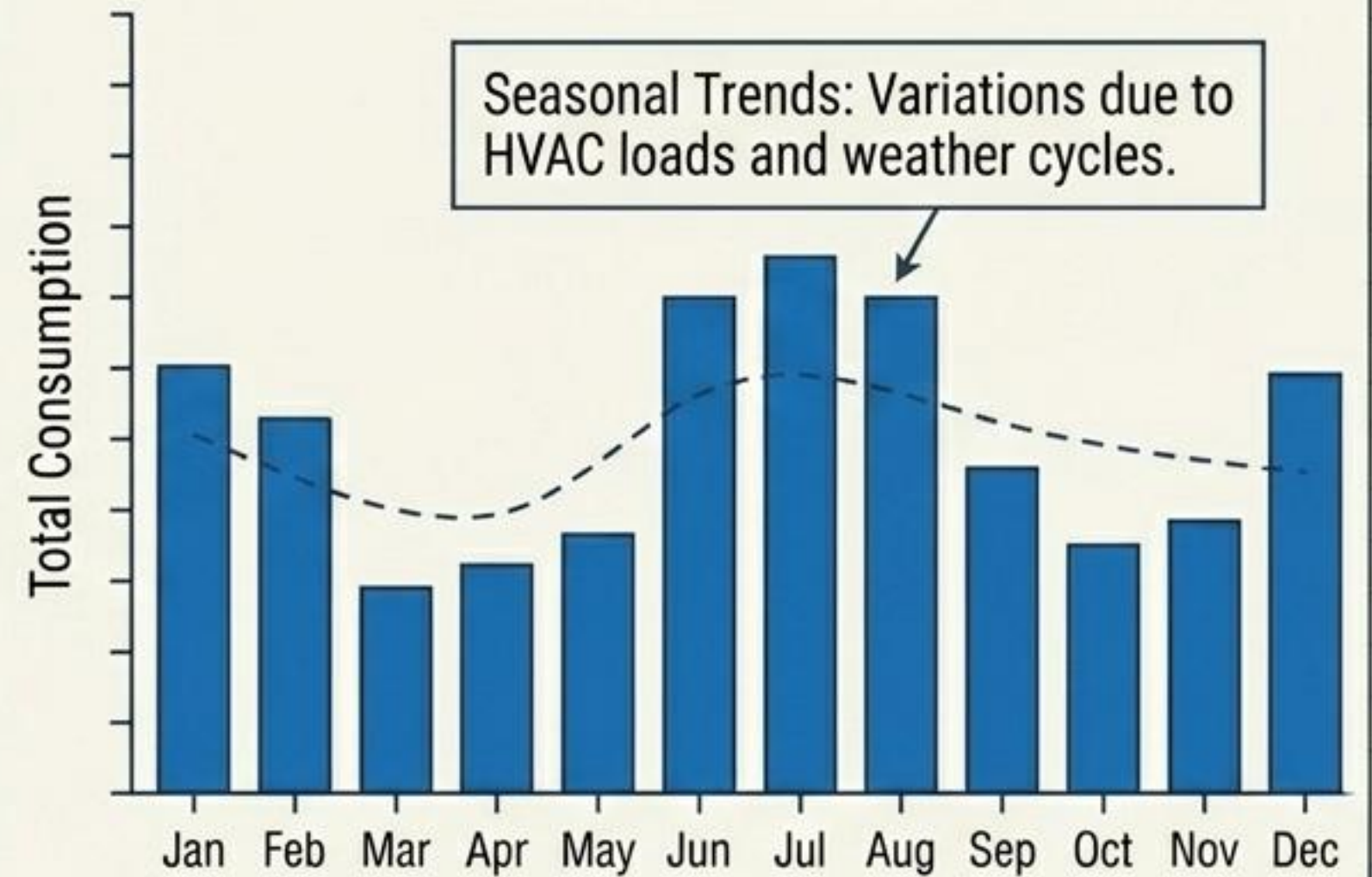


Visualizing Consumption: Deciphering Energy Use Profiles

24-Hour Demand Load Profile



12-Month Seasonal Consumption



Data Sources: Utility bill analysis, equipment inventory, continuous load monitoring.

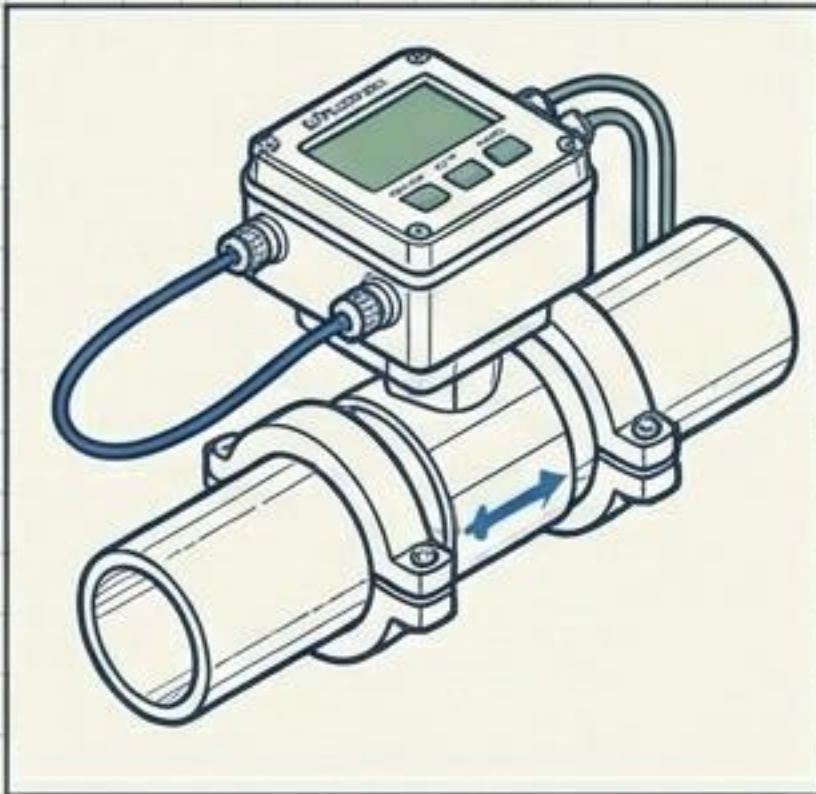
The Auditor's Toolkit: Instruments for Precision Measurement



Power Analyzer & Clamp Meters: Measures Voltage (V), Current (I), Power Factor (PF), and Harmonics.



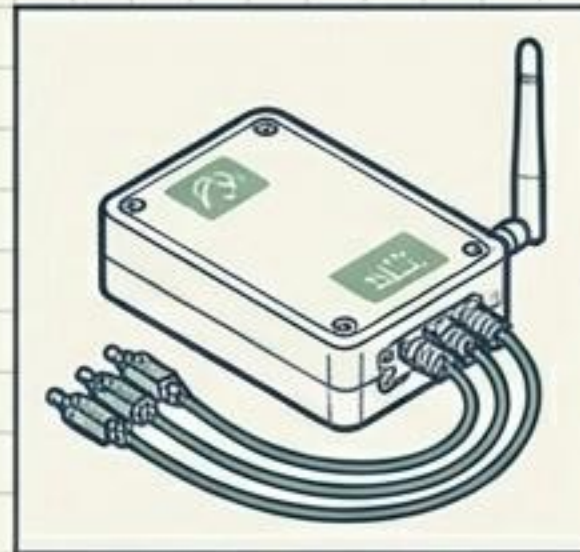
Thermal Imagers & IR Thermometers: Detects heat loss, insulation failure, and combustion inefficiencies.



Ultrasonic Flow Meters: Non-invasive measurement of fluid velocities in pipes.



Lux Meters: Quantifies illumination levels against workplace standards.



Data Loggers: Captures continuous baseline data over extended periods.

System Diagnostics: Key Parameters Across Three Domains

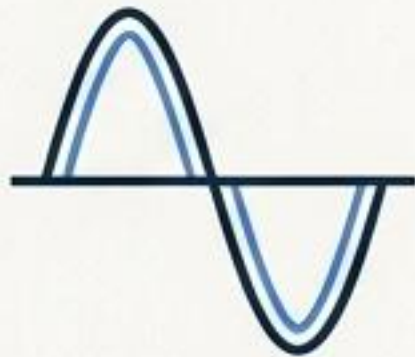
Electrical Systems

Metrics

Voltage, Current,
Active/Reactive Power

Red Flags

Poor Power Factor, high
harmonic distortion causing
motor overheating



Thermal Systems

Metrics

Temperature gradients, exhaust
gas composition

Red Flags

Suboptimal combustion
efficiency, damaged insulation,
steam leaks



Flow & Pressure Systems

Metrics

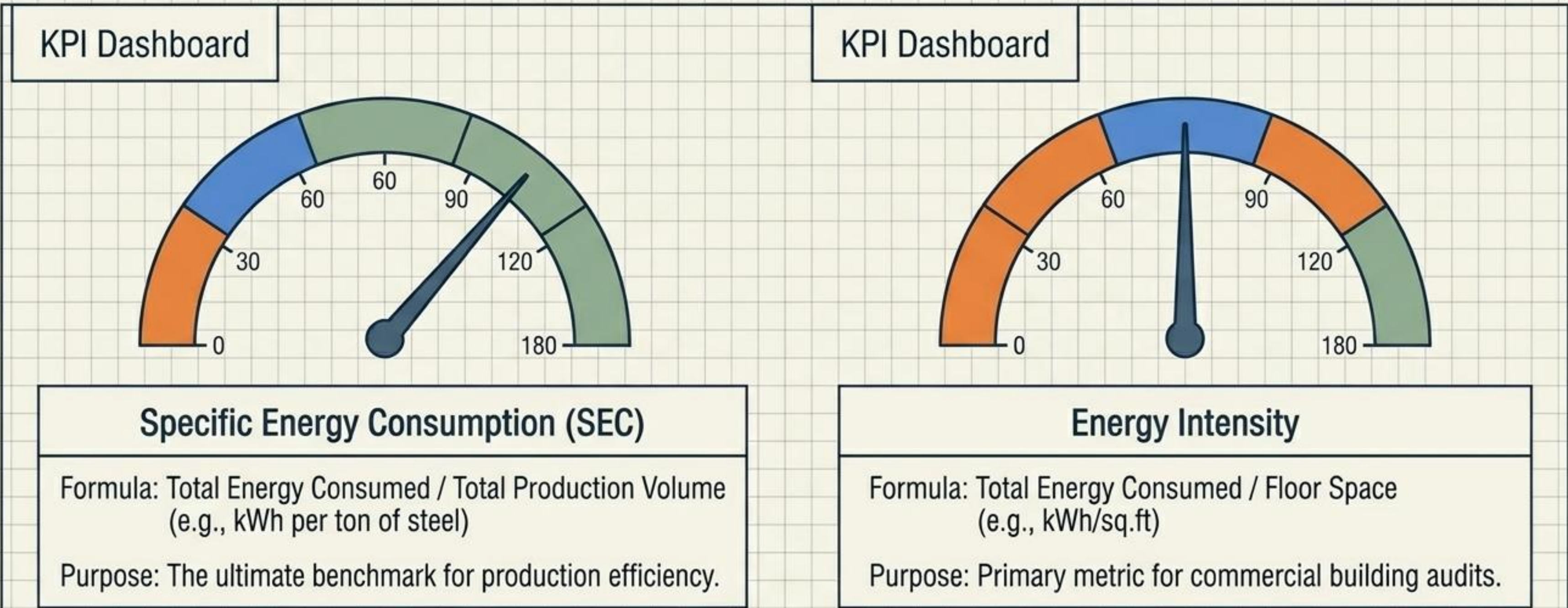
Fluid velocity, static/dynamic
pressure

Red Flags

Inefficient pump/fan curves,
throttling valves, pressure
drops in compressed air lines



Metrics That Matter: Energy Performance Indicators (EnPIs)

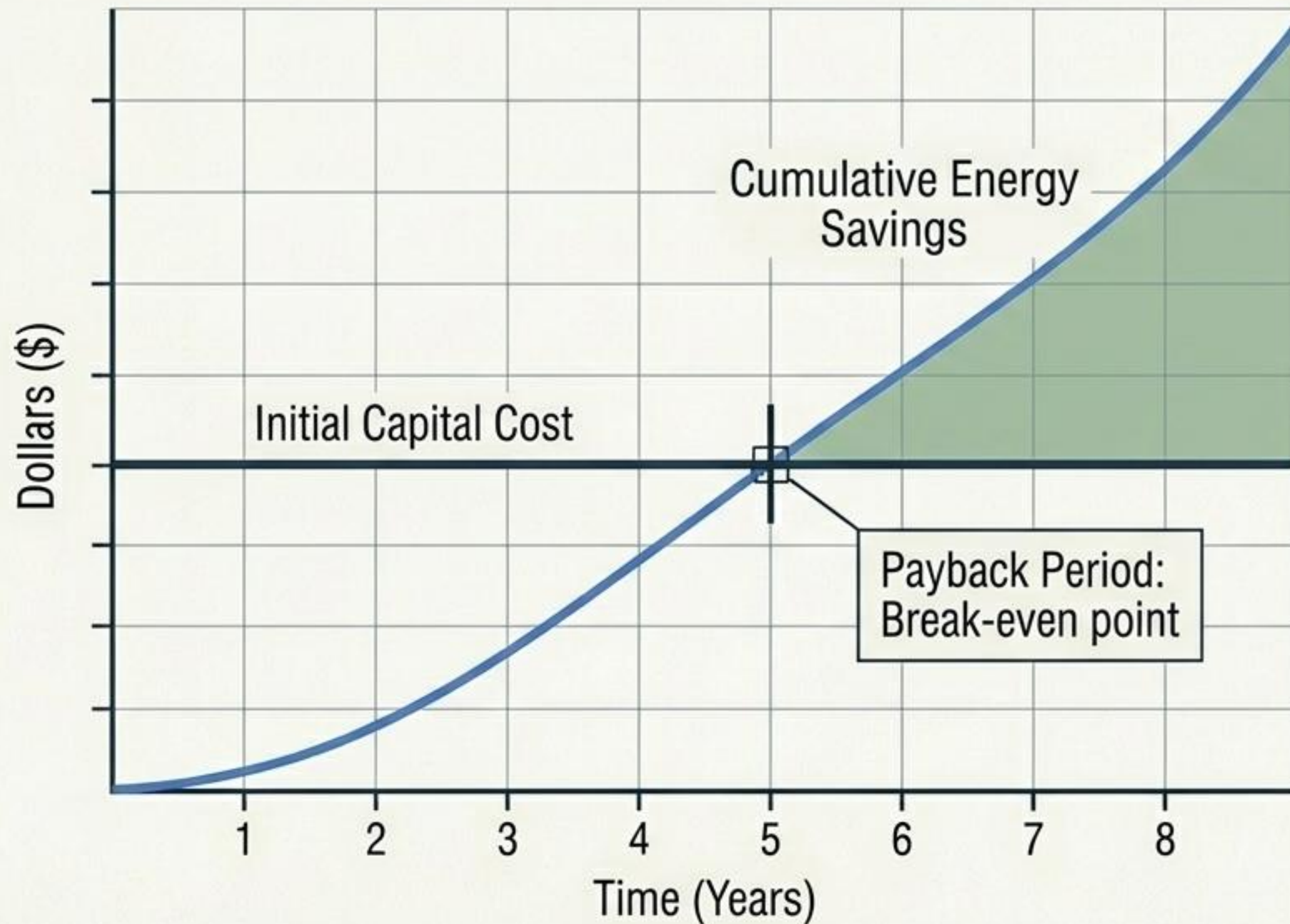


Data Validation: Always cross-reference primary field data with secondary utility data before establishing performance baselines.

Unlocking Value: Prioritizing Energy Conservation Opportunities (ECOs)



The Financial Lens: Economic Evaluation of ECOs



Net Present Value (NPV)

Calculates the current value of future energy savings, accounting for the time value of money and inflation.

Internal Rate of Return (IRR)

The percentage return the energy project yields, used to compare against other corporate investments.

Life-Cycle Costing

Evaluates total cost of ownership (purchase + maintenance + energy used over lifespan) rather than just initial sticker price.

Translating Data to Action: The Energy Audit Report

Executive Summary

High-level overview of current SEC, total potential savings, and required investment.
(Written for the CFO/CEO).

Findings & Observations

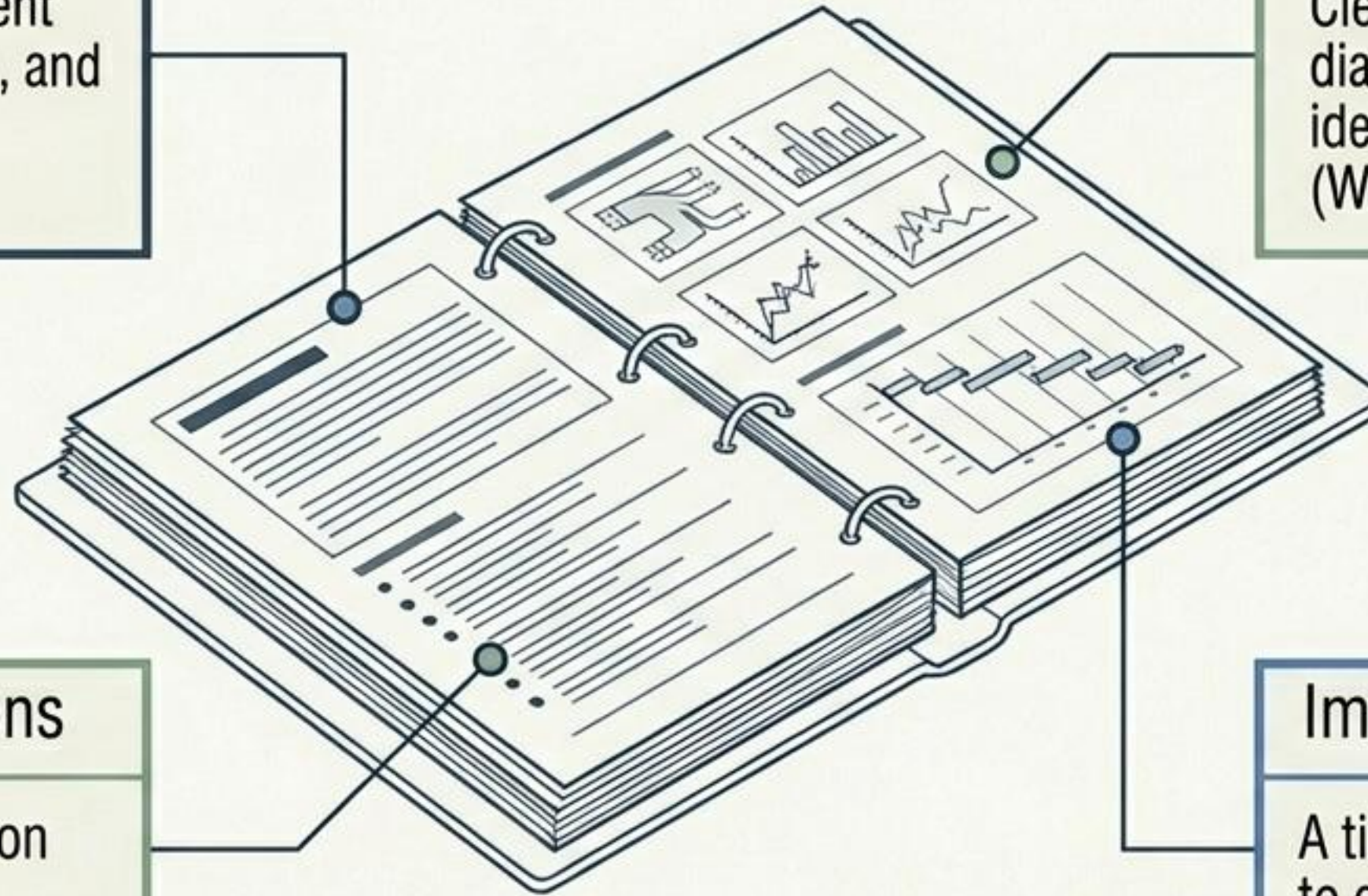
Clear presentation of Sankey diagrams, load profiles, and identified losses.
(Written for Plant Managers).

Recommended Actions

Ranked list of ECOs based on the feasibility quadrant.

Implementation Roadmap

A time-bound, phased approach to executing the engineering recommendations.



Reality Check: Application, Case Studies, and Challenges

Industrial Plant Audit

Focus: Heavy machinery, process heating, motor efficiency.

Outcome: High capital investment, massive SEC reduction.



Commercial Building Audit

Focus: HVAC optimization, lighting (Lux levels), occupancy sensors.

Outcome: Lower capital, improved Energy Intensity (kWh/sq.ft).

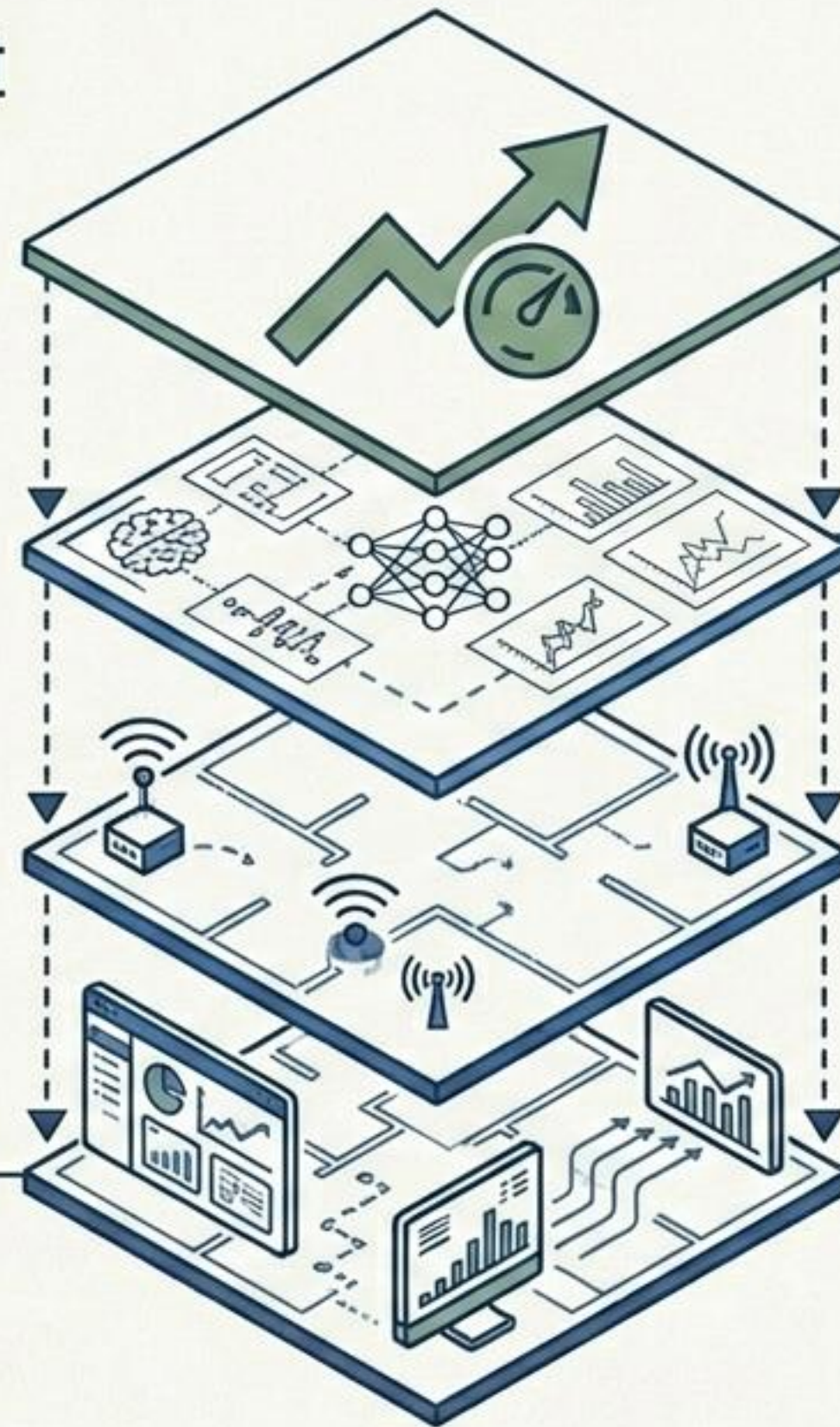


Barriers to Success (Implementation Challenges)

- Lack of historical baseline utility data.
- Production constraints preventing system shutdown for measurement.
- Change management: Operator resistance to new operational protocols.

Future Horizons: The Shift to Digital & Smart Auditing

From Manual to Digital: Moving from annual clipboard walk-throughs to real-time, continuous monitoring.



Continuous Optimization

AI and Analytics

Machine learning algorithms predicting peak demand spikes and automating equipment shutdowns.

Smart Metering & IoT

Deploying wireless sensors for granular, machine-level load profiling without human intervention.

Energy Management Systems (EnMS)

Integrating audit metrics directly into the daily operational dashboards of the facility.

The Auditor's Checklist: Key Module Takeaways

- 1. System Context:** Audits balance environmental compliance with financial cost-reduction.
- 2. The 5-Step Process:** Plan, Collect, Measure, Analyze, Report.
- 3. Energy Balance:** Utilizing Sankey diagrams to trace 100% of input against useful output and **losses**.
- 4. Metric Benchmarking:** Validating performance using Specific Energy Consumption (SEC).
- 5. Economic Justification:** ECOs must be backed by **Payback Period, NPV, and IRR** analysis.

Conclusion: Energy auditing is not a one-time fix; it is a catalyst for continuous operational improvement.