gafcon DIGITAL

A Subsidiary of Anser and Accenture

National Institute of BUILDING SCIENCES™

Existing Buildings: Building Technology & Retrofits

Digital Twins Drive Value

December 6th 2023

AUROS GROUP

accenture

Why Are We Here Today?

Buildings consume 40% of global energy

Agenda

Introductions

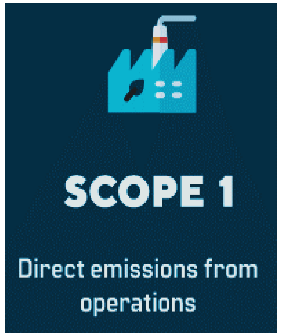
Content:

- What is a physics-based digital twin simulation engine?
- How do you apply the process to existing buildings?
- What are the implications compared to a traditional process?

Questions and discussion

Greenhouse Gas (GHG) Definitions & Terminology

Buildings consume 40% of global energy



Scope 1 emissions:

- Emission sources that an organization owns or controls directly
- **Example:** burning fuel in fleet of vehicles (if they're not electrically-powered)

Scope 2 emissions:

- Emissions that a company causes indirectly when the energy it purchases and uses is produced
- **Example:** emissions from the generation of the electricity they are powered by

Scope 3 emissions:

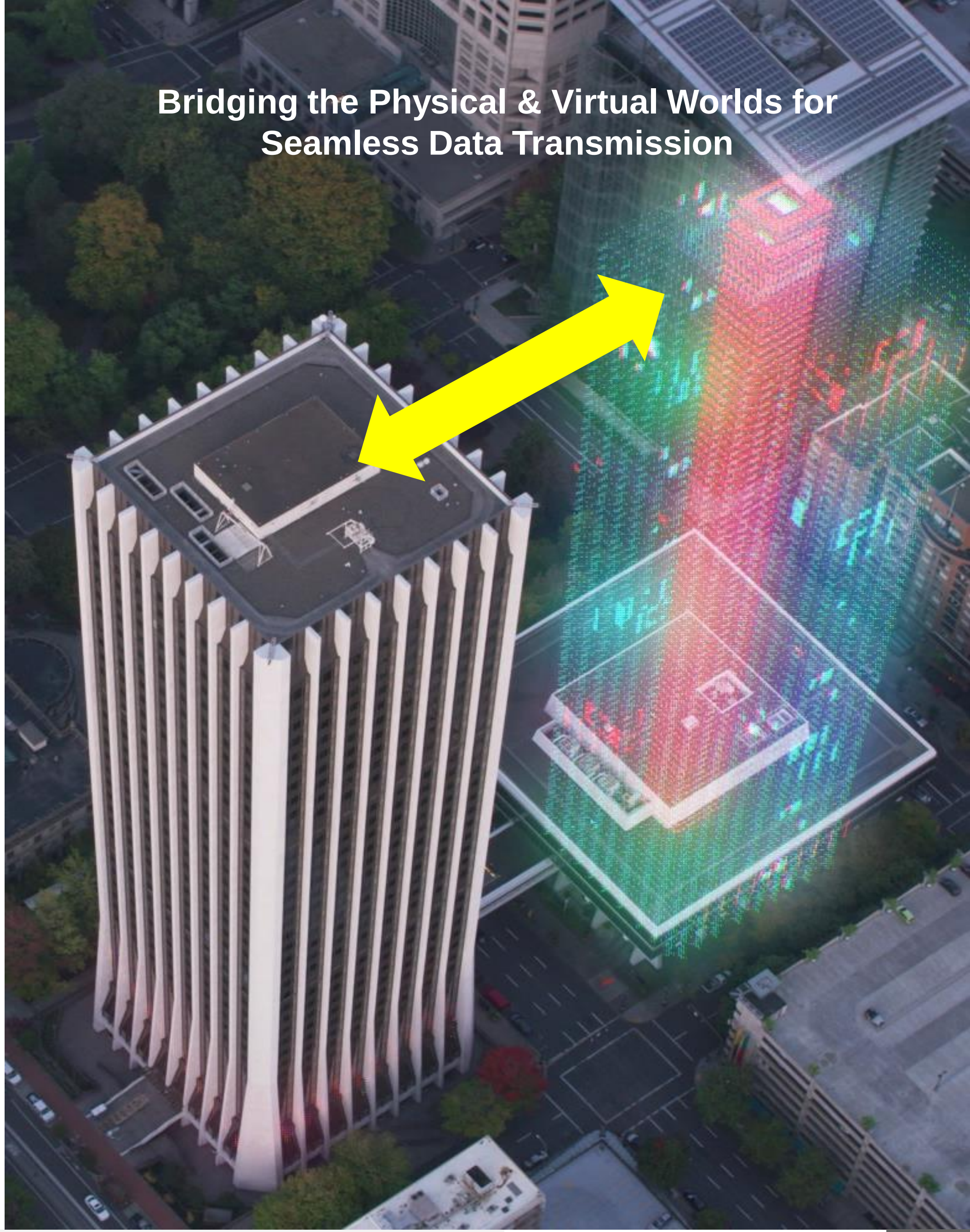
- Embodied emissions that are not produced by the company itself
- **Example:** buy, use and dispose of products and materials from suppliers

We are here today to primarily discuss Scope 1 and 2 emissions

Performance-Based Digital Twins Bridge Gaps

- **Generate data** when there is poor quality data or data is unavailable
- **Physics-based simulation** using virtual sensors + physical sensors
- **Proactive performance** virtual time and money for “what-if” scenarios
- **De-risk investments** through leveraging performance Digital Twin
- **Bidirectional communication** between physical and digital assets
- **IFM incorporation** throughout asset lifecycle and MBx
- **Closed-loop solutions** continuously calibrate assets
- **Close performance gap** that goes unnoticed driving wasted investments
- **Validate ESG+H** decarbonize, financial penalties/taxes and incentives

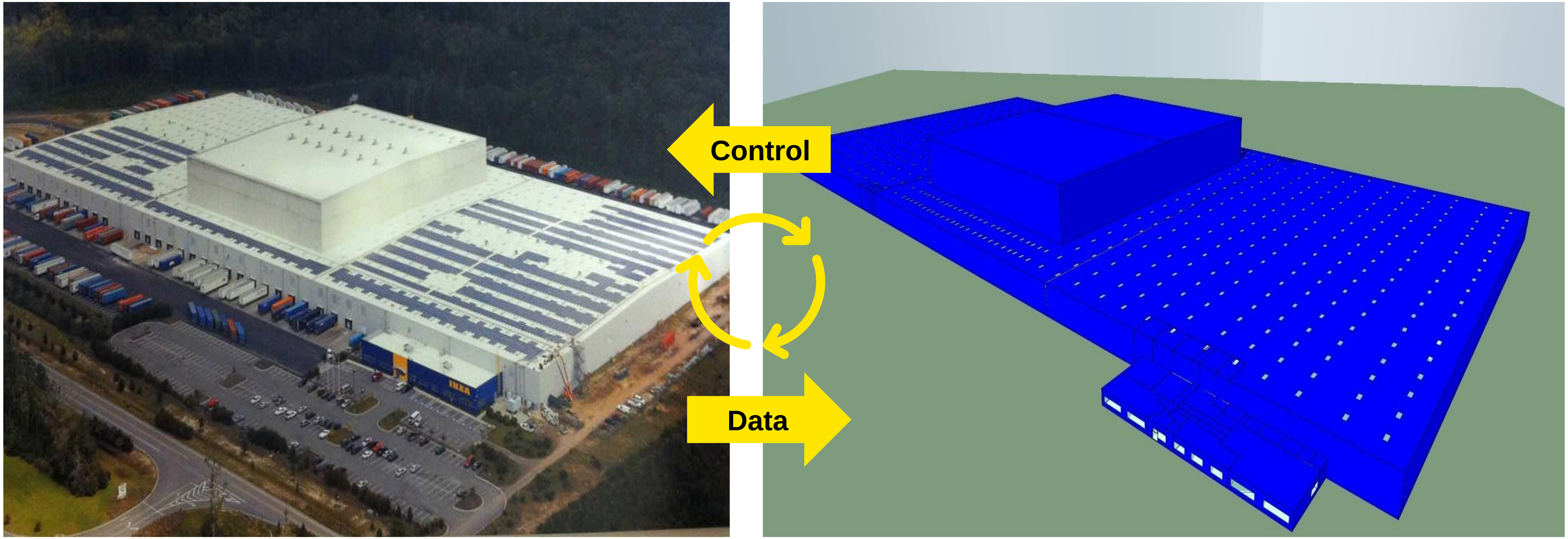
Complete the Digital Building Lifecycle



Repurposing the "Sleeping Digital Twin" Virtual Asset

Generated from the original design model

Physical Asset **Virtual Asset**

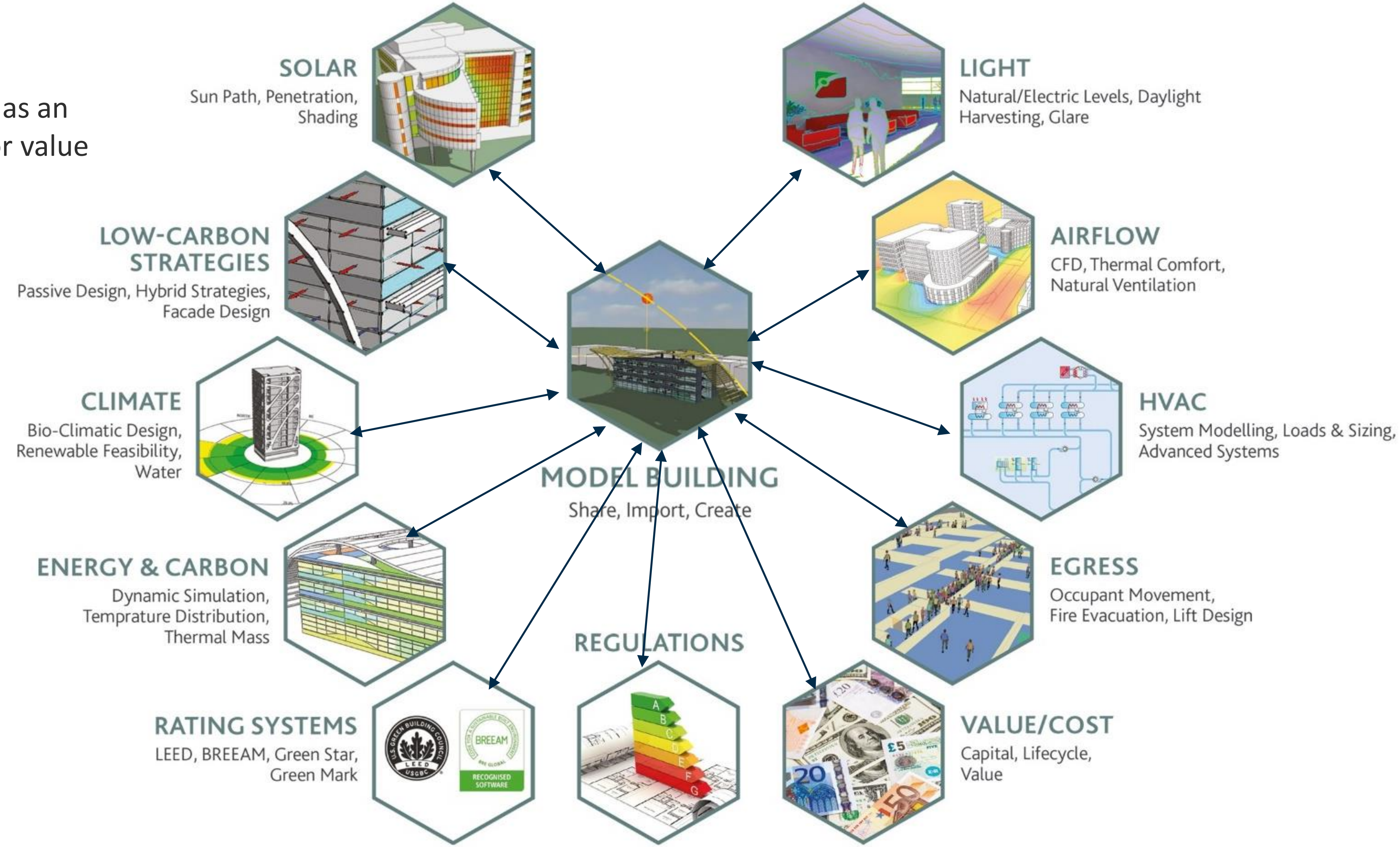


As-Built Existing Facility

Design Energy Model
(previous investments wasted)

Digital Twins Using A Holistic Single Model Approach

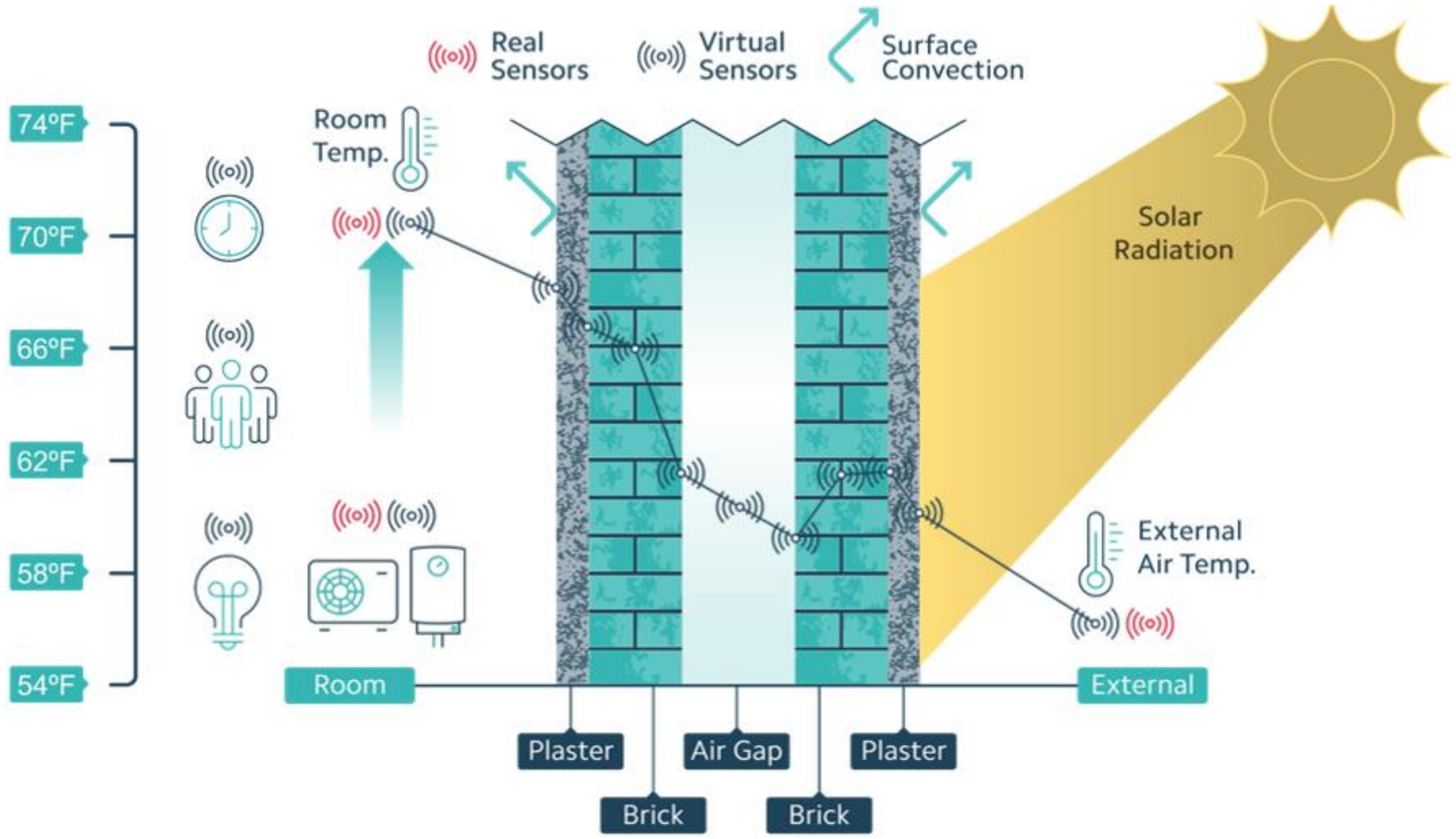
- Performance-based approach has an impact when simply changing or value engineering a single entity
- Long-term facility cost and ESG+H impact vs short-term gains
- On-going operational consistencies from early-stage design
- Unlock the key to finding hidden cost saving opportunities



*NOTE: Powered by IES

Digitizing Physics, Virtual Sensors & Virtual BMS

- Each room can have >650+ **virtual sensors**
- Data can **register and record** every 1-30 mins
- Sensitive rooms (e.g., datacenters) can record data **every few seconds**
- Virtual sensors **don't fail** unlike physical sensors with limited useful life-span
- Comparing **costs** of a physical sensor vs a virtual sensor
- Combing physical and virtual sensors provide **greater analysis** and comprehensive understanding of asset performance



Digital Building Lifecycle

Proactive Digital Twins for Building Performance and Sustainability (BPS) Components

1. Plan

Determine ESG+H potential scalability, risk & financial impacts

2. Design

Simulate 'what-if' options for existing assets

3. Construct

Monitor construction / retrofits & aggregate data

4. Deploy

Transition static BIMs to dynamic performance DT with MBx

5. Operate

Monitor real-time performance with calibrated model

Continuous improvement throughout closed-loop analysis through asset lifecycle

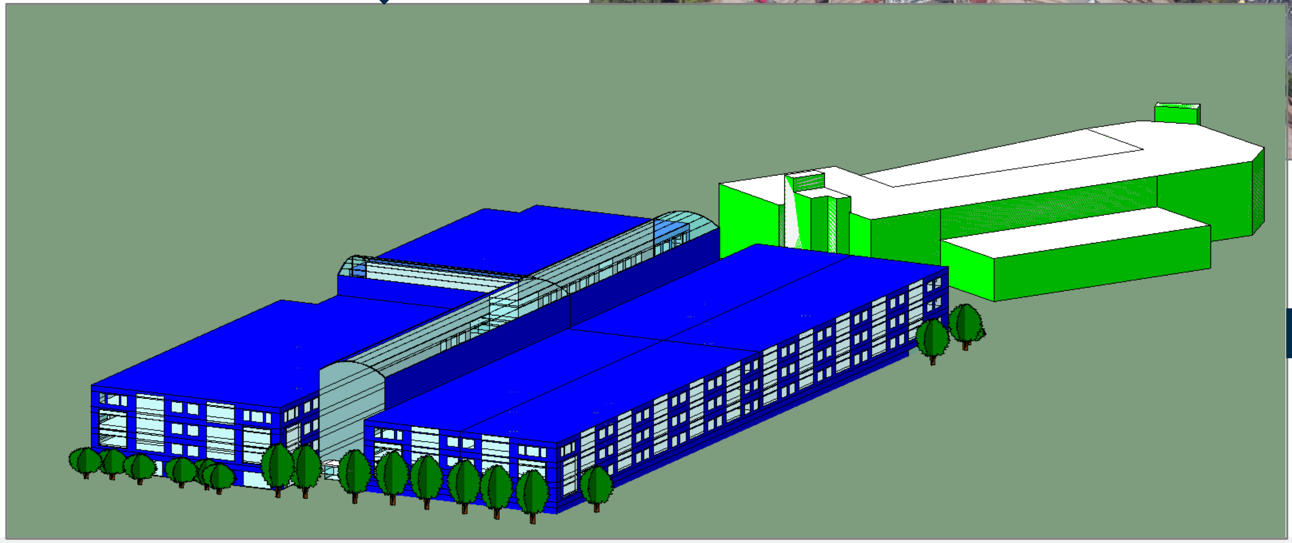
Notes:

- ESG+H = Environmental, Social, Governance + Human/Health
- BIM = Building Information Modelling
- DT = Digital Twin
- MBx = Model-Based Commissioning

Case Study: A Surgical Approach to the Decarbonization of an Existing Building

Know what is possible before you start

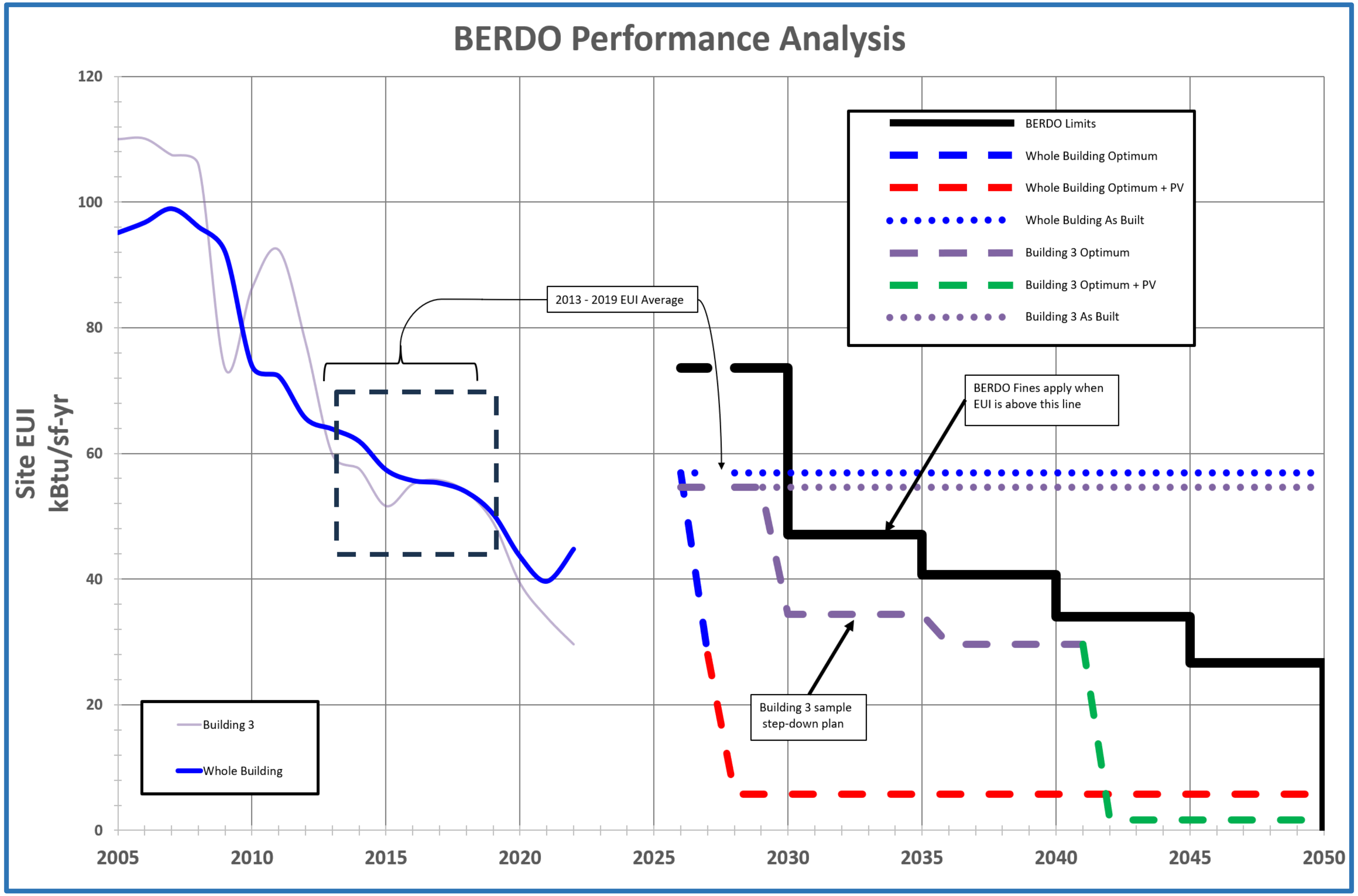
Existing Facility



Virtual Model

Optimum Decarbonization Potential

Visualization of strategies to reach goals



Whole-Building Optimum Model

Potential Energy Conservation Measures (ECM)

Energy Conservation Measures (ECM) were grouped into categories utilizing the natural order of sustainability.

Passive -> Active -> Renewables

Passive ECM's

- Exterior Wall Insulation was increased from R-7 to R-10.
- Roof Insulation was increased from R-15 to R-30.
- Window Replacement with High Performance triple pane glazing and thermally broken frames.
- Implement either a shading device in the atrium roof or replace glazing with electrochromic glass to help control the solar gains when appropriate.
- A whole building air barrier was implemented, and the building airtightness was tested to under 1 ACH_{50}.
- All LED Lighting with motion sensor controls.
- Plug Load reduction strategy. We reduced the current plug loads (1.2 W/ft^2) to 0.6 W/ft^2 when the building is not occupied.

Active ECM's

- Install new ductwork for the return air plenums. While this measure by itself does not impact energy usage, it increases the thermal comfort in the Atrium, and allows for implementation of Heat Recovery.
- Replace RTU's at end of life with an RTU with a minimum 75% Heat Recovery and 60% Humidity Recovery.
- Run the RTU's in economizer mode when appropriate overnight in the summer to reduce the need for active cooling during the day.

Renewables

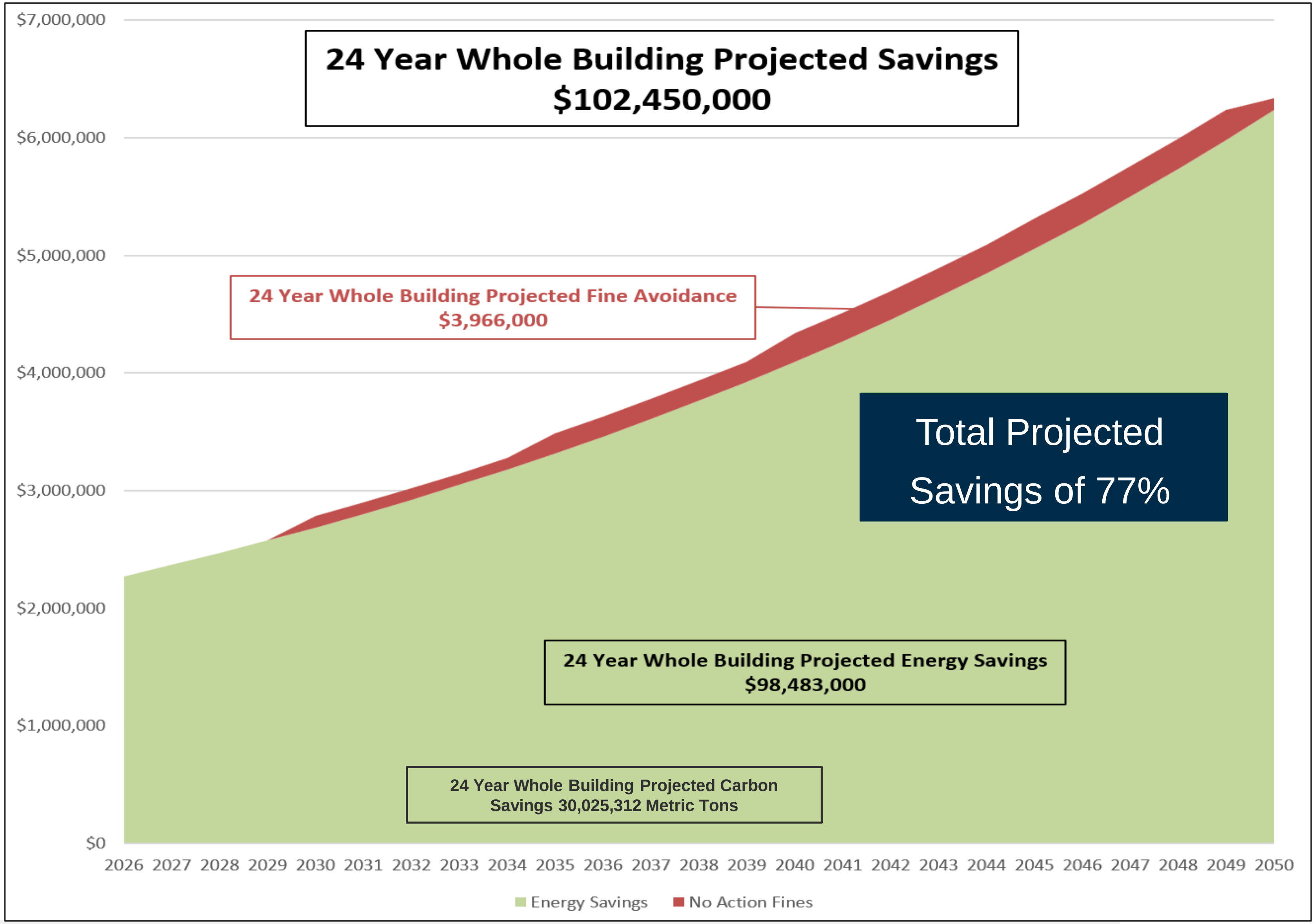
- We have the following area's available to us for rooftop solar panels:
  - Building 1 – 72,600 ft^2 (assume only 60% can be used because of rooftop mechanicals) – **43,560 ft^2**
  - Building 2 – 30,280 ft^2 (assume only 60% can be used because of rooftop mechanicals) – **18,168 ft^2**
  - Building 3 – 37,900 ft^2 (assume only 60% can be used because of rooftop mechanicals) – **22,740 ft^2**
  - Adjacent Parking Garage – **52000 ft^2**
  - **TOTAL: 136,500 ft^2**
- A standard 400-watt rooftop panel with 30-degree tilt, south facing with zero adjacent shading was assumed.
- Implementing these panels over 136,500 ft2 will have the capacity to offset a whole building EUI of 24 kBtu/sf/yr.

AUROS GROUP

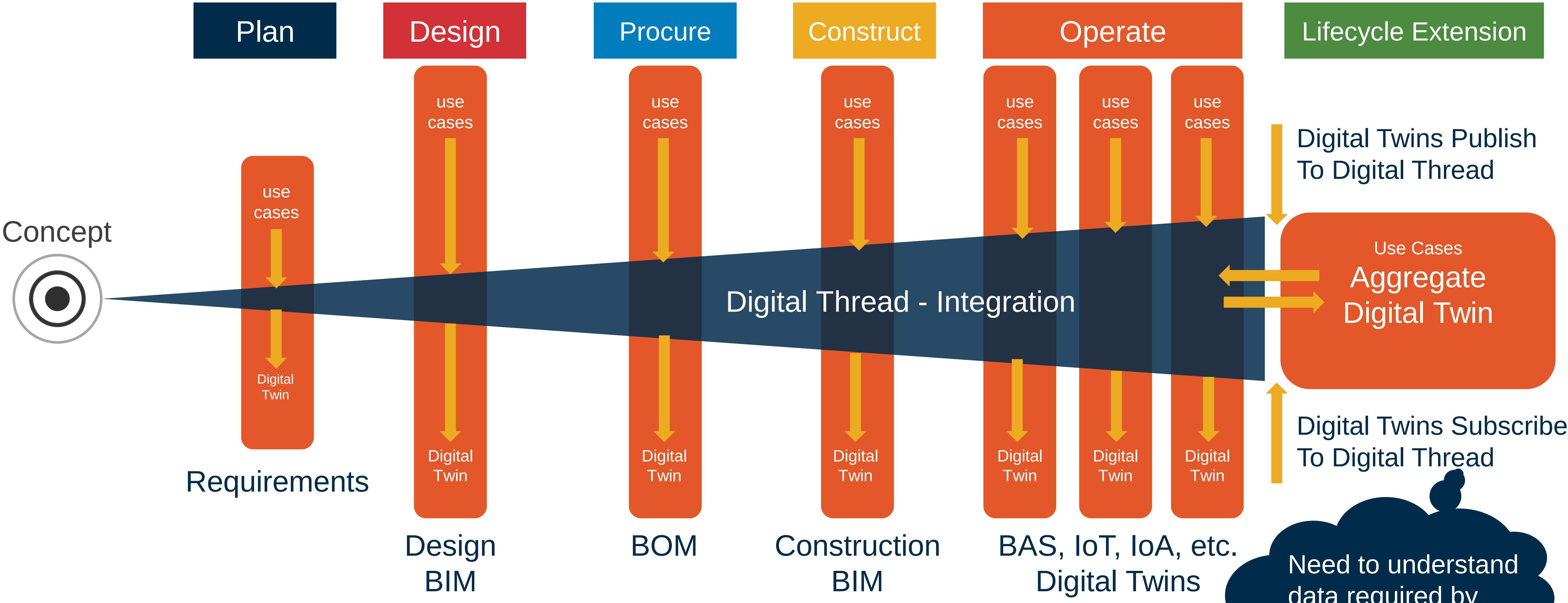
Optimum Decarbonization Potential

Results:

Total projected savings



What is a Digital Thread?



Providing owners with full digital twin value requires an end-to-end integration, with established design and engineering guidelines, a common data platform and language, and relentless oversight.

Communicate

The elimination of paper and paper-based systems through digitization allows our communication to be more effective and delivered via users' system of choice.

Addressing this legacy issue is referred to as the elimination of yesterday's problems.

Collaborate

Communication both enables and drives collaboration. Implementing a digital building lifecycle consolidates that collaboration and drives the need to rethink project delivery frameworks.

The process to enable a digital thread to support the digital building lifecycle is referred to as today's problem.

Correlate

When all parts are coordinated, process standardization produces clean data that, with context, provides information; and with learning can be transformed into knowledge; and applied as competitive advantage.

Tomorrow's problems will be solved through prediction and closed loop analysis.

Digital Twin Use Case Maturity Model Related to Digital Building Lifecycle

ENTERPRISE

5

- Predictive and analytics capability (what-ifs)
- Integration with AI and machine learning
- Organizational democratization of data
- Integrated, evolutionary and managed improvement
- Extensible from buildings to campus and cities

PROACTIVE

4

- Predictive Modeling (e.g. Weather and influence on building performance)
- Simulation (Physics based, human behavior, traffic patterns)
- Closed Loop Analysis to improve overall performance
- Organizational Risk Management and Mitigation
- Energy Conservation Measures

REACTIVE

3

- IoT and IoA Data Integration (e.g. sensors, weather, spaces and people integration)
- Asset Data Integration
- Alerts and Triggers
- Human and Health Related
- Visualization and analysis of real time and historical data

STRUCTURED

2

- Technical Architecture with emphasis on integration with existing systems
- Data Architecture (alignment) and Digitization of Existing Process with emphasis on clean data acquisition
- Graphic Representation to support Context of Data Display
- Alignment with reality capture for existing buildings
- IT / OT governance and interface

FOUNDATIONAL

1

- Organizational Goals (Business Case), Assessment, Mobilization, and Development and Communication of Initial Use Cases
- Assessment and Improvement of BIM and Data Standards including audits and enforcement
- Process Integration to produce clean data and eliminate data silos
- Steering Committee, Governance and Change Management, including baseline performance to support business case
- Training, adoption and celebration of initial successes

Building Information Management

Owner Driven PMO

Leadership and Strategy; Business Benefits; Governance; Communications and Outreach; Program Road Map; Resourcing.

Summary of Key Takeaways

1. Remember buildings consume 40% of our energy
2. Successful outcomes require collaboration of all stakeholders across the building lifecycle
3. Identify the potential performance of your building before you invest
4. The digital thread enables the collaboration to link the potential performance with reality

Contact Information:

- Todd Lukesh, Gafcon Digital: tlukesh@gafcondigital.com
- Beth Eckenrode, Auros Group: beth.eckenrode@aurosgroup.com
- John Turner, Gafcon Digital: jturner@gafcondigital.com
- Johnny Fortune, NIBS: jfortune@nibs.org

Thank you!