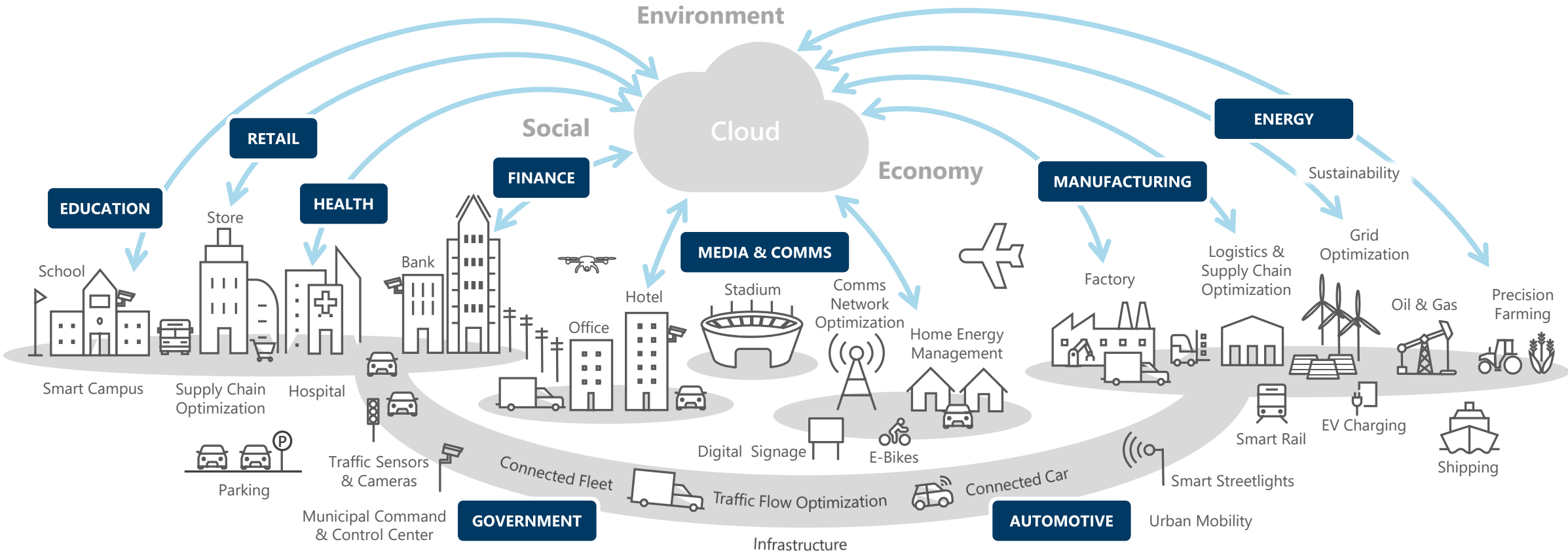
Microsoft

DIGITAL TWINS TRANSFORM ALTERNATIVE ENERGY PRODUCTION

Bert Van Hoof
Microsoft Cloud for Industries

Energy and the built world



TODAY
Intelligent Assets

EMERGING
Intelligent Environments

FUTURE
Intelligent Ecosystems

Changing energy landscape

Equity

Market Forces

- Renewable Energy ↑
- Distributed Energy Resources ↑
- IoT Devices ↑ & Digital Transformation ↑
- Policy and Regulations ↑
- Geopolitical & Energy Market Volatility ↑

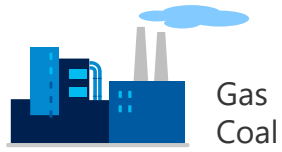
Operational Challenges

- Supply & Demand Volatility ↑
- Aging Grid - Investments ↑
- New Scenarios ↑ (Solar, Electric Vehicle, …)
- Prediction Complexity ↑
- Cybersecurity concerns ↑

Fundamental Changes

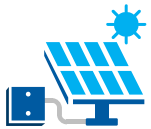
- Bidirectional flow of Electric Power ↑
- Electricity Storage (large quantity) ↑

Electric grid assets and infrastructure

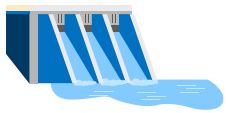


Baseload Power Station

Wind Farms

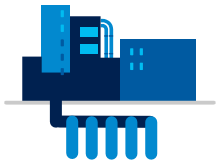


Solar Farms



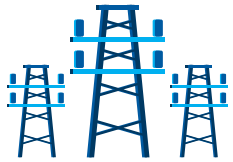
Hydro Power

Nuclear Power

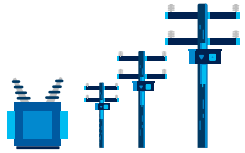


Geothermal Power

- Transmission System moves power from large power plants at high voltage (>69 kV) to the distribution network
- Infrastructure of thousands of miles of cables needed to transport electricity over long distances



Transmission network



Distribution Network

- Infrastructure of cables, substations, and feeders to distribute electricity to customers
- Distribution System "steps down" power from high voltage to medium voltage (<69 kV) at substations

EV Fleet

EV Charging

Streetlights

Home

Commercial Buildings

Industry

Datacenters

Local Storage

Local Solar

Local Wind

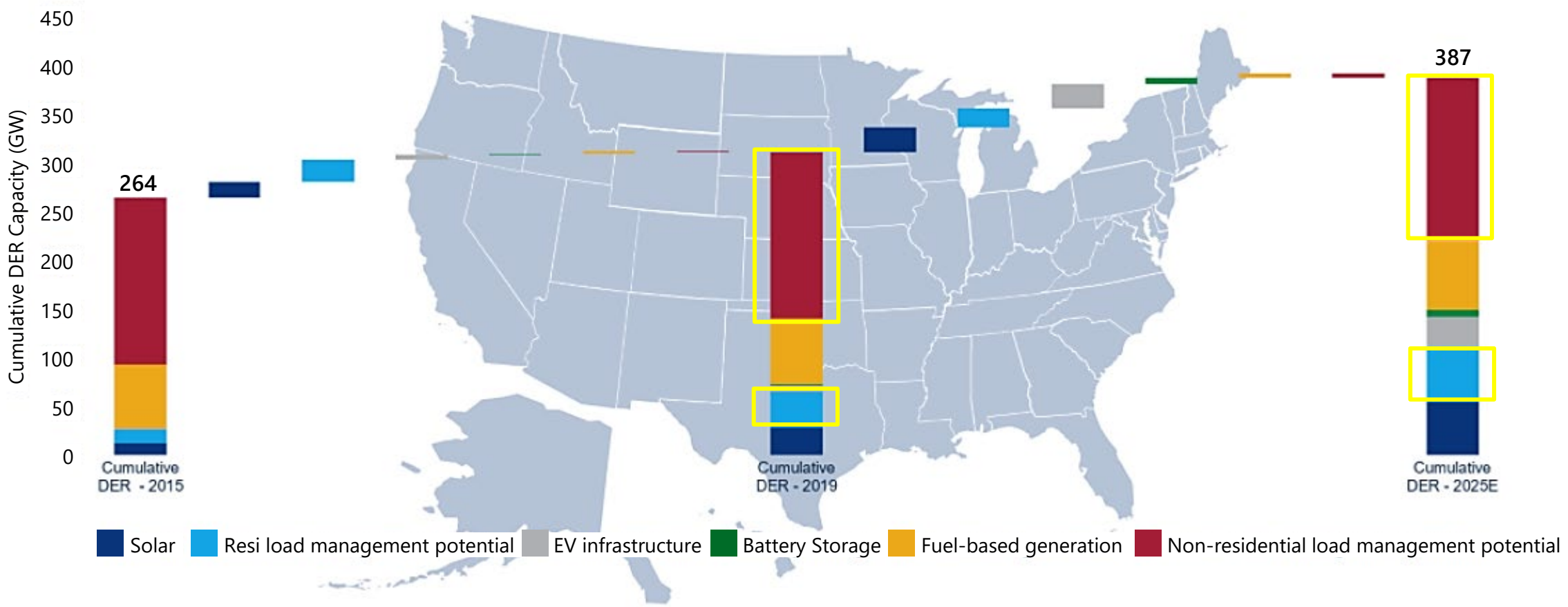
A **distributed energy resource** (DER) is a **local unit of power generation, connected** to a larger power grid **at the distribution level**

Customers generate and store their own electricity through solar panels, batteries, electric vehicles, fuel cells, microturbines, generators

Electric grid market mechanics ($)

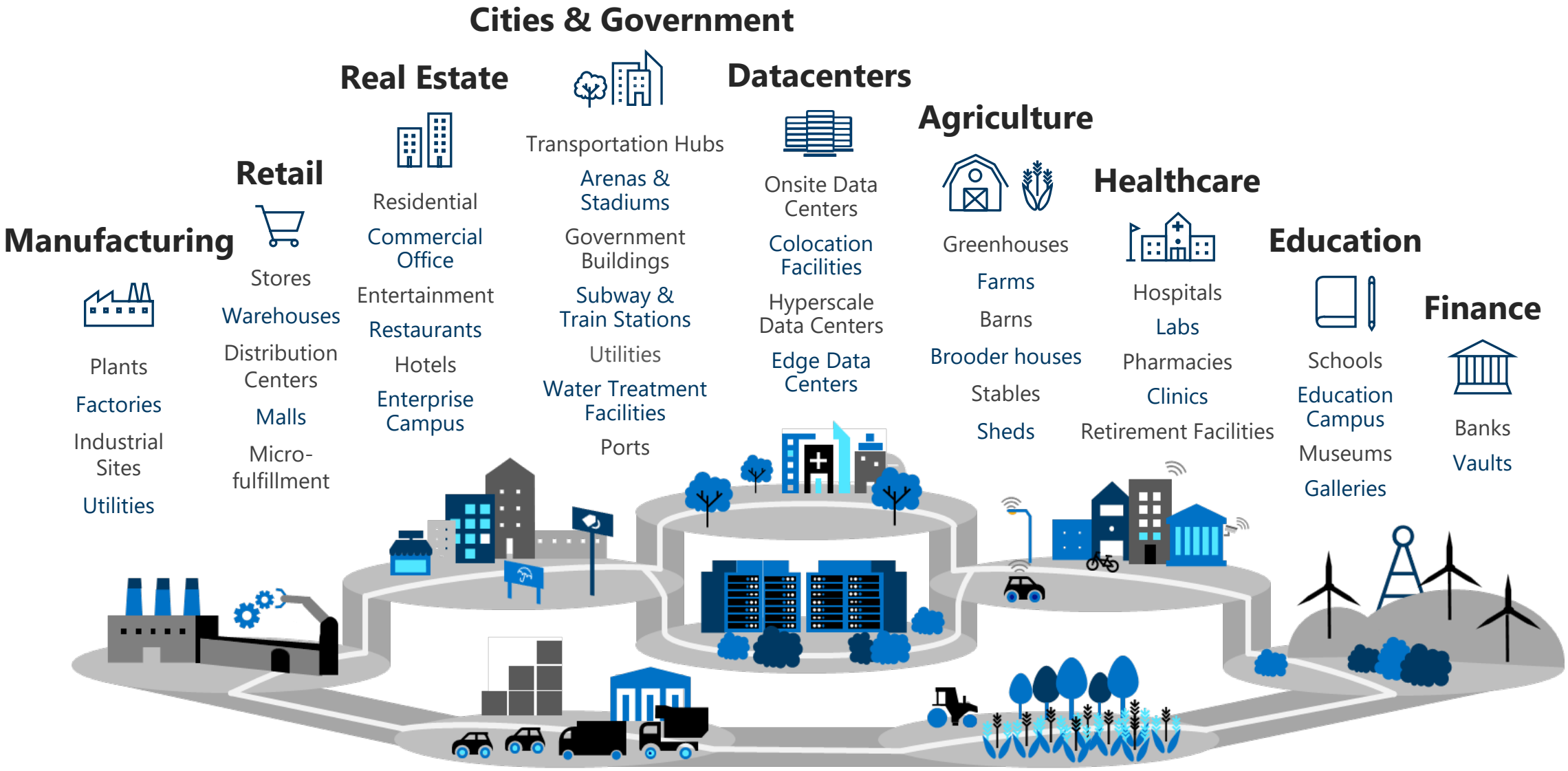
DER Capacity in the United States

Cumulative DER capacity additions by resource and customer type (2016 – 2025)



Source: Wood MacKenzie Energy Storage, Grid Edge Service, U.S. Distributed Solar Service; U.S. Department of Energy

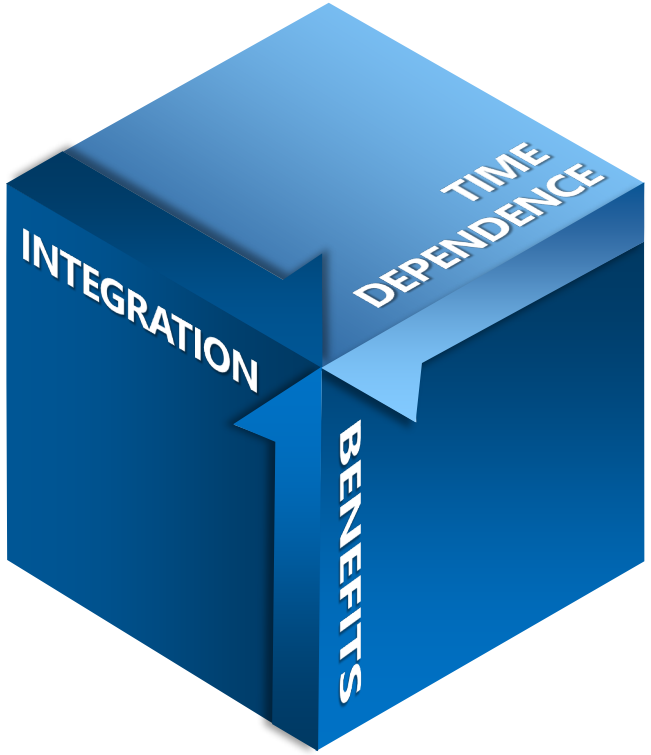
Smart buildings and facilities



Active Efficiency

Optimize energy use by blending traditional energy efficiency measures with digital transformation

Coalesce well-established energy efficiency approaches with the new capabilities of digital twins, distributed energy resources, and key decarbonization strategies



Autonomous systems

Static (building envelope improvements)
→ Real-time response and interaction (demand response / demand flexibility)

Multi-system integration

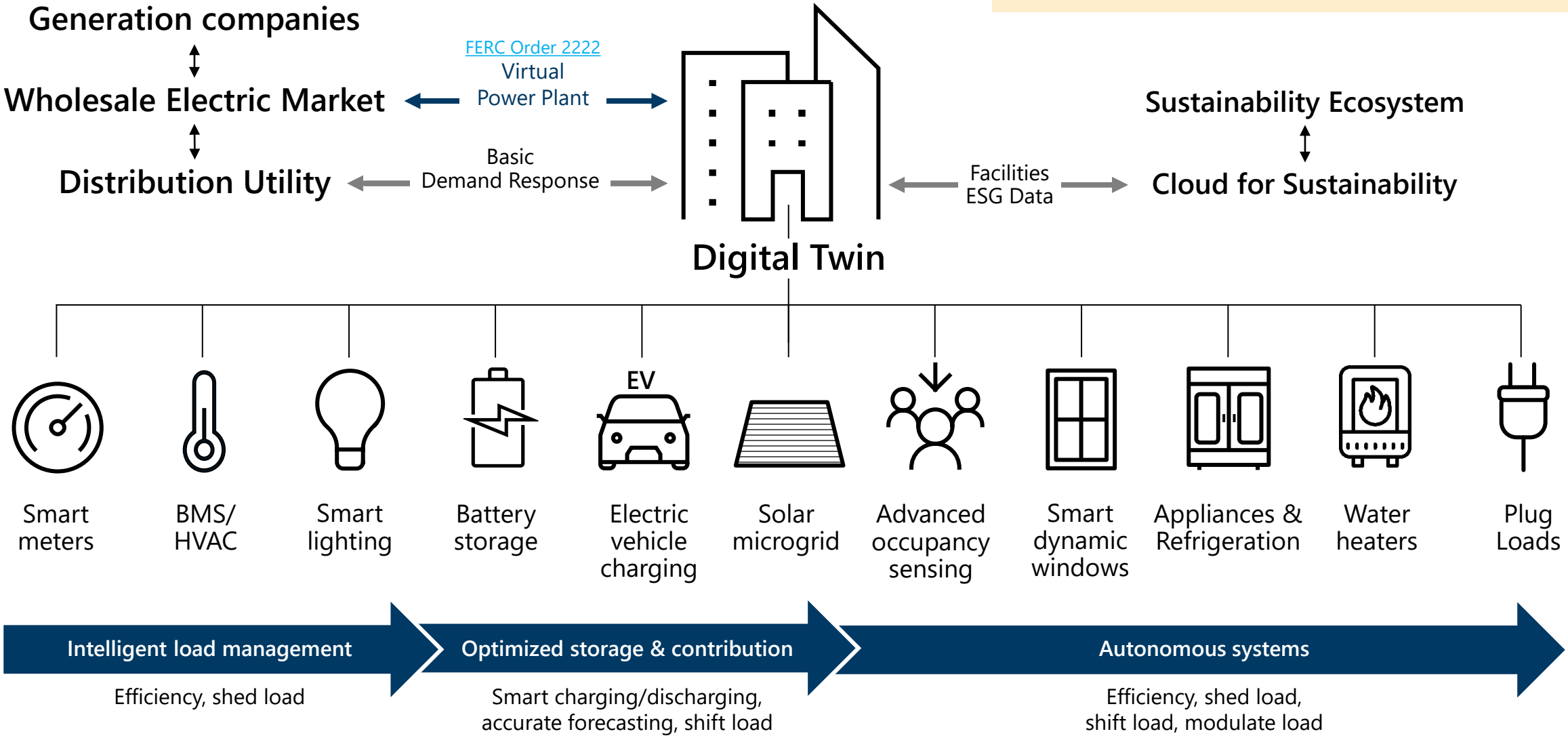
Component-level (LEDs)
→ multi-system, cross-ecosystem integration (GEB, EV2G, EV2H)

Multi-dimensional benefits

Energy savings and economic productivity
→ Resilience, health, and GHG reductions

Grid-interactive Efficient Buildings

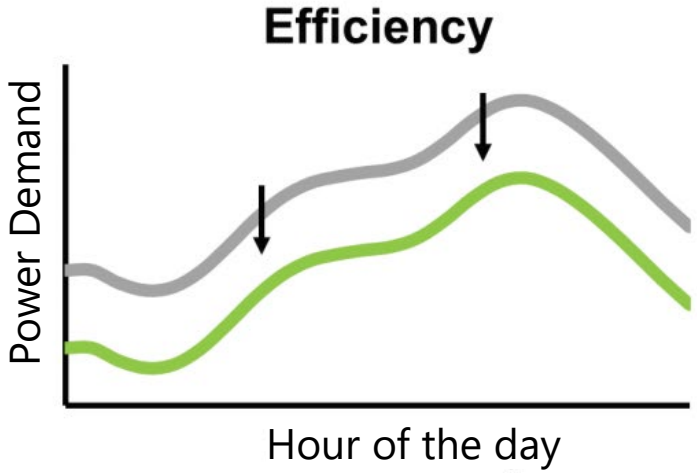
The U.S. Department of Energy (DOE) estimates national adoption of Grid-interactive Efficient Buildings will be worth $100 - 200B in electric power system cost savings. A National Roadmap for GEBs

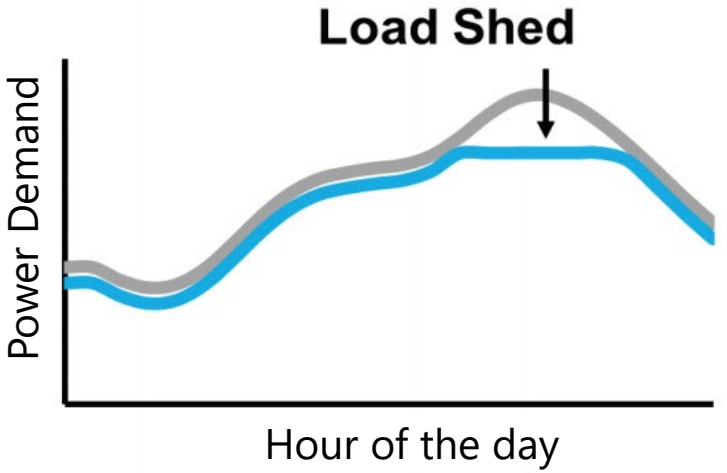


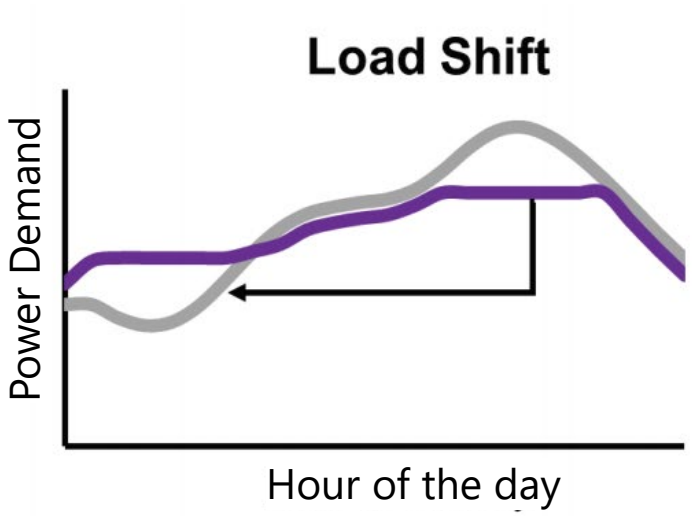
Intelligent load management

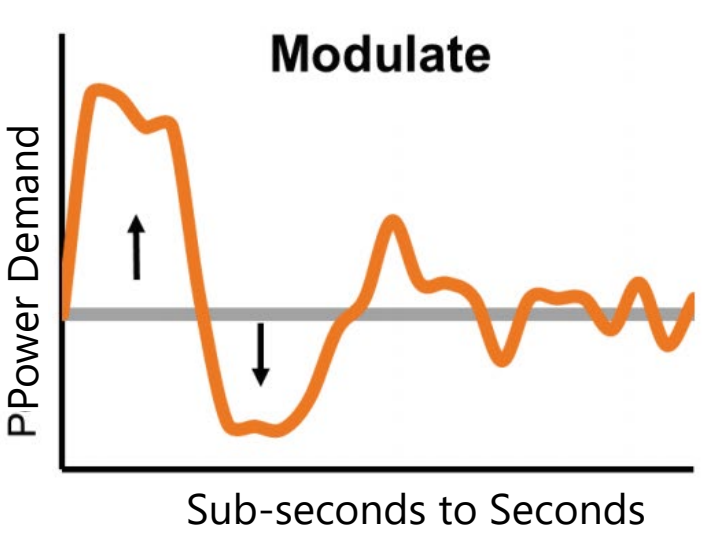
Flexibility Load Curves

In these graphs, the gray curve represents an example baseline building load and the colored curves (green, blue, purple and orange) show the resulting building load.

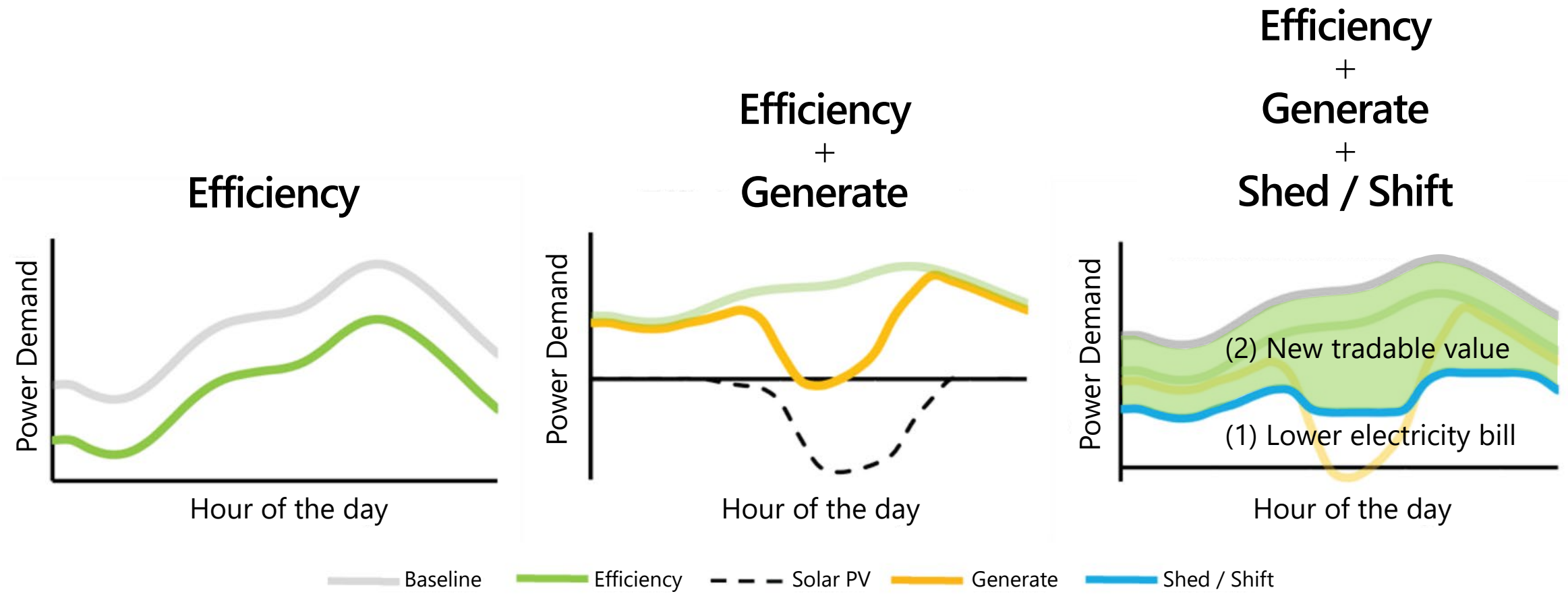








New incentives



Traditional control systems have reached their limits

Static and rigid

Cannot consider
all observable data

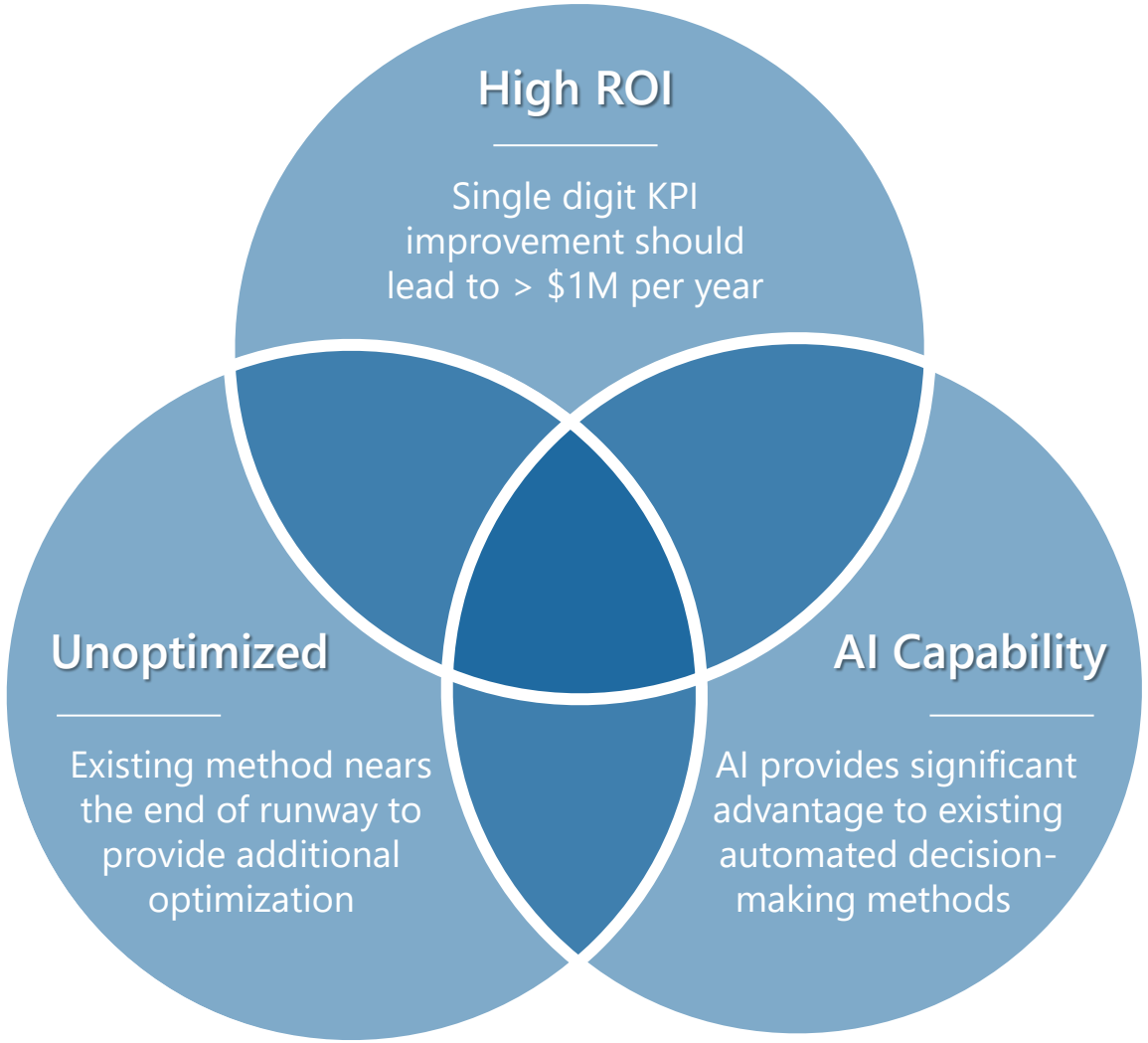
Lack imagination

Traditional control systems fall short or do not go the last mile when you have too many inputs/outputs to optimize, or things are changing in an unpredictable way

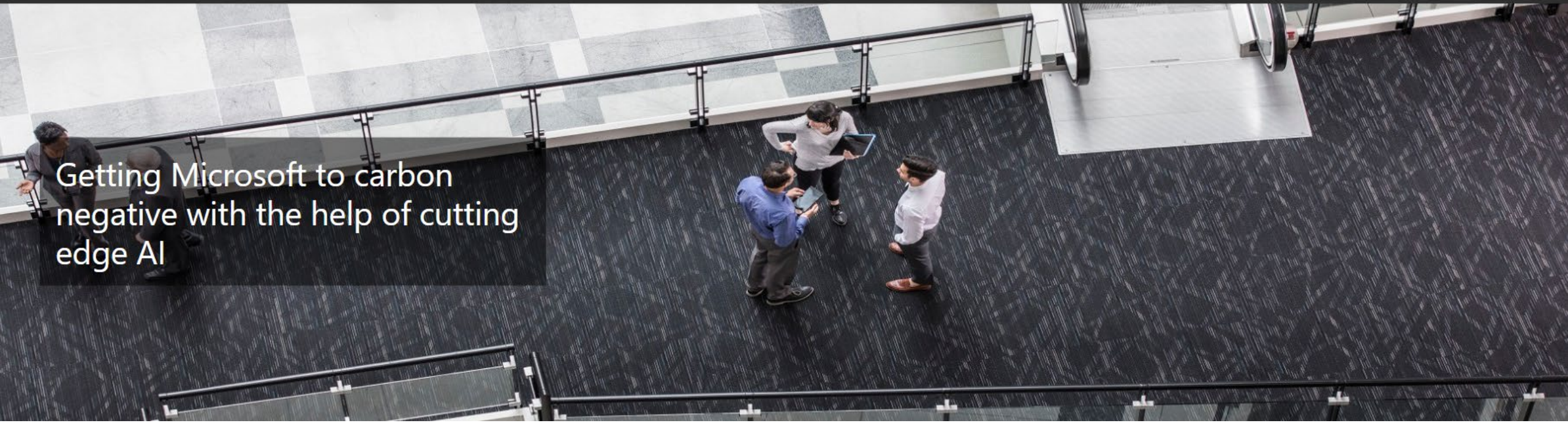
Enterprise Use Cases for AI Brains

Business Decision Maker's Guide to Selecting Use Cases

Not every control or optimization application requires an AI brain, but brains offer unique characteristics compared to control theory and optimization algorithms



If humans are required to supervise or augment an automated control system, an AI brain will likely improve human performance



Getting Microsoft to carbon negative with the help of cutting edge AI

The more variables and controllers that are in a system, the harder it is for a human to optimize it.

Mohan Reddy:
Director - GWS
Microsoft

If we could reduce energy consumption by 15% just by changing a few set points – I must imagine there are a lot of other areas where the AI approach can help.

Tearle Whitson:
Sr. Director
CBRE

We had our experts work with Project Bonsai to make sure the AI we were creating knew everything we knew.

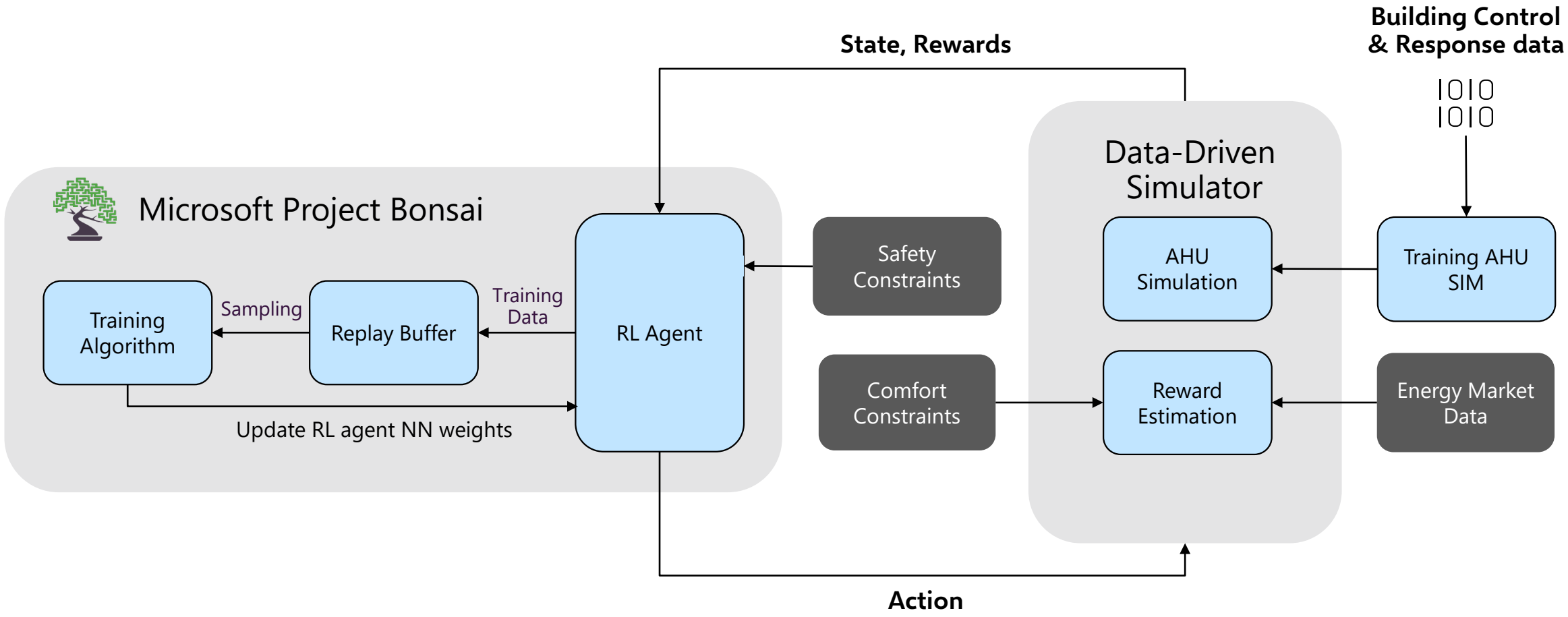
Ray Nichols:
Chief Engineer
CBRE

With Project Bonsai, we uncovered recommended optimizations that we never could have come to on our own.

Brendan Bryant:
Mechanical Engineer
DB Engineering

AI-based energy optimization recommendation

Autonomous Systems: AI-powered automation that optimizes your equipment, systems, and processes by sensing and responding in real-time



Superpowers of Autonomous AI

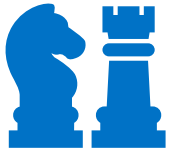
More human-like decision making for specific use cases

Perceives, then Acts

Learns and Adapts

Spots Patterns

Plans Ahead

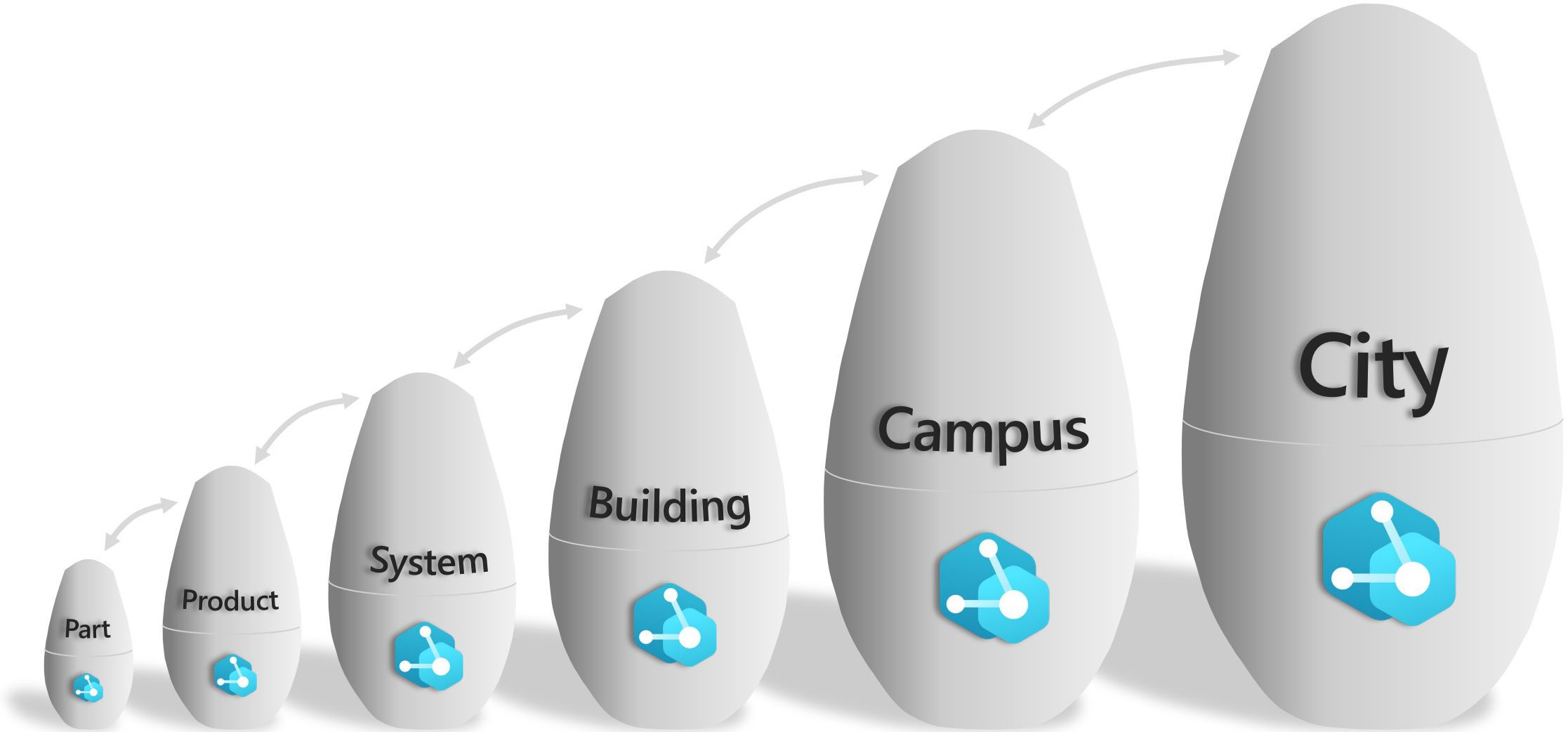


Strategizes

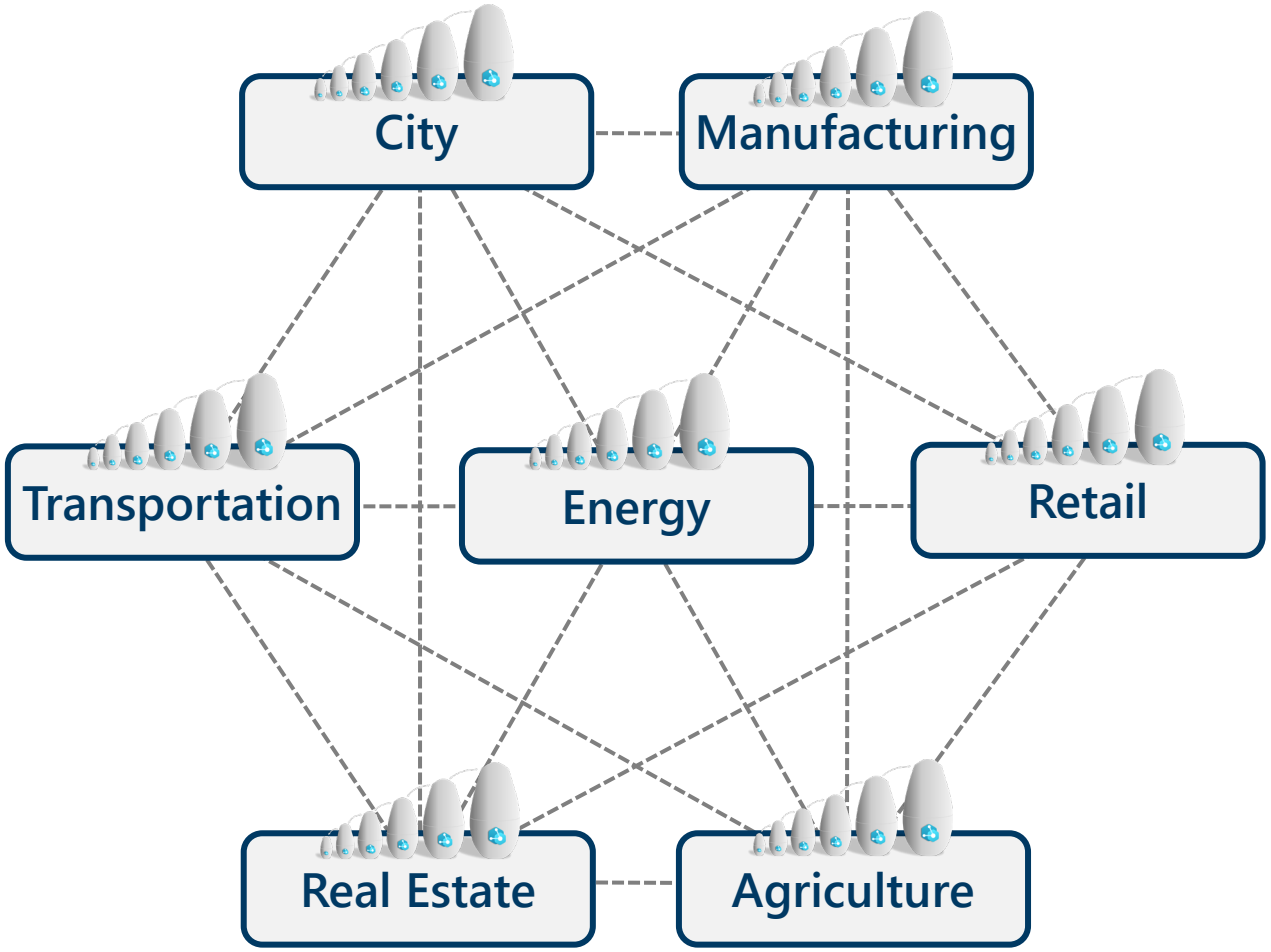
Infers from Experience

Twin-Twin federation

"Russian dolls" of digital twins



Intelligent ecosytems

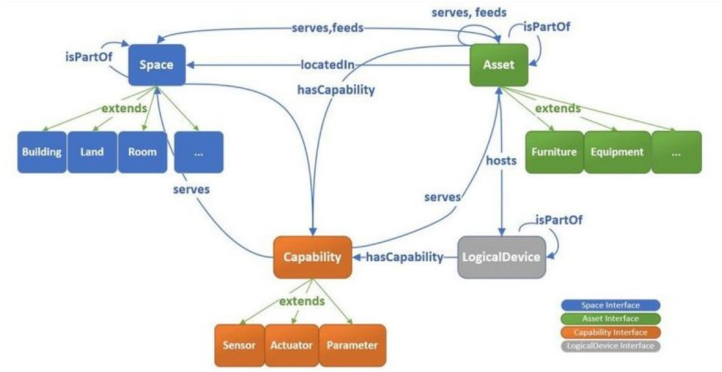


Open-source digital twin ontologies

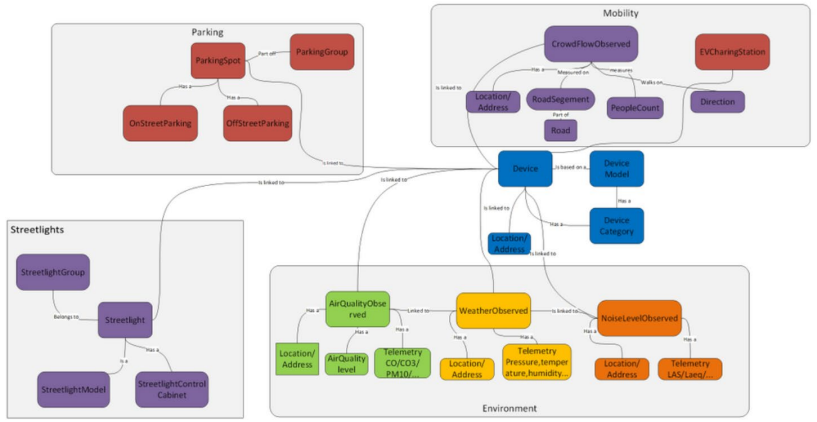
RealEstateCore

ETSI

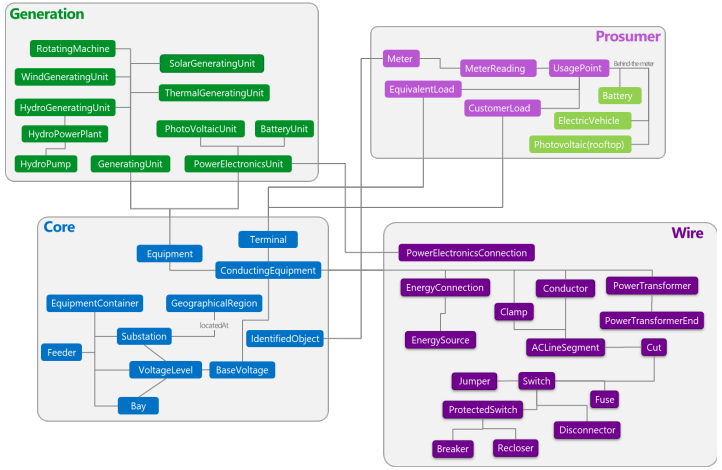
IEC



[Open-source DTDL-based Smart building ontology]

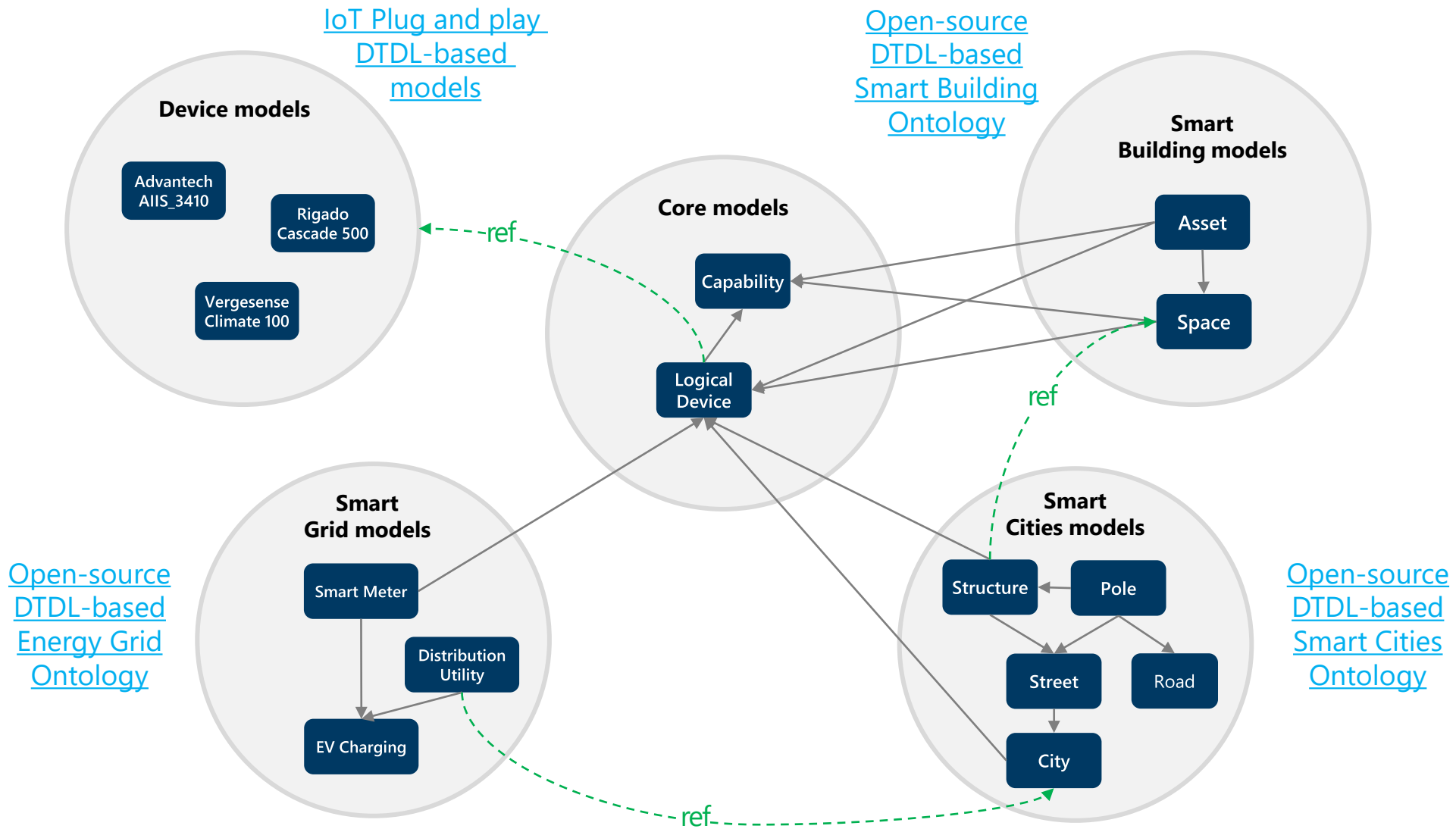


[Open-source DTDL-based Smart cities ontology]



[Open-source DTDL-based Energy grid ontology]

Ontology federation



Microsoft's presence in Georgia

We want to create a positive impact as an active partner in the Atlanta community. We are excited to work hand in hand with local organizations and community groups in Atlanta to ensure Microsoft and the city thrive

- **Atlantic Yards campus**
  Located in the heart of the Midtown, one of Atlanta's most vibrant and bustling neighborhoods, close to public transportation stations, key Microsoft customers and partners, premier dining and shopping, and a handful of Georgia colleges and universities
- **New 90-acre campus**
  on a parcel of land at Quarry Yards and Quarry Hills on the Westside, purchased by Microsoft
- **New datacenter region**
  Presence in Douglas and Fulton counties
- **Affordable broadband**
  for more people in Atlanta, including through our national Airband Initiative
- **Support non-profit organizations**
  through greater access to technology and funding for Atlanta's diverse and critical non-profit organizations
- **Digital Skilling Programs**
  Adding to Microsoft's own skilling programs on AI and our existing Technology Education and Literacy in Schools (TEALS), work with strong non-profits in Atlanta that have existing impressive skilling programs
- **Facilities for the community**
  Setting aside 25% of our expansion site for the construction of affordable and empowered housing and other local community services and needs
- **Close Opportunity gaps**
  Creating programs that aim to close opportunity gaps, partnering with the many historic universities in the area
- **Environmental sustainability**
  Being a carbon negative, water positive, zero waste company by 2030 is engrained into our designs with focus on environ-mental justice and equity solutions

Mapping energy efficiency for a just transition

Problem Statement

A clear gap in building energy efficiency data and integration of equity data limits the ability for policymakers, investors, and building developers to target retrofitting and building efficiency to households and community buildings with the highest energy burdens.

Environmental Challenges

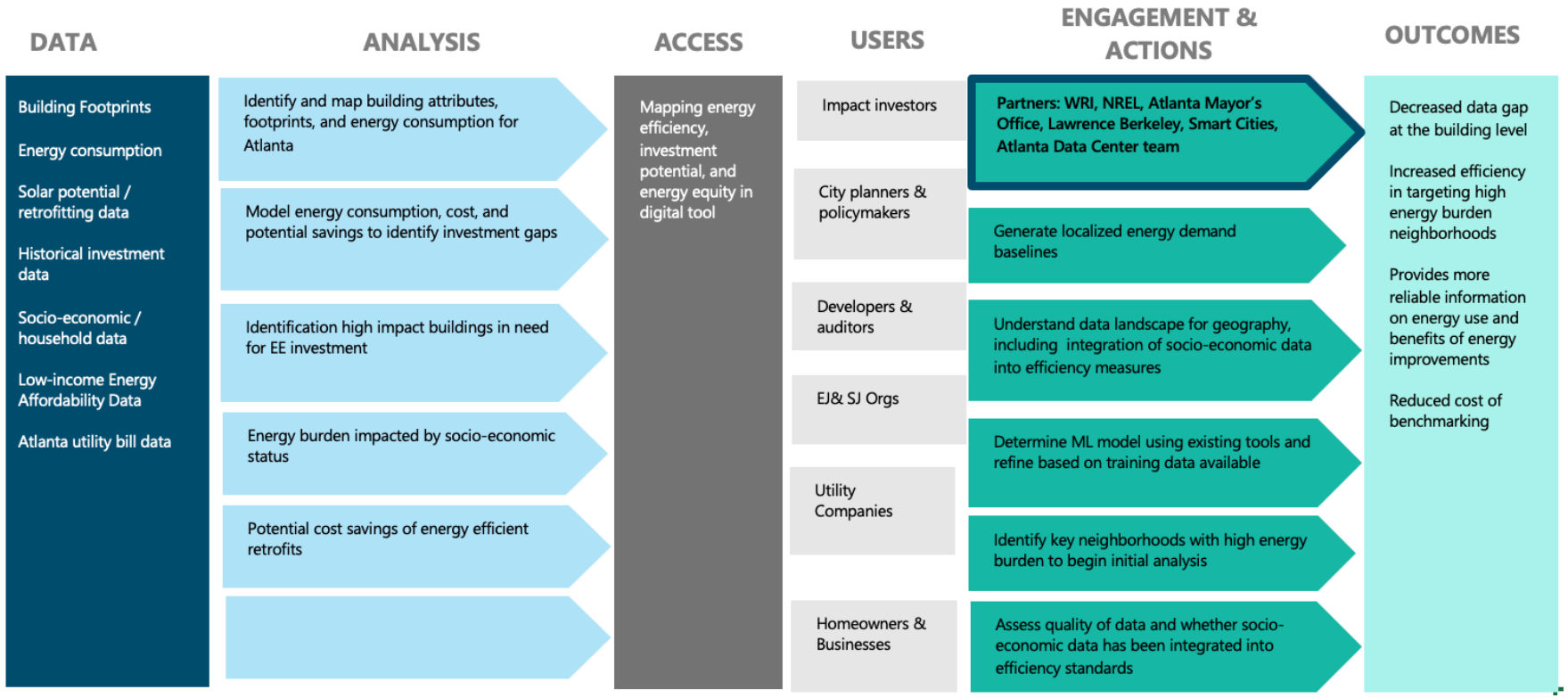
- Buildings account for 76% of electricity use and 40% of all US energy use
- Inefficiencies disparately impact low-income households who spend 7.2 – 10 percent of their incomes on energy

Business Case

- Energy benchmarking supports policymakers and developers in designing targeted & impactful solutions for increasing energy efficiency. To do so, they need access to data (high resolution spatial data, building footprints, socio-economic indicators) and analytics that allows them to develop interventions to alleviate cost and inefficiencies in high-energy burden areas.

Data Gaps

- Limited access to building heights and floor areas to support cost-effective and accurate models of building energy consumption
- Lack of AI/ML models for energy consumption prediction make benchmarking a costly and prone to error practice
- Integration of socio-economic data into efficiency benchmarking




Microsoft