

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 201: Sustainable Urban Mobility

201 A: Introduction to Urban Mobility & Policy

TRAINER

- Selen İnal



Agenda

MODULE 1 - Introduction to Urban Mobility & Policy

- Introduction to Sustainable Urban Mobility
- The EU Green Deal and Urban Mobility
- What is a Sustainable Urban Mobility Plan (SUMP)
- Public vs Private Transport: Shaping Future Cities
- Group Discussion: Mobility Goals and Local Challenges

Training Module Objectives



- Understand the Concept of Urban Mobility
- Recognize Key Components of Urban Transport Systems
- Differentiate Between Public and Private Transportation
- Explore the Principles of Sustainable Urban Mobility.
- Familiarize with Policy Frameworks and Strategic Planning Tools
- Evaluate Global and Regional Case Studies
- Engage in Critical Reflection on Local Challenges

Introduction to Sustainable Urban Mobility

Definition of Urban Mobility

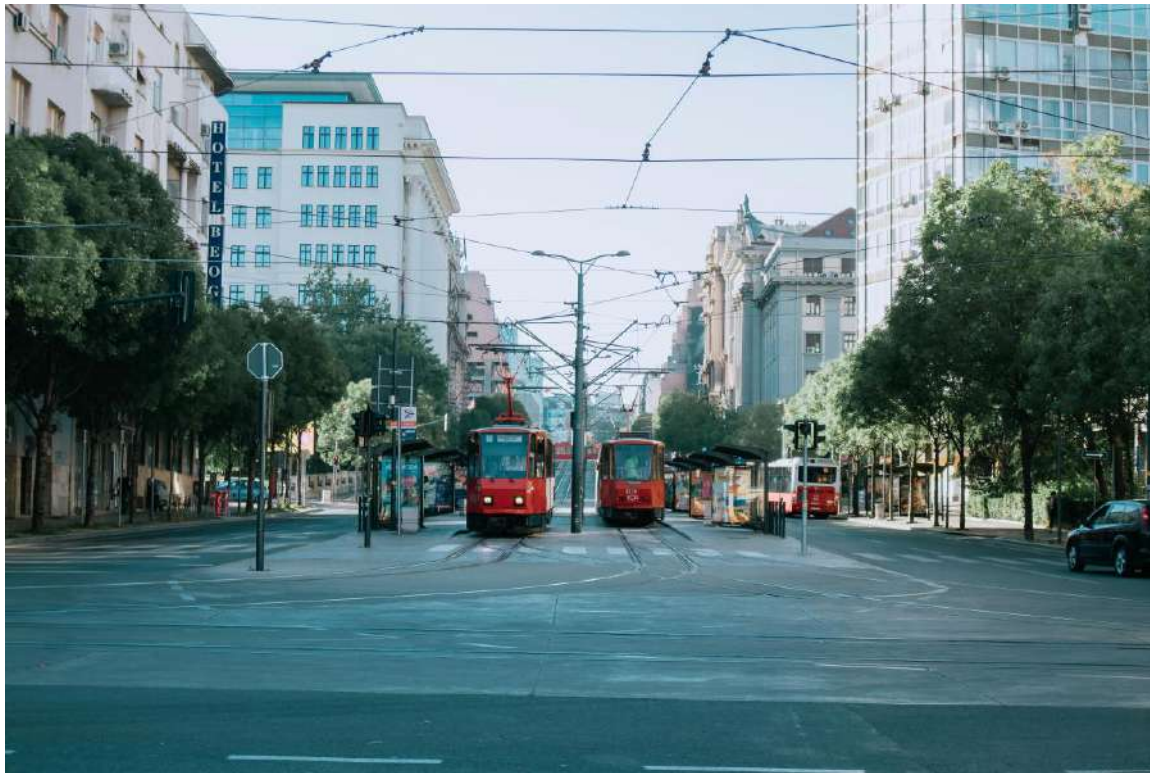
- Movement of people and goods within urban areas using various transportation modes such as walking, cycling, public transit, and private vehicles.
- Planning, management, and provision of transportation services and infrastructure to ensure efficient, safe, and sustainable mobility for urban residents.



Key Components of Urban Mobility 1

- **Transportation Modes:** Public transport, private Vehicles, non-motorized, shared mobility, freight
- **Infrastructure:** Roads, highways, intersections, rail tracks, transit stations, hubs, sidewalks, crosswalks, pedestrian zones, dedicated bike lanes, parking, bike stations, smart traffic systems, IoT sensors
- **Technology & Data:** Intelligent Transport Systems (ITS), Mobility-as-a-Service (MaaS) platforms, GPS, real-time tracking, data analytics for planning and optimization





Key Components of Urban Mobility 2

- **Urban Planning & Land Use:** Transit-Oriented Development (TOD), mixed-use and compact development, zoning to reduce sprawl
- **Sustainability & Environment:** Low-emission zones, e-vehicles, EV charging, green corridors, carbon monitoring
- **Governance & Policy:** Sustainable Urban Mobility Plans (SUMP), infrastructure funding & public-private partnerships, regulations on access, emissions, and accessibility
- **User Behavior & Engagement:** Travel behavior insights, public participation and feedback, awareness campaigns (safety, health, sustainability)



Objectives of Urban Mobility

- Enhance accessibility and connectivity within urban areas.
- Reduce traffic congestion and environmental impact.
- Promote sustainable and inclusive transportation solutions.

Effective urban mobility systems aim to improve the quality of life for city dwellers by providing reliable and diverse transportation options that cater to the needs of all users.

What is Sustainable Urban Mobility ?

- Transportation systems and planning strategies that aim to meet the mobility needs of people and businesses in urban areas while
 - minimizing **environmental** impact,
 - promoting **social** equity, and
 - enhancing **economic** viability.

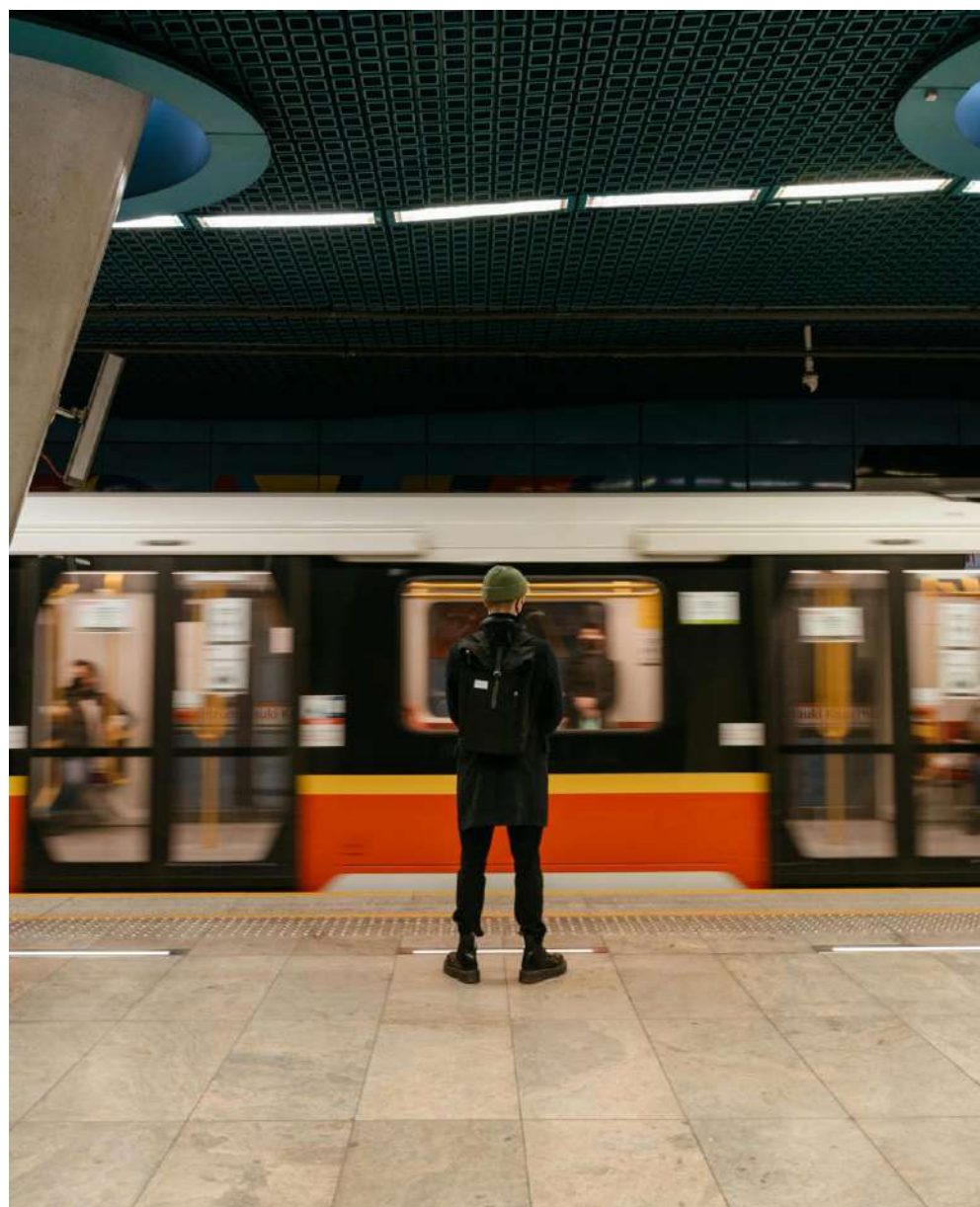
Emphasizes the integration of various transportation modes, prioritizing public transport, walking, cycling, and low-emission vehicles to create efficient and inclusive urban mobility solutions.





Key Objectives of Sustainable Urban Mobility

- **Environmental Sustainability:** Reducing greenhouse gas emissions, air and noise pollution, and energy consumption through the promotion of clean and energy-efficient transport modes.
- **Social Equity:** Ensuring accessible and affordable transportation options for all individuals, including those in vulnerable situations, to improve inclusivity and quality of life.
- **Economic Efficiency:** Enhancing the efficiency of urban transport systems to support economic development and competitiveness.
- **Integrated Planning:** Coordinating land use and transport planning to create compact, connected, and sustainable urban environments.



Examples of Sustainable Urban Mobility

- **Environmental Sustainability:** Electrification of fleets (e.g., Oslo: 35% emission cut via LEZs and EV rollout), Integration of renewables into transit infrastructure, Use of Life Cycle Assessments to guide sustainable infrastructure investments
- **Social Equity:** Accessible public transport within 10-min walk for 90% of population, Inclusive design for vulnerable groups (elderly, low-income, disabled), Vision Zero and safety benchmarks: e.g., Sweden halved pedestrian fatalities
- **Economic Efficiency:** Congestion = GDP loss; TOD unlocks €4 in benefit per €1 invested, Electrification reduces bus operation costs by 30–50%, Transit-linked real estate & local businesses benefit from better access



Why Do We Need Sustainable Urban Mobility?

- Urban transport accounts for ~25% of global emissions
- Congestion costs billions in lost productivity annually
- Rising public health risks: Respiratory illness, stress, inequality
- Sustainable mobility is critical for resilient, inclusive urban futures

The 15-Minute City Concept



$\frac{1}{4}$ mil = 800 metre

- The 15-Minute City is an urban model where essential services are accessible within a 15-minute walk or bike ride, aiming to reduce car use, enhance livability, and support local economies.
- 15-Minute City Implementations:
 - Paris, France
 - Melbourne, Australia
 - Portland, USA

Core Principles of 15-Minute City Concept

- Proximity
- Walkability and Bike-Friendliness
- Mixed and Diverse Land Use
- Strong Local Economies
- Green and Public Spaces
- Reduced Car Dependency
- Inclusivity and Community Engagement



$\frac{1}{4}$ mil = 800 metre

The EU Green Deal and Urban Mobility

E.U. Green Deal: Transforming Transport

- The European Green Deal is the EU's roadmap to becoming climate-neutral by 2050.
- Transport accounts for approximately 25% of the EU's greenhouse gas emissions.
- The Green Deal aims for a 90% reduction in transport-related emissions by 2050.
- Emphasis on sustainable, smart, and inclusive mobility systems.



Source: <https://www.transportenvironment.org>

EU's Strategy for Sustainable and Smart Mobility

- Introduced in December 2020 as part of the Green Deal.
- Aims to make the EU transport system sustainable, smart, and resilient.
- Outlines 10 key areas (“flagships”) with 82 initiatives to guide actions until 2024.
- Focus areas include zero-emission vehicles, digitalization, and enhancing public transport.



Europe must reduce emissions from transport further and faster.

Urban Mobility's Role in the Green Deal

- Urban areas are central to achieving the Green Deal's transport objectives.
- Promotion of Sustainable Urban Mobility Plans (SUMPs) for cities.
- Focus on enhancing public transport, cycling, and walking infrastructure.
- Integration of innovative mobility services and digital solutions.



Source: <https://www.worldbank.org>

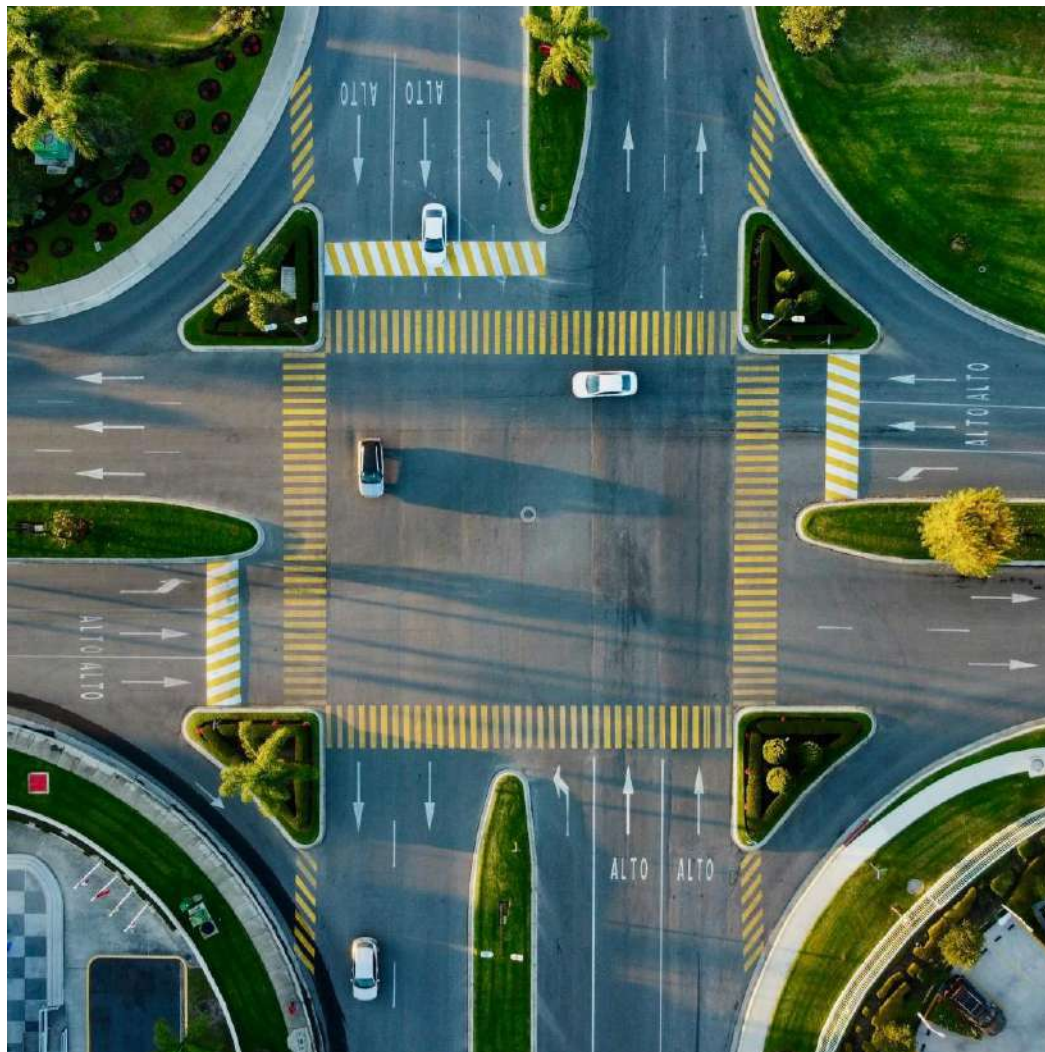
Challenges and Opportunities

Challenges:

- Infrastructure limitations and funding constraints.
- Public resistance to change and behavioral habits.
- Technological integration and data management.

Opportunities:

- Access to EU funding and support programs.
- Potential for innovation and economic growth.
- Improved public health and environmental benefits.



What is a Sustainable Urban Mobility Plan (SUMP) ?



Source: <https://planningedinburgh.com>

Sustainable Urban Mobility Plan (SUMP)

- A strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life.
- Builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles.
- Should cover the entire functional urban area, considering real traffic flows and commuting patterns.

Core Principles of SUMP

- Plan for sustainable mobility in the functional urban area
- Cooperate across institutional boundaries
- Involve citizens and stakeholders
- Assess current and future performance
- Define a long-term vision and clear implementation plan
- Develop all transport modes in an integrated manner
- Arrange for monitoring and evaluation
- Assure quality



Source: <https://www.spiceworks.com>

Phases of the SUMP Planning Cycle 1

Phase I – Preparation & Analysis:

- Initiate the planning process with political commitment.
- Analyze the current mobility situation and identify key issues.



Source: <https://www.boell.de>

Phase II – Strategy Development:

- Develop a long-term vision and set strategic objectives.
- Engage stakeholders to define priorities.

Phases of the SUMP Planning Cycle 2

Phase III – Measure Planning:

- Identify and assess potential measures.
- Develop an integrated package of measures.

Phase IV – Implementation & Monitoring:

- Prepare for implementation, including financing and responsibilities.
- Monitor and evaluate the implementation process.



Source: <https://www.boell.de>

Why Implement a SUMP?



- Improved accessibility and mobility for all citizens.
- Enhanced quality of life through reduced congestion and pollution.
- Economic benefits from efficient transport systems.
- Environmental sustainability by reducing greenhouse gas emissions.
- Increased safety and security in urban transport.

Public vs Private Transport: Shaping Future Cities

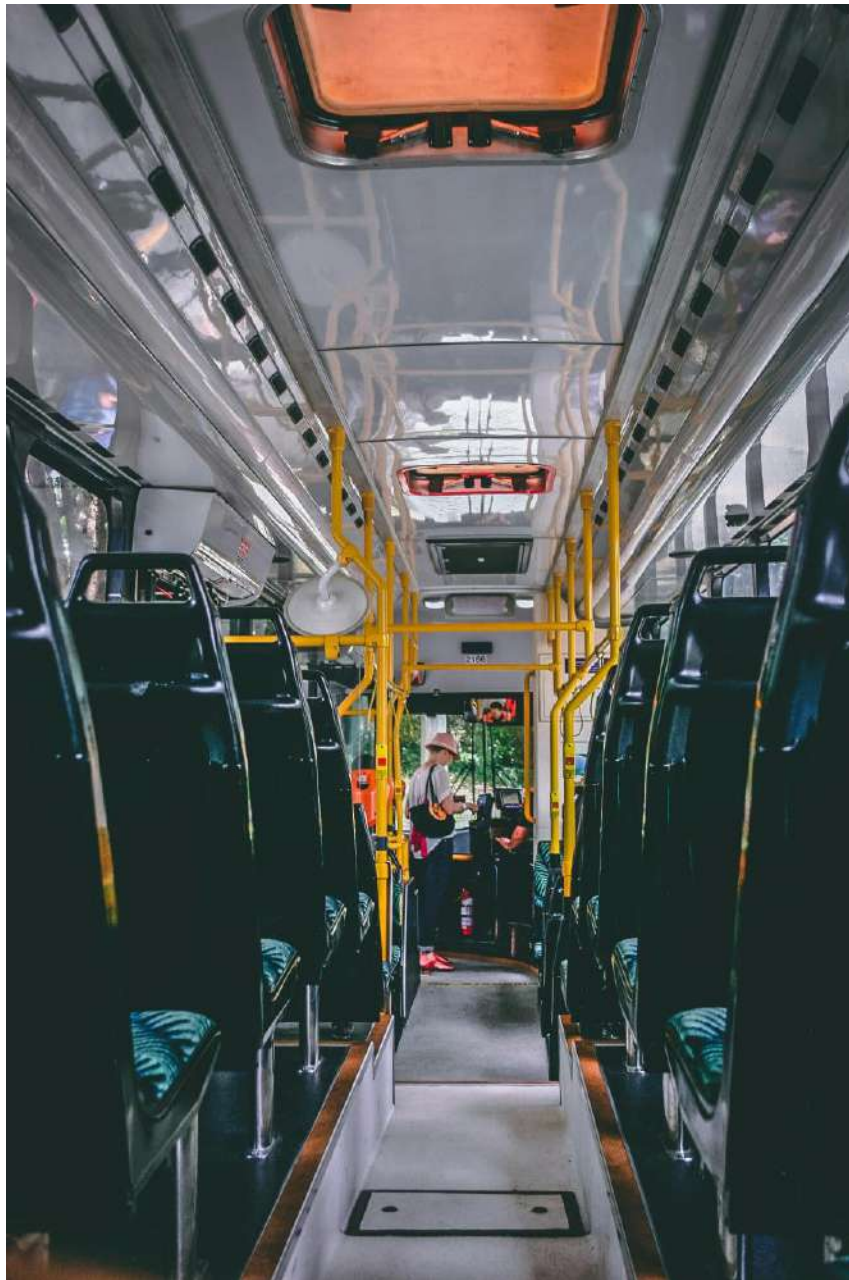


Public vs. Private Transport: An Overview

- **Public Transport:** Shared transportation services available to the general public, including buses, trains, subways, and trams.
- **Private Transport:** Personal vehicles such as cars, motorcycles, and bicycles owned and operated by individuals.
- Understanding the characteristics, benefits, and challenges of each mode is crucial for urban mobility planning.

Benefits of Public Transportation

- Environmental Impact
- Cost Efficiency
- Traffic Reduction
- Accessibility
- Public Health



Limitations of Public Transportation

- **Coverage Gaps:** Limited reach in suburban or rural areas.
- **Scheduling Issues:** Fixed schedules may not align with all users' needs.
- **Overcrowding:** Peak hours can lead to discomfort and delays.
- **Maintenance and Funding:** Requires significant investment to maintain infrastructure and service quality.



Benefits of Private Transportation

- **Flexibility:** Allows for travel at any time without dependence on schedules.
- **Convenience:** Direct routes without transfers.
- **Privacy:** Personal space during travel.
- **Accessibility:** Essential in areas lacking public transport options.



Limitations of Private Transportation

- **Environmental Impact:** Higher emissions contributing to air pollution and climate change.
- **Traffic Congestion:** Increased number of vehicles leads to longer commute times.
- **Cost:** Expenses related to fuel, maintenance, insurance, and parking.
- **Urban Space:** Requires substantial infrastructure and parking spaces, reducing land availability for other uses.



A Comparative Overview



- **Cost to User:** Public transport is generally more affordable.
- **Environmental Impact:** Public transport has a lower carbon footprint.
- **Flexibility:** Private transport offers more flexibility in terms of time and route.
- **Accessibility:** Public transport provides broader access, especially for non-drivers.
- **Urban Planning:** Public transport supports higher-density, sustainable urban development.

Shaping the Future of Urban Transport

- **Integration of Modes:** Developing seamless connections between public and private transport options.
- **Technological Advancements:** Adoption of electric vehicles, autonomous transport, and smart infrastructure.
- **Policy Initiatives:** Implementing measures like congestion pricing and low-emission zones.
- **Sustainable Planning:** Promoting active transport modes and transit-oriented development.



Group Discussion: Mobility goals and local challenges

Group Discussion – Mobility Goals and Local Challenges 1

Objective: Facilitate an open dialogue among participants to share experiences, challenges, and aspirations related to urban mobility in their respective cities.

Structure:

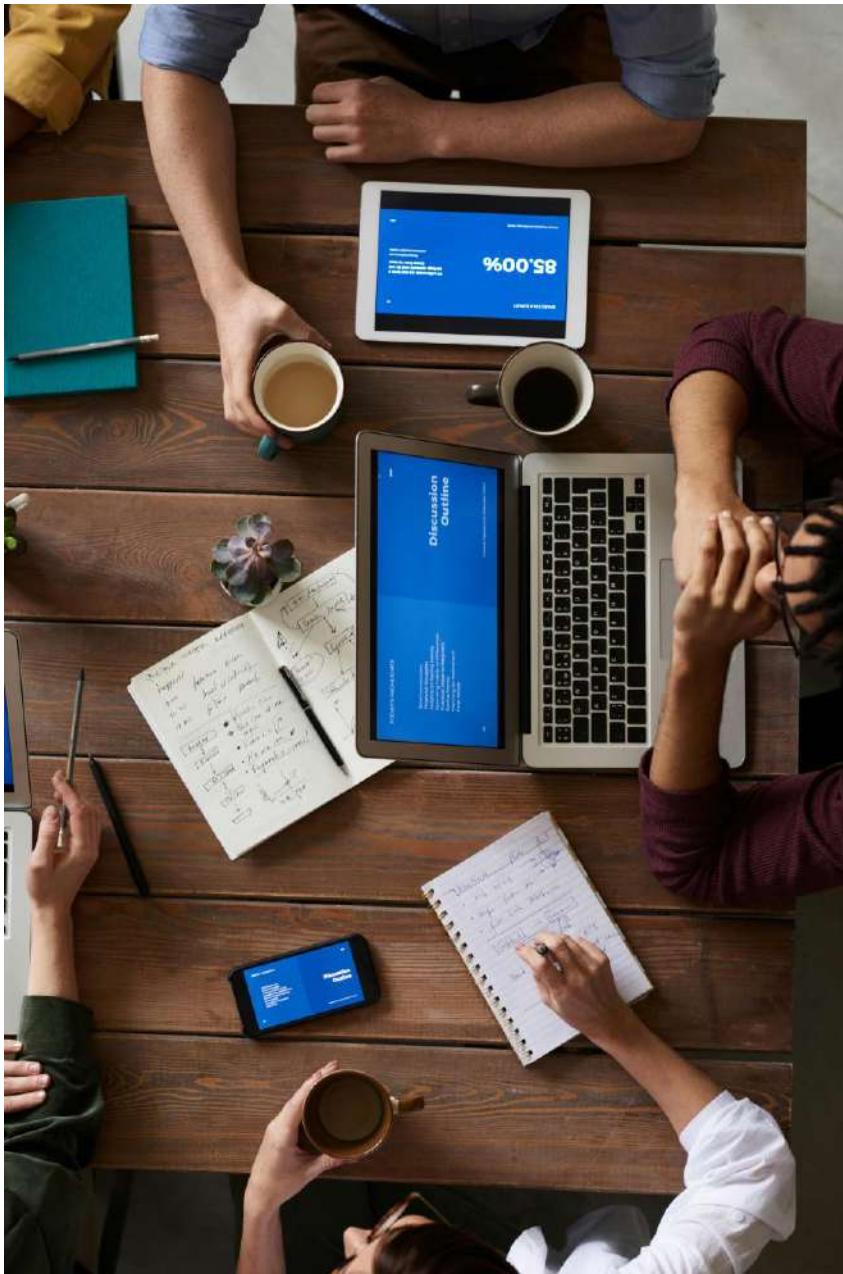
- Breakout groups of 2–4 participants.
- Each group selects a facilitator and a note-taker
- Discussion duration: 20 minutes
- Group presentations: 10 minutes (2 minutes per group)



Group Discussion – Mobility Goals and Local Challenges 2

Discussion Questions:

- What are the primary mobility challenges faced by your city?
- How do these challenges impact different segments of the population?
- What initiatives have been implemented to address these challenges?
- What are your city's goals for sustainable urban mobility?
- What barriers exist in achieving these goals?
- How can community engagement be enhanced in mobility planning?





Summary & Key Takeaways



Urban Mobility Fundamentals



Sustainability and Policy Integration



Public vs. Private Transport



Planning the Future



Final Takeaway

Thank you!

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201 B: Active & Shared Mobility Solutions

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Agenda

MODULE 2 - Active & Shared Mobility Solutions

- Walkable Cities: Urban Design for People
- Bicycles as Urban Transport: Design and Policy
- Inclusive Urban Mobility for All Genders & Ages
- Shared Mobility: Principles and Models
- Workshop: Design a 15-Minute City Neighborhood Layout

Training Module Objectives



- Understand the principles of active mobility and its role in sustainable urban development.
- Explore design elements that promote walkability and cycling in urban areas.
- Examine inclusive mobility strategies that cater to diverse populations.
- Analyze shared mobility models and their integration into urban transport systems.
- Apply concepts by designing a 15-minute city neighborhood layout.

Walkable Cities: Urban Design for People

Importance of Walkability



- Enhances public health by encouraging physical activity.
- Reduces traffic congestion and environmental pollution.
- Stimulates local economies through increased foot traffic.
- Fosters social interactions and community engagement.

Design Elements for Walkable Cities

- Wide, unobstructed sidewalks with shade and seating.
- Safe pedestrian crossings with adequate lighting.
- Mixed-use developments to reduce travel distances.
- Traffic calming measures to enhance pedestrian safety.



Case Studies 1 – Paris, France

Reclaiming Streets for People:

- Major pedestrian zones (e.g. Seine riverbanks, Rue de Rivoli)
- 1,000+ km of bike lanes added (Plan Vélo)
- Urban greening and “cool islands” projects
- Low Emission Zones to reduce car usage

Results:

- 40% increase in bike traffic (2019–2023)
- Over 70% of residents support car-free policies
- Model replicated in other EU cities (Brussels, Milan)



Case Studies 2 – Melbourne, Australia

Vision: Melbourne's Plan Melbourne 2017–2050 aims to develop “20-minute neighborhoods”.

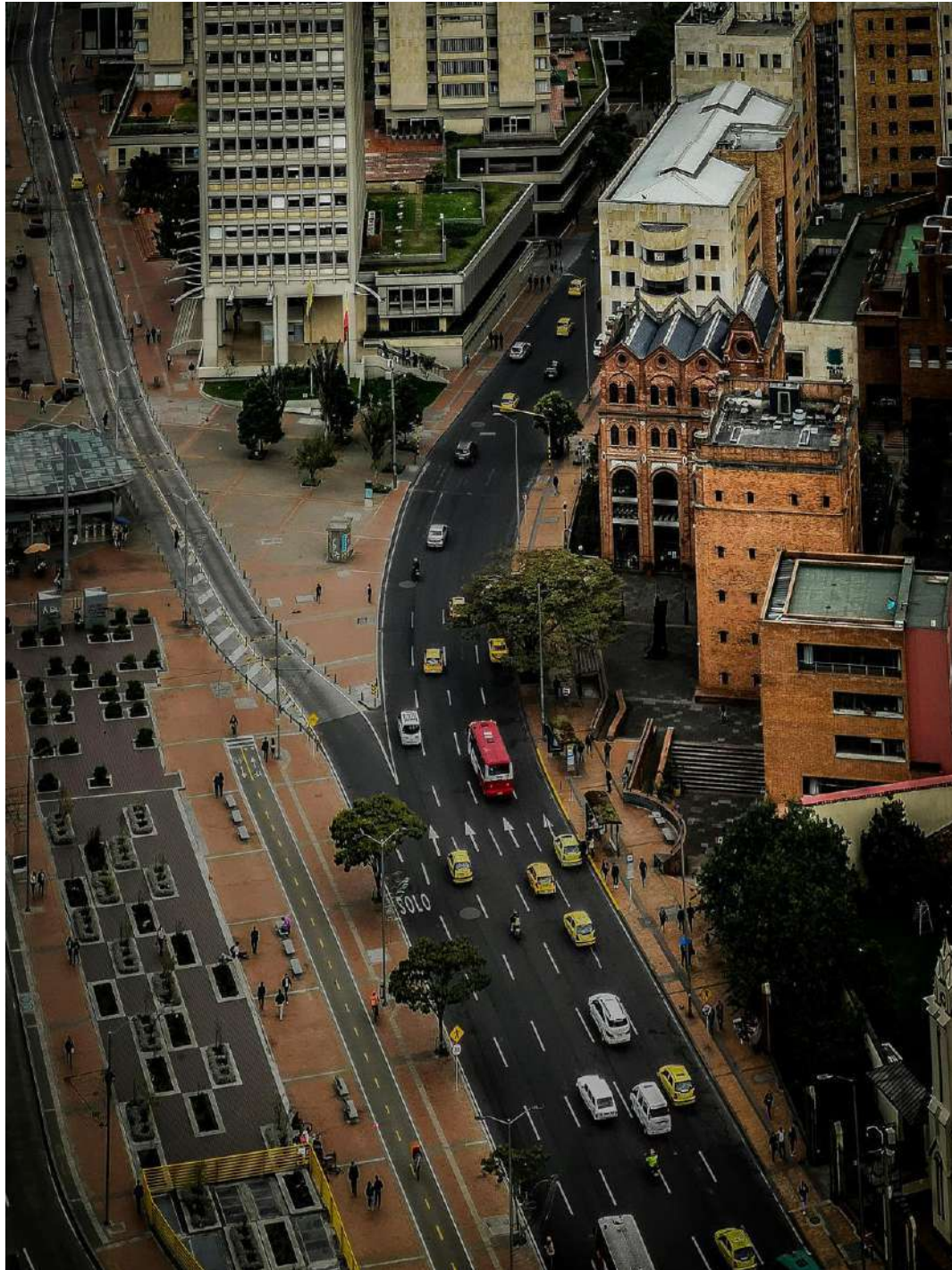
Key Features:

- Mixed-use development in suburban centers
- Upgraded footpaths, crossings, and public lighting
- Integration with local bus and tram systems
- Green space planning tied to walking routes

Impacts:

- Stronger local economies in walkable centers
- Increase in active travel by 18% in pilot suburbs
- Used as a climate resilience and equity strategy





Case Studies 3 - Bogotá, Colombia

Prioritizing Public Transit & Active Travel:

- TransMilenio BRT: Fast, efficient bus network
- 600+ km of bike lanes + BRT integration
- “Ciclovía” Sundays: 120 km car-free weekly
- Focus on affordable, scalable mobility

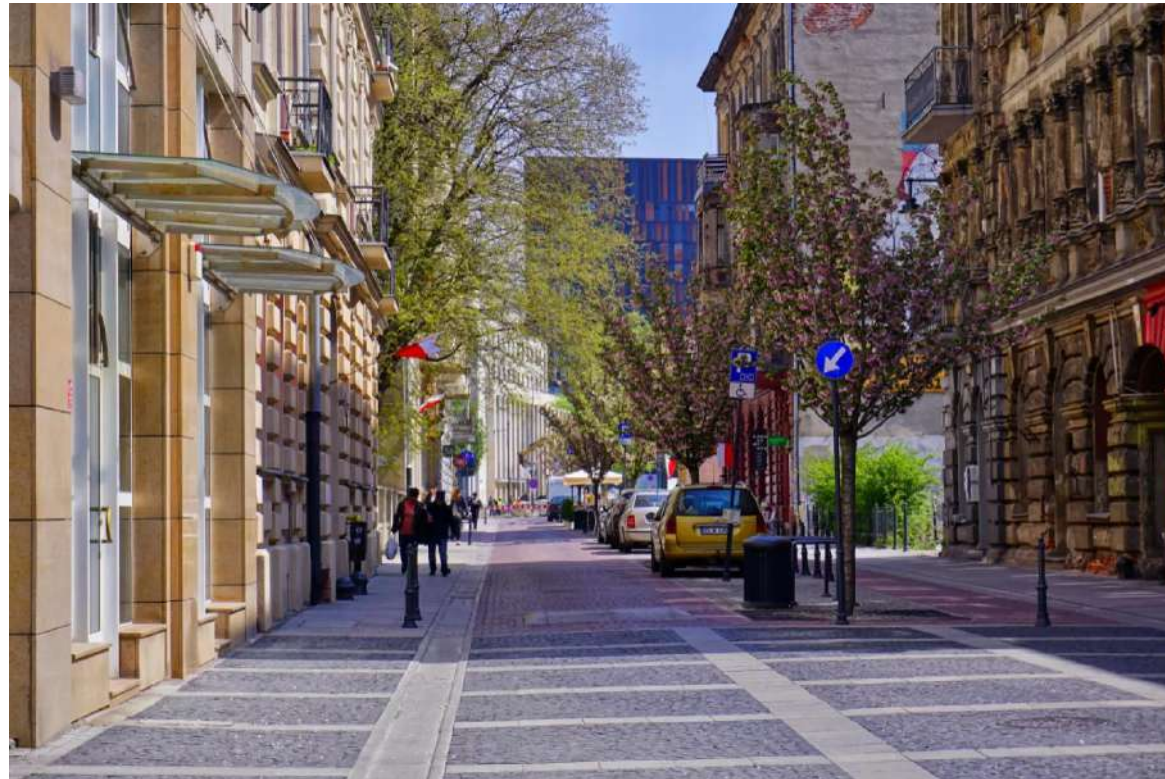
Outcomes:

- Urban mobility improved without large metro investments
- Cycling share grew from <1% to ~6% in 10 years
- Model widely studied in the Global South

What is a Woonerf Concept ?

Definition:

- A Woonerf (Dutch for “living street”) is a shared street design that blurs the boundaries between spaces for cars, pedestrians, and cyclists.
- Originated in the Netherlands in the 1970s to reclaim residential streets from motor traffic.



Source: <https://www.planetizen.com>

Key Characteristics:

- No raised curbs — shared, level surface
- Very low vehicle speeds (often 10–15 km/h)
- Prioritizes pedestrians and community activity
- Integrated street furniture, play areas, greenery



Source: <https://www.planetizen.com>

Benefits of Woonerf

- **Safety:** Slower speeds = Reduced crashes
- **Vibrancy:** Encourages outdoor social interaction
- **Flexibility:** Multi-use spaces for walking, playing, sitting
- **Equity:** Accessible to all ages and mobility levels
- **Environmental:** Supports stormwater infiltration and cooling through green infrastructure

Quote:

“A street that invites children to play and neighbors to talk is a street that serves more than just cars.”



Source: <https://www.humankind.city>

Woonerf Examples Around the World

- **Netherlands:** Houten and Delft – pioneering residential areas
- **Belgium:** Brussels – slow street network integration
- **Germany:** Freiburg's Vauban district
- **USA:** Seattle and Minneapolis pilot woonerf-style blocks
- **Türkiye (emerging):** Interest in shared street design in Izmir and Istanbul revitalization zones

Bicycles as Urban Transport: Design and Policy

Why Focus on Cycling?

- Cycling = cost-effective, healthy, and eco-friendly urban transport
- Fits both dense urban cores and suburban peripheries
- Aligned with Marchetti's Constant: People travel ~1 hr/day regardless of mode
- Can scale quickly with low investment compared to road or rail systems



Role of Cycling in Urban Mobility



- Multifaceted Benefits:
- Reduces traffic congestion and parking demand
- Cuts GHG emissions and local air pollution
- Promotes physical and mental well-being
- Enables short-medium trips (0.5–8 km) efficiently
- Supports equity when designed inclusively

Cycling Infrastructure Essentials

- Protected bike lanes and continuous cycle tracks
- Secure bicycle parking at transit hubs and destinations
- Wayfinding signage and trip planning tools
- Maintenance stations and lighting for safety
- Integration with public transport for intermodality





Source: <https://parcitypatory.org>

Design for Human-Scaled Environments

- At ~15 km/h, cyclists move at a “human speed”
- Can negotiate space like pedestrians – less reliance on lights/signs
- Reduces the need for over-regulation
- Ideal for mixed-use areas, woonerfs, and low-traffic neighborhoods

High-Speed Cycling in Car-Dominant Zones

- Suburban cycling requires:
- Wider, protected bike lanes
- Buffer from traffic noise
- Support for ebikes & light mopeds
- Create the illusion of human-scale with trees, setbacks, and smart separation



Source: <https://cyclingsolutions.info>

Policy Measures That Work

- Incentives for bicycle purchases (e.g. subsidies, tax credits)
- Bike-sharing programs & integrated transport cards
- Safety & culture campaigns to normalize cycling
- Zoning and building codes to require bike access and parking
- Supportive regulations that reduce car-centric development



Case Examples & Global Insights

- NLNetherlands: National Bicycle Strategy; citywide mode-shift goal
- DKDenmark: “Cycle Superhighways” across Greater Copenhagen
- FRFrance: Paris Plan Vélo – €250M investment in bike lanes
- DEGermany: Secure parking + insurance incentives



Inclusive Urban Mobility for All Genders & Ages

Why Inclusive Mobility Matters



- Traditional transport design often neglects non-dominant users — women, elderly, children, caregivers, and gender-diverse people.
- These groups face disproportionate barriers: Harassment and lack of safety, inaccessible infrastructure, unaffordable, infrequent transit.
- Inclusive urban mobility enhances: Access to employment, healthcare, education, gender equality, social equity, climate action.

Understanding Mobility Needs



- Mobility = Access to urban life — work, school, markets, services
- Women often perform “trip chaining”: dropping kids, shopping, elderly care, work, etc.
- Most marginalized users travel off-peak, when service is low
- Older adults and disabled people need: Barrier-free access, rest points, slower, smoother surfaces
- Language, safety, affordability, and cultural factors affect immigrant and minority users



Recognizing Gendered Mobility Patterns

- Caregivers require multiple short trips, often on foot or transit
- Personal security is a primary concern for women and girls
- Travel patterns are non-linear: combining errands, caregiving, and work
- Lack of voice in planning processes = persistent exclusion

Key Insight: Inclusion starts with recognizing different lived experiences in how people move.

Using Data to Advance Inclusive Mobility

Why it matters: “If it’s not measured, it’s not managed.”, invisible barriers can’t be funded or fixed

Tools & Approaches:

- Disaggregated data by gender, age, ability
- User mapping: Who travels where, when, and how?
- Feedback systems: apps, SMS, focus groups
- GIS heatmaps: highlight unsafe zones, time gaps

Use data to inform: Transit routing & timing, infrastructure investments, budgeting priorities



Key Design Principles for Inclusive Urban Mobility

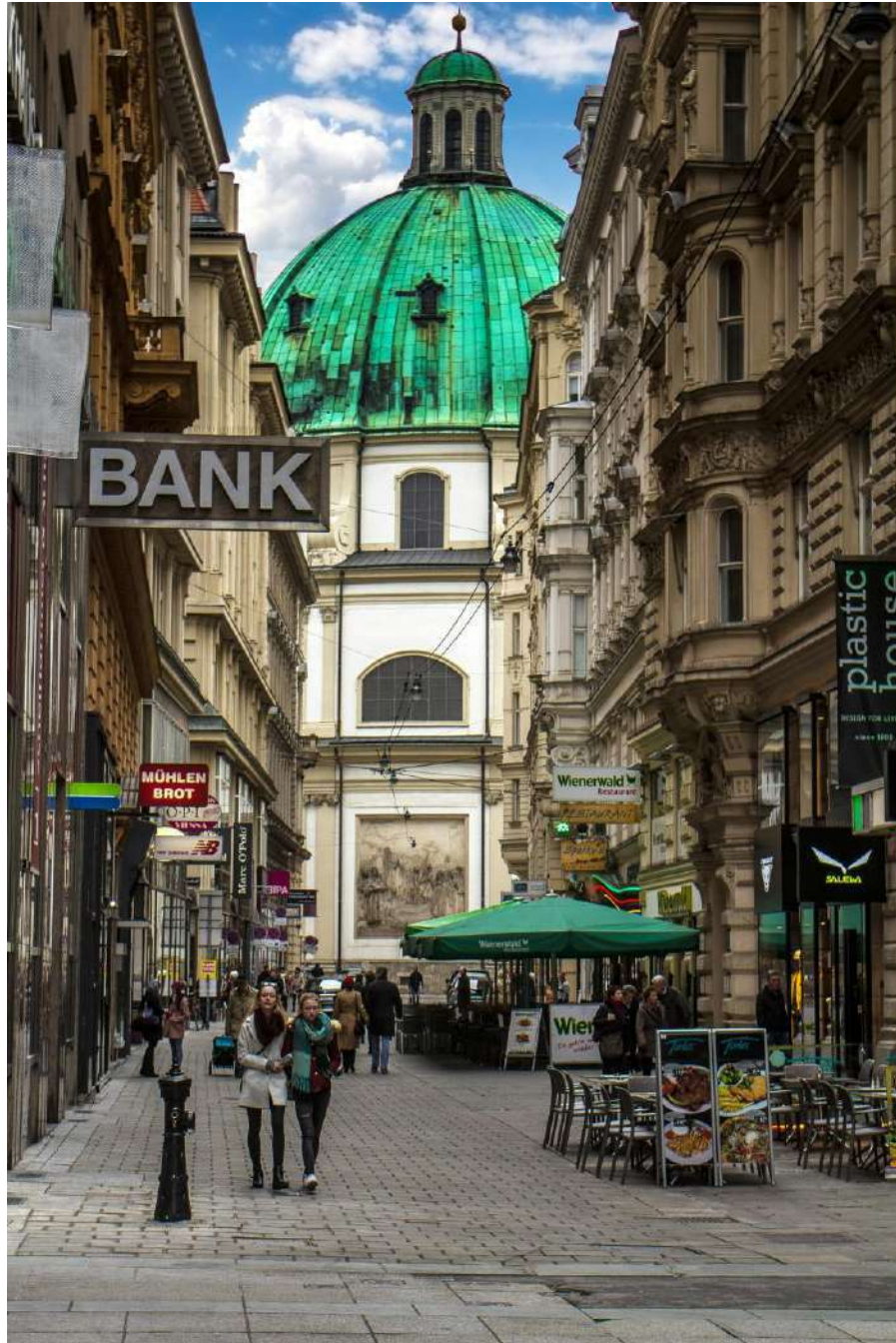


- Universal Design
- Safety by Design
- Service Flexibility
- Multi-Lingual & Accessible Information
- Participation in Planning

Global Initiatives 1 - Vienna, Austria

Gender Mainstreaming in Mobility Planning:

- Integrated gender-sensitive data into urban mobility design
- Redesigned public spaces with wider sidewalks, more lighting, and benches
- Developed Frauen-Werk-Stadt neighborhood for walkability & access
- Increased safety and usability for women, elderly, and children
- Model adopted across the EU as a reference for inclusive planning



Global Initiatives 2 - Seoul, South Korea

Tech-Enabled Universal Access:

- 100% of subway stations equipped with elevators or lifts
- Smart apps display real-time accessibility info (wheelchair access, safe routes)
- Anti-harassment tools: CCTV, women-only cars, safety alert apps
- Barrier-free paths, braille blocks, and talking signals throughout the city
- Promotes seamless mobility for elderly, disabled, and all users



Global Initiatives 3 - Copenhagen, Denmark

Inclusive Cycling for All:

- Protected cycle tracks on 80% of main roads
- Family- and senior-friendly options: cargo bikes, trishaws, safe crossings
- “Cycle Superhighways” connect suburbs to center
- Infrastructure supports women, seniors, children, and newcomers
- Cycling is safe, normalized, and accessible for everyday trips



Shared Mobility: Principles and Models



What is Shared Mobility?

- Shared mobility includes car-sharing, bike-sharing, e-scooters, ride-hailing, and microtransit
- Users access vehicles on-demand, typically via smartphone platforms
- Growing rapidly in urban areas:
 - Global market value projected to reach \$500B by 2030
 - In Paris: Over 15,000 shared bikes and 20,000 scooters active in 2024

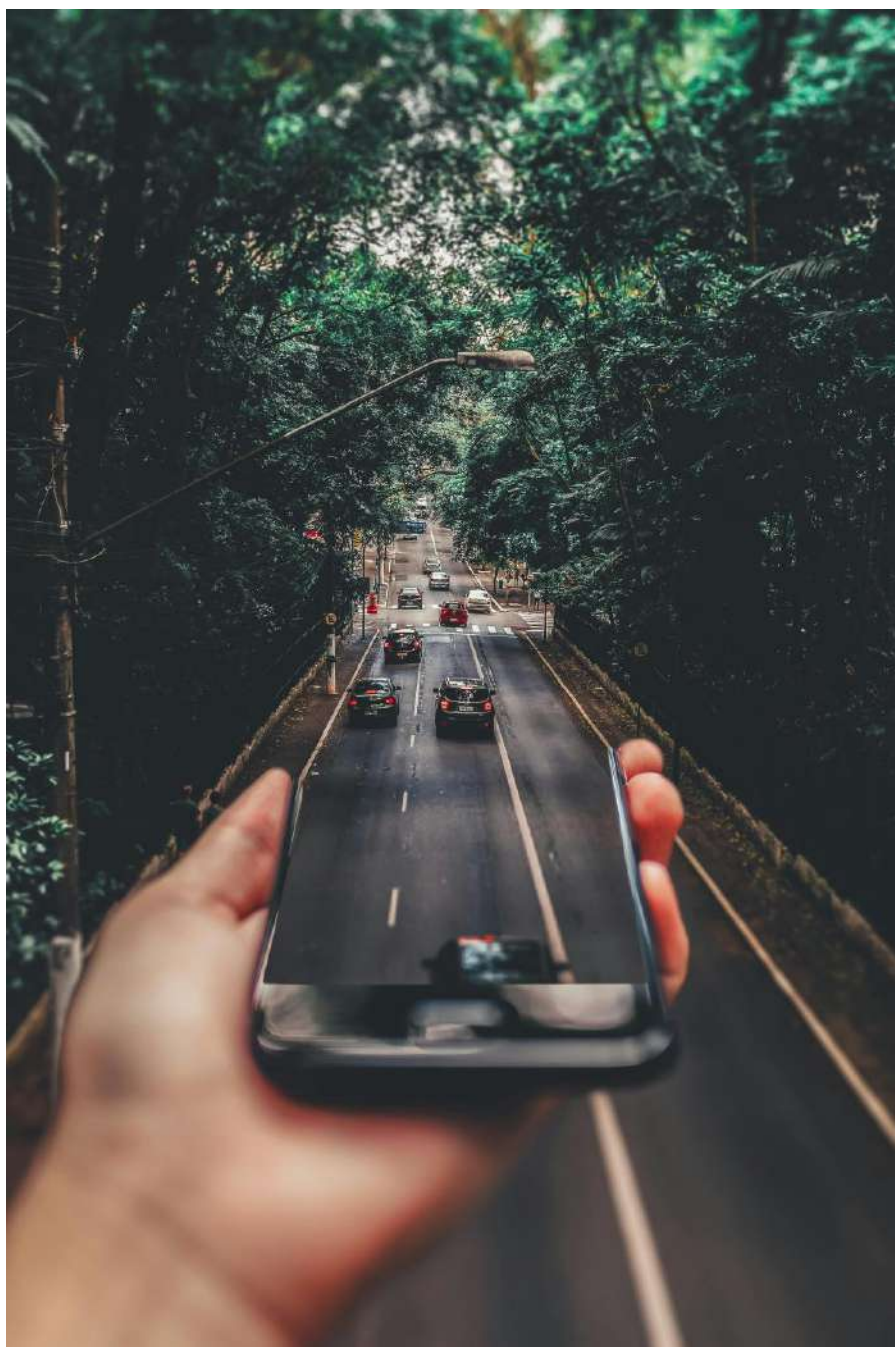
“Shared mobility expands access while reducing vehicle ownership.”

Benefits of Shared Mobility



- Reduces private car dependency → Less congestion & emissions
- Frees up urban land: every shared car replaces 5–10 private ones (ITF, 2020)
- Fills first/last mile transit gaps
- Supports climate goals: E-scooter and e-bike programs reduce CO₂ emissions by 30–50% per trip compared to cars
- Affordable options for low-income and car-free households

Popular Shared Mobility Models



- **Bike-sharing:** Public or app-based bike fleets Ex: Paris Vélib', CitiBike NYC
- **E-scooters:** Docked or dockless scooters via mobile apps Ex: Voi, Lime, Bird
- **Car-sharing:** On-demand rental of cars for short-term use Ex: Zipcar, ShareNow
- **Ride-hailing:** App-based taxis or pooled trips Ex: Uber, Lyft, Bolt
- **Microtransit:** Shared shuttles or minibuses with flexible routes Ex: ViaVan, Chalo (India)



Policy & Planning Considerations

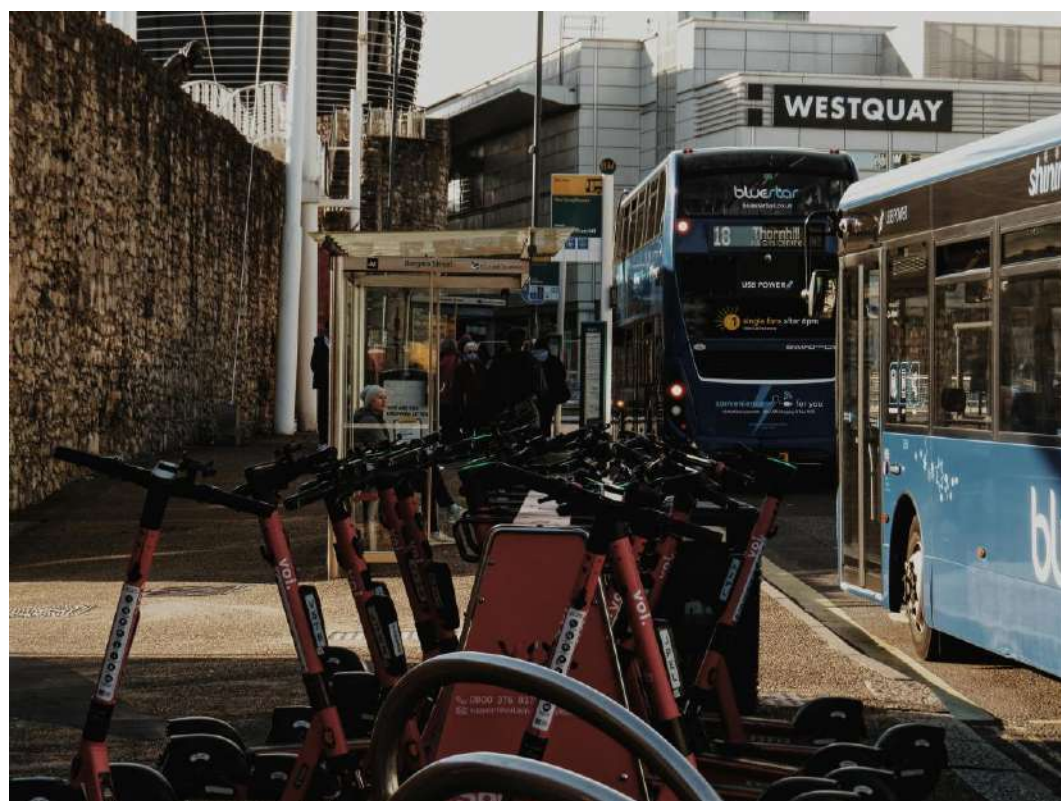
- **Integration with Public Transit:** Vienna & Berlin allow shared modes to park near subway hubs
- **Geofencing & Parking Rules:** Paris banned e-scooter sidewalk parking after 2022 congestion issues
- **Data Sharing Requirements:** Los Angeles mandates all operators provide real-time GPS & usage data
- **Fee Models & Permits:** Cities like Lisbon auction operating licenses and require annual renewals
- **Equity Mandates:** San Francisco requires 20% of shared vehicle fleets in underserved zones
- **Sustainability Incentives:** Madrid grants tax breaks to all-electric car-share fleets

Challenges & Mitigations

- **Sidewalk clutter:** Oaris removed 15,000 e-scooters in 2023 after vote on ban
- **Uneven access:** Portland requires operators to serve East Portland low-income area
- **Road safety issues:** Berlin mandates helmet use for scooter riders
- **Competition w/ transit:** NYC adjusted routes to ensure shared rides supplement, not compete
- **Data privacy:** European cities align with GDPR-compliant tracking and storage



Future Outlook



- Mobility-as-a-Service (MaaS): all-in-one apps (e.g. Whim, Jelbi) merging public and private options
- Growth of electric shared fleets — 70% of shared cars in Oslo are now electric
- AI-based dynamic routing and adaptive pricing emerging in microtransit
- Public-private partnerships becoming the norm, not the exception

Shared mobility is not a trend—it's an ecosystem shift.

Workshop: Designing a 15-minute city neighborhood layout

Workshop: Designing a 15-Minute City Neighborhood Layout 1

Concept:

- Urban planning approach where residents can access most daily needs within a 15-minute walk or bike ride.
- Focuses on creating self-sufficient, inclusive, and sustainable neighborhoods.

Elements:

- Mixed-use development combining residential, commercial, and recreational spaces.
- Accessible public services such as schools, healthcare, and parks.
- Efficient and safe active transport infrastructure.
- Community engagement in planning and decision-making processes



$\frac{1}{4}$ mil = 800 metre

Workshop: Designing a 15-Minute City Neighborhood Layout 2

Instructions:

- Participants will work in groups to design a 15-minute city neighborhood layout.
- Consider factors such as land use, transport infrastructure, public services, and inclusivity.
- Present designs and rationale to the larger group for discussion and feedback.



$\frac{1}{4}$ mil = 800 metre

Summary & Key Takeaways



Active Mobility as a Foundation



Inclusive Urban Design



Cycling Infrastructure & Policy



Shared Mobility Integration



Final Takeaway



Thank you!

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201 D: Data-Driven Urban Planning

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Agenda

MODULE 4 - Data-Driven Urban Planning

- Transport Modeling Basics for Planners
- Using GIS and Data for Urban Mobility
- Citizen Data & Privacy in Urban Planning
- Activity: Mapping a basic mobility pattern in participant's city

Training Module Objectives



- Understand fundamental concepts of transport modeling and its applications in urban planning.
- Explore the use of Geographic Information Systems (GIS) and data analytics in analyzing urban mobility patterns.
- Examine considerations related to citizen data privacy and ethical data use in urban planning.
- Apply learned concepts through a practical activity mapping mobility patterns in their own cities.

Transport Modeling Basics for Planners



Introduction to Transport Modeling

Definition: Transport modeling involves simulating and analyzing transportation systems to forecast future travel demand and assess the impact of various planning scenarios.

Purpose:

- Inform infrastructure development and policy decisions.
- Evaluate the effectiveness of transportation projects.
- Support sustainable urban mobility planning.

Key Components of Transport Models

Four-Step Model:

1. Trip Generation: Estimating the number of trips originating and ending in different zones.
2. Trip Distribution: Determining where trips will go.
3. Mode Choice: Predicting the mode of transport chosen.
4. Route Assignment: Assigning trips to specific routes.



Emerging Transport Models

Emerging Models:

- Activity-Based Models: Focus on individual travel behavior and activities.
- Agent-Based Models: Simulate actions and interactions of autonomous agents.



Source: <https://www.geotab.com>

Applications in Urban Planning

Use Cases:

- Assessing the impact of new transit lines.
- Evaluating congestion mitigation strategies.
- Planning for future land use and development.

Tools:

- Software such as VISUM, TransCAD, and PTV Vissim.



Using GIS and Data for Urban Mobility

Role of GIS in Urban Mobility

Functions:

- Spatial analysis of transportation networks.
- Visualization of mobility patterns and accessibility.
- Integration of various data sources for comprehensive analysis.

Benefits:

- Enhanced decision-making through data visualization.
- Identification of mobility gaps and needs.
- Support for participatory planning processes.



Data Sources and Tools

Data Sources:

- Travel surveys and censuses.
- Mobile phone and GPS data.
- Public transport usage data.

GIS Tools:

- Software such as ArcGIS, QGIS, and Maptionnaire.
- Use of heat maps, network analysis, and spatial statistics.





Case Studies 1 - GIS in Bike-Sharing Planning

📌 Paris, France – Vélib' Bike-Share Planning

- Data-Driven Expansion: Utilized GIS to analyze population density, employment centers, transit proximity, and underserved areas.
- Strategic Placement: Overlaid cycling infrastructure and land use data to identify high-demand zones.
- Outcome: Optimized docking station locations, enhancing accessibility and usage.

📌 Mexico City - ECOBICI & Safety Mapping

- Equitable Coverage: Applied GIS to ensure bike-share access across diverse income groups.
- Gender-Sensitive Planning: Integrated gender data to address safety concerns, influencing lighting and station placement.
- Outcome: Improved safety and accessibility for women cyclists.

Case Studies 2 – Pedestrian Accessibility Mapping



Melbourne, Australia

- Utilized GIS and crowd-sourced data to assess sidewalk conditions, curb ramps, crossing delays, and proximity to amenities.
- Developed a Pedestrian Priority Index to prioritize infrastructure upgrades near schools, elderly populations, and health facilities.

Kigali, Rwanda

- Collaborated with local NGOs and students to map pedestrian infrastructure using OpenStreetMap tools.
- Identified areas lacking footpaths and safe crossings, leading to the addition of walkways, widened sidewalks, and improved lighting.

Case Studies 3 – Real-Time Congestion Analysis

Los Angeles, USA

- ATSAC System: Manages over 4,500 intersections using 40,000 loop detectors.
- Impact: Reduced travel time by 10% through adaptive signal control.

Seoul, South Korea

- TOPIS Platform: Integrates GPS data from buses and taxis to monitor traffic.
- Application: Provides real-time congestion maps and adjusts bus routes dynamically.

Bengaluru, India

- AI-Powered Signals: Implemented at 125 junctions, adjusting timings based on real-time traffic.
- Outcome: Achieved up to 33% reduction in travel time.



Citizen Data & Privacy in Urban Planning

Importance of Data Privacy

Considerations:

- Ethical collection and use of personal mobility data.
- Compliance with data protection regulations (e.g., GDPR).
- Ensuring transparency and public trust.



Strategies for Protecting Privacy

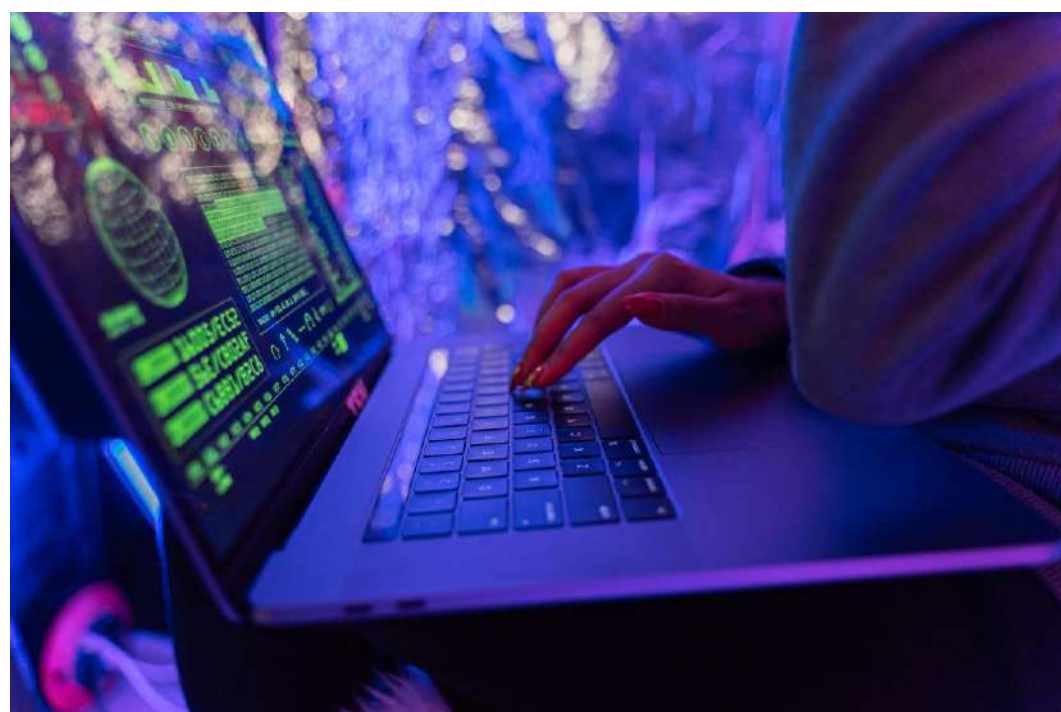
- **Anonymization:** Removing personally identifiable information from datasets.
- **Data Aggregation:** Presenting data in summarized forms to prevent identification.
- **Consent:** Obtaining informed consent from individuals for data collection.
- **Security Measures:** Implementing robust data security protocols.



Balancing Data Use and Privacy

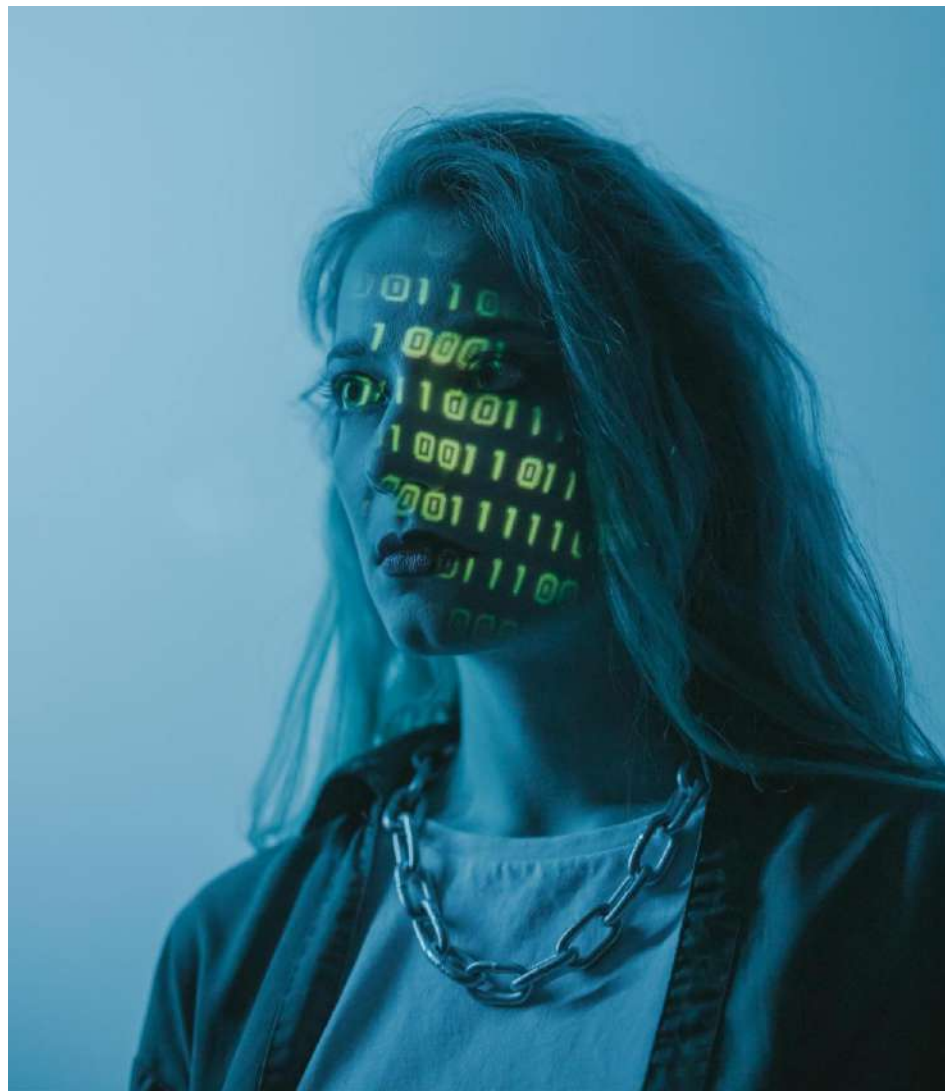
Challenges:

- Need for detailed data to inform planning.
- Risks associated with data breaches and misuse.



Approaches:

- Engaging stakeholders in discussions about data use.
- Developing clear data governance frameworks.
- Promoting open data initiatives with privacy safeguards.



Building Trust Through Data Transparency

Why It Matters:

- Transparency boosts public confidence in data-driven urban planning.
- Informed citizens are more likely to participate and support smart city initiatives.

Best Practices:

- Open Data Portals: Share non-sensitive datasets for public use.
- Clear Communication: Explain how data is collected, stored, and used.
- Feedback Loops: Allow citizens to question and improve data practices.

Examples: Amsterdam & Chicago

Activity: Mapping a basic mobility pattern in participant's city

Activity: Mapping a basic mobility pattern in participant's city 1

- **Objective:** Apply learned concepts to map and analyze a basic mobility pattern in participants' own cities.



Instructions:

- Identify a common travel route or corridor in your city.
- Collect data on travel modes, trip purposes, and peak times.
- Use GIS tools to visualize the mobility pattern.
- Discuss findings and implications for urban planning.

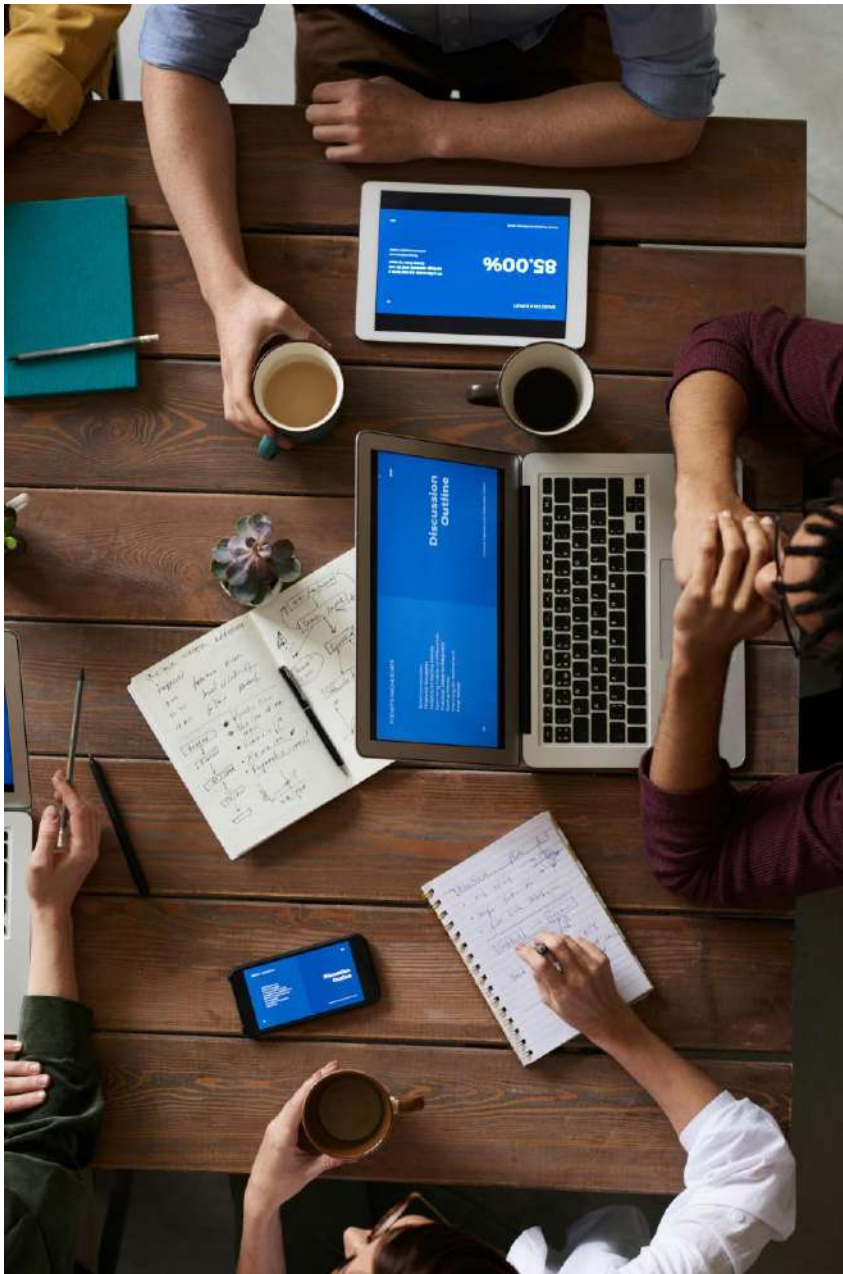
Activity: Mapping a basic mobility pattern in participant's city 2

Suggested Tools:

- QGIS or ArcGIS for mapping.
- Google Maps or OpenStreetMap for base maps.
- Survey tools for data collection (e.g., Google Forms).

Data Sources:

- Local transportation agencies.
- Publicly available datasets.
- Participant observations and surveys.



Activity: Mapping a basic mobility pattern in participant's city 3

Discussion Points:

- What patterns emerged from your mapping exercise?
- What challenges did you encounter in data collection and analysis?
- How can these insights inform urban mobility planning in your city?
- **Presentation:** Each group presents their findings and recommendations.



Summary & Key Takeaways



Transport Modeling: Foundations for Better Planning



GIS for Urban Mobility Insights



Citizen Data & Privacy



From Theory to Practice



Final Takeaway



Thank you!

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 201: Sustainable Urban Mobility

201 E: Climate & Equity in Urban Mobility

TRAINER

- Selen İnal



Agenda

MODULE 5 - Climate & Equity in Urban Mobility

- Climate Change & Urban Transport Impact
- Gender-Inclusive Transport Planning
- Affordability and Access in Urban Mobility
- Group Discussion: Inclusion and Climate Equity in Mobility

Training Module Objectives



- Understand the interplay between urban transport systems and climate change.
- Explore strategies for gender-inclusive transport planning.
- Examine issues related to affordability and access in urban mobility.
- Engage in discussions to identify actionable solutions for inclusive and climate-resilient mobility.

Climate Change & Urban Transport Impact

Urban Transport and Climate Change

Key Points:

- Transportation contributes significantly to urban greenhouse gas emissions.
- Urban areas are particularly vulnerable to climate impacts like heatwaves and flooding.
- Sustainable transport solutions are essential for climate mitigation and adaptation.



Strategies for Climate-Resilient Urban Mobility

Approaches:

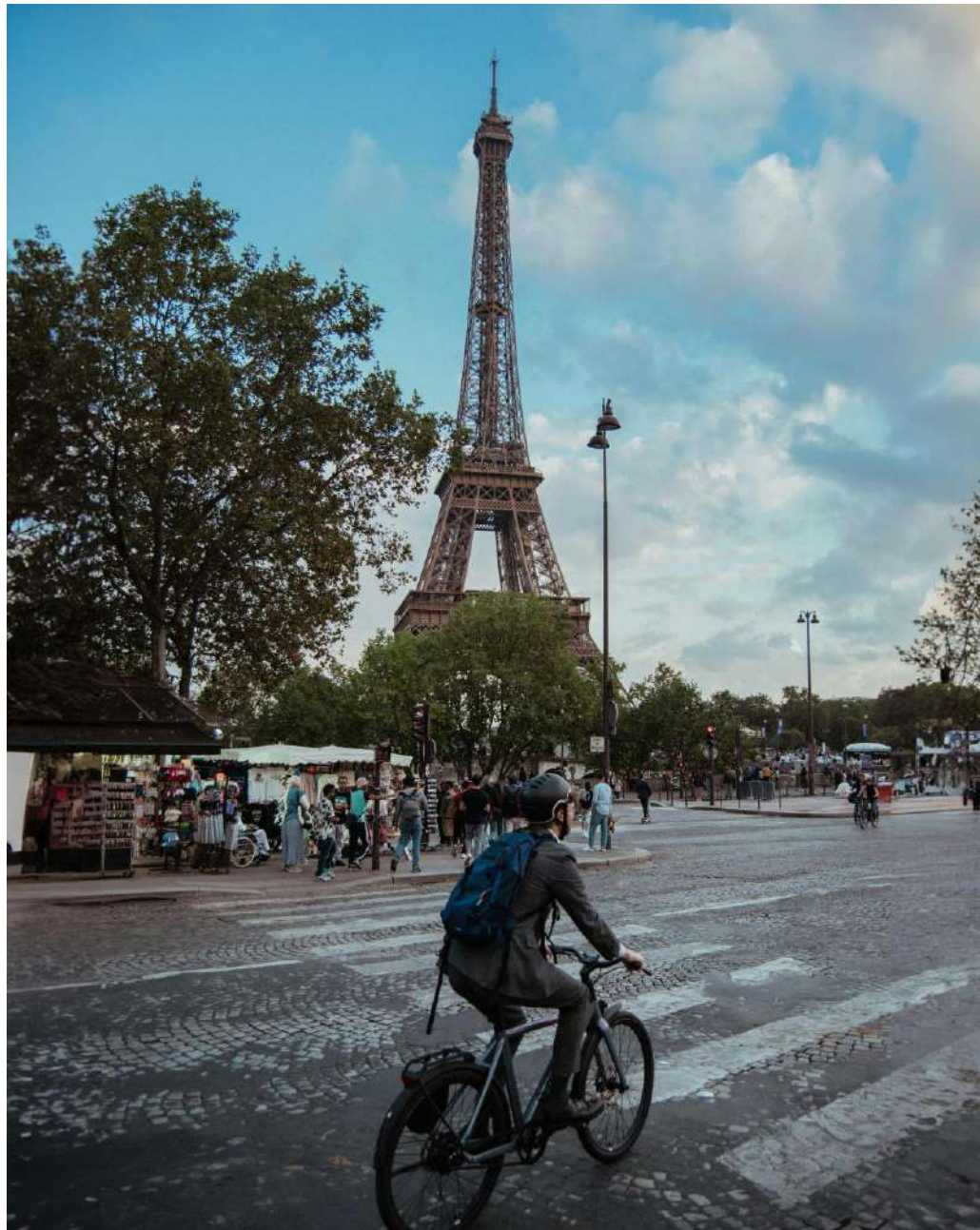
- Promoting active transport modes (walking, cycling).
- Investing in public transit infrastructure.
- Implementing low-emission zones and congestion pricing.
- Integrating land use and transport planning.



Case Studies 1 - Paris

Paris: Cycling Toward a 100% Bikeable City:

- €250M Cycling Plan (2021–2026): Aims to make Paris fully cyclable.
- 180 km New Lanes: Includes 52 km of “coronapistes” made permanent post-COVID.
- Cycling Surges: Bikes now account for 11.2% of trips—surpassing cars at 4.3%.
- Safety Upgrades: “Green wave” traffic lights and 130,000 secure bike parking spots.



Case Studies 2 - Copenhagen

Copenhagen: Toward Carbon Neutrality by 2025:

- Carbon Goal: 42% emission cut since 2005; aims for full neutrality by 2025.
- Mode Shift Target: 75% of trips by bike, foot, or public transport.
- Bike Leadership: 390+ km of lanes; 62% cycle daily.
- Green Mobility: Investing in electric buses & metro expansion.



Case Studies 3 - Bogotá

Bogotá: Electrifying Public Transit:

- 269 New E-Buses (by 2025): Will cut 26,000 tons of CO₂ annually.
- World's Largest E-Fleet: Benefits over 2 million daily users.
- Smart Tech: Includes regenerative braking & real-time sensors.
- Major Investment: COP 1.6 trillion for charging infrastructure.



Source: <https://www.maior.it>

Gender-Inclusive Transport Planning

Understanding Gender Disparities in Mobility

Insights:

- Women often have different travel patterns, including trip chaining and off-peak travel.
- Safety concerns and caregiving responsibilities influence women's mobility choices.
- Transport systems frequently overlook these gender-specific needs.



Source: <https://datapopalliance.org>

Principles of Gender-Inclusive Planning

Strategies:

- Conducting gender-sensitive mobility assessments.
- Ensuring representation of women in transport planning processes.
- Designing infrastructure that considers safety, accessibility, and convenience for all genders.



Source: <https://datapopalliance.org>



Source: <https://www.theguardian.com>

Global Initiatives 1 – Vienna, Austria

Gender Mainstreaming Pioneer: Since the 1990s, Vienna has incorporated gender equality into urban planning.

Key Projects:

- “Frauen-Werk-Stadt” housing designed around women’s daily needs
- Safer sidewalks, lighting, and playground design

Impact: Set a global benchmark for inclusive, accessible, and safe urban spaces for all genders.

Global Initiatives 2 – Quito, Ecuador

UN Women's Safe Cities Leader (since 2010): First city in the Americas to join.

Core Measures:

- Citywide surveys on public harassment
- Public awareness campaigns and transit staff training
- Designated women-only spaces on public transport



Source: <https://sustmob.org>

Impact: Improved safety, reporting mechanisms, and gender-sensitive urban policies.

Global Initiatives 3 – Umeå, Sweden



Source: <https://www.theguardian.com>

Photo Credit: Elin Berge

- Feminist Urban Planning: Umeå integrates gender equality into city design, prioritizing women's safety and accessibility.
- Innovative Infrastructure: Features include gender-aware bus stops with enhanced lighting and visibility, and pedestrian-friendly environments.
- Community Engagement: Initiatives like the “gendered landscape” bus tour educate citizens on gender-sensitive urban spaces.

Impact: Recognized globally for creating inclusive public spaces that address the needs of all genders.

Affordability and Access in Urban Mobility

The Importance of Equitable Access

Challenges:



- High transport costs can limit access to employment, education, and healthcare.
- Underserved communities often face longer commutes and fewer transport options.
- Transport policies may inadvertently exacerbate social inequalities.

Strategies for Enhancing Affordability and Access

Approaches:

- Implementing fare subsidies or free transit programs for low-income populations.
- Expanding public transport networks to underserved areas.
- Integrating multimodal transport options to improve connectivity.



Case Studies 1 - Bogotá

Bogotá: Enhancing Affordability and Access



Source: <https://itdp.org>

- **Integrated Public Transport System (SITP):** Unified fare system across buses and BRT, with discounted rates for low-income users.
- **Fare Subsidies:** Targeted subsidies for vulnerable populations, improving affordability.
- **Feeder Services:** Free feeder buses connect peripheral areas to main transit lines, enhancing access.
- **Impact:** Increased mobility for low-income residents, reducing travel costs and time

Case Studies 2 - San Francisco

San Francisco: Advancing Equitable Mobility



Source: <https://www.sfmta.com>

- **Transit First Policy:** Prioritizes public transit, walking, and cycling to reduce car dependency.
- **Equity Programs:** SFMTA offers discounted fares for seniors, youth, and low-income riders.
- **Accessibility Initiatives:** Investments in infrastructure to improve access in underserved neighborhoods.
- **Outcome:** Enhanced transit equity, though challenges remain in service coverage and affordability.

Case Studies 3 - Delhi

Delhi: Improving Affordability and Access



Source: <https://aamaadmiparty.wiki>

- **Free Bus Travel for Women:** Introduced to increase women's mobility and safety.
- **Public Transport Accessibility Levels (PTAL):** Studies reveal disparities in access between planned and unplanned areas.
- **First and Last-Mile Connectivity:** Efforts to enhance connectivity through feeder services and infrastructure improvements.
- **Impact:** Progress in making public transport more affordable and accessible, especially for marginalized groups.

Group Discussion: Inclusion and Climate Equity in Mobility

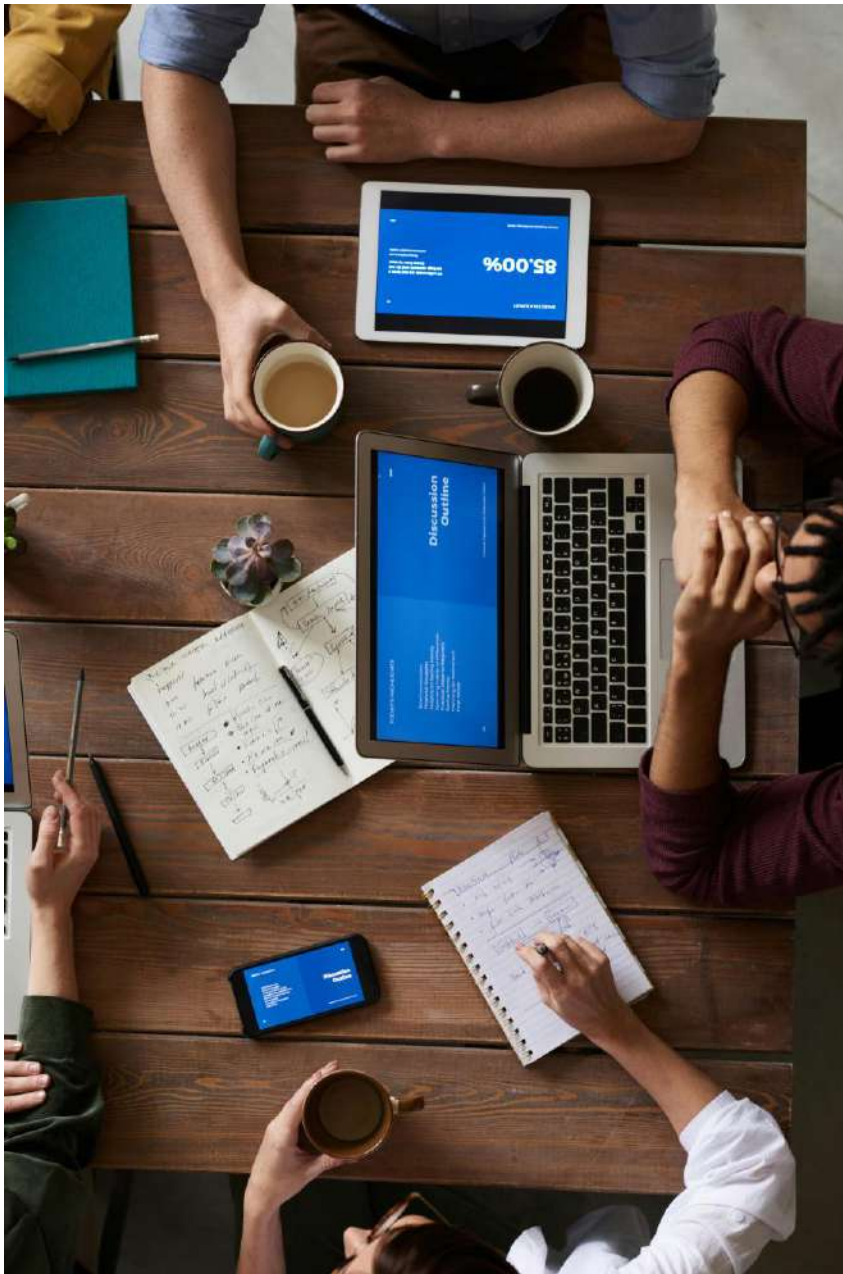
Groups Discussion: Inclusion and Climate Equity in Mobility 1

Discussion Objectives:

- Reflect on local challenges related to inclusive and climate-resilient mobility.
- Share experiences and best practices from different contexts.
- Identify actionable strategies to promote equity and sustainability in urban transport.



Group Discussion: Inclusion and Climate Equity in Mobility 2



Guiding Questions:

- What are the main barriers to equitable mobility in your city?
- How does climate change impact transport accessibility for vulnerable populations?
- What initiatives have been successful in promoting inclusive and sustainable mobility?
- How can community engagement enhance transport planning processes?

Group Discussion: Inclusion and Climate Equity in Mobility 3

Instructions:



- Form small groups to discuss the guiding questions.
- Identify one key challenge and propose a potential solution.
- Prepare a brief presentation to share your group's insights with the larger group.



Summary & Key Takeaways

-  Urban Transport & Climate Responsibility
-  Gender-Inclusive Transport Planning
-  Equity in Affordability & Access
-  Case-Based Inspiration
-  Dialogue for Change
-  Final Takeaway

Thank you!

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 201: Sustainable Urban Mobility

201 C: Transport Innovation & Technology

TRAINER

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COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004



Agenda

MODULE 3 – Transport Innovation & Technology

- Mobility as a Service (MaaS): An Introduction
- Autonomous Urban Transport Systems
- Urban Air Mobility (UAM)
- Electric Vehicles and Infrastructure Planning
- Group Discussion: Feasibility of applying smart solutions in small cities

Training Module Objectives

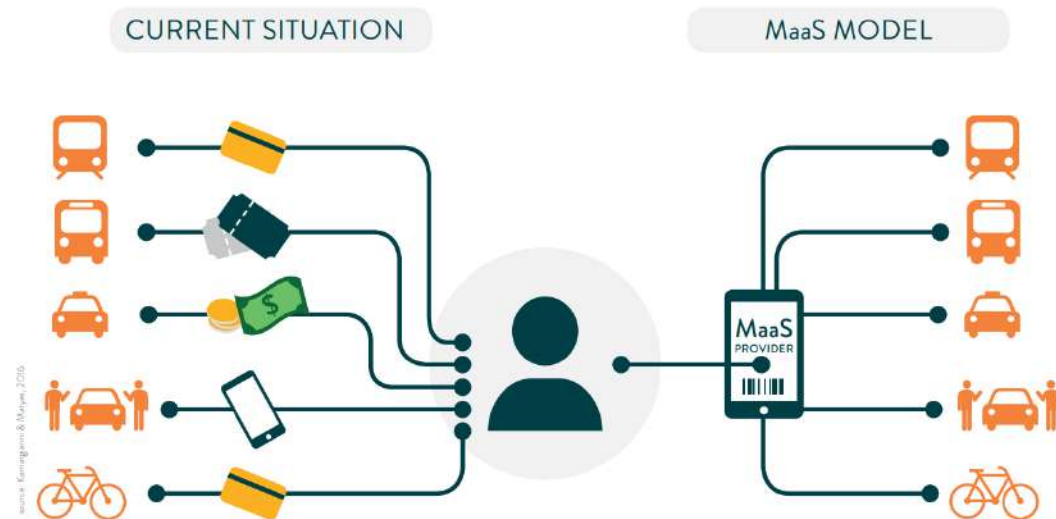


- Understand the concept and components of Mobility as a Service (MaaS).
- Explore the development and impact of autonomous urban transport systems.
- Examine the emerging field of Urban Air Mobility (UAM) and its potential applications.
- Analyze the integration of electric vehicles (EVs) into urban infrastructure planning.
- Assess the feasibility and challenges of implementing smart transport solutions in small cities.

Mobility as a Service (MaaS): An Introduction

Understanding MaaS

- **Definition:** Mobility as a Service (MaaS) is an integrated approach to transportation that combines various modes—such as public transit, ride-sharing, bike-sharing, and car rentals—into a single, accessible, and user-centric platform.



Key Components of MaaS

Elements:

- Multi-modal integration
- Real-time information and updates
- Seamless payment systems
- Personalized user experiences
- Data analytics for service optimization



Source: <https://skedgo.com>

Global Examples of MaaS 1 – Helsinki's Whim

- **Integrated Transport Modes:** Public transit, taxis, bikes, e-scooters, rental cars.
- **Subscription Options:** Tiered plans from pay-as-you-go to unlimited access.
- **User Engagement:** Over 6 million trips logged.
- **Impact:** Reduced private car usage; enhanced multimodal travel.



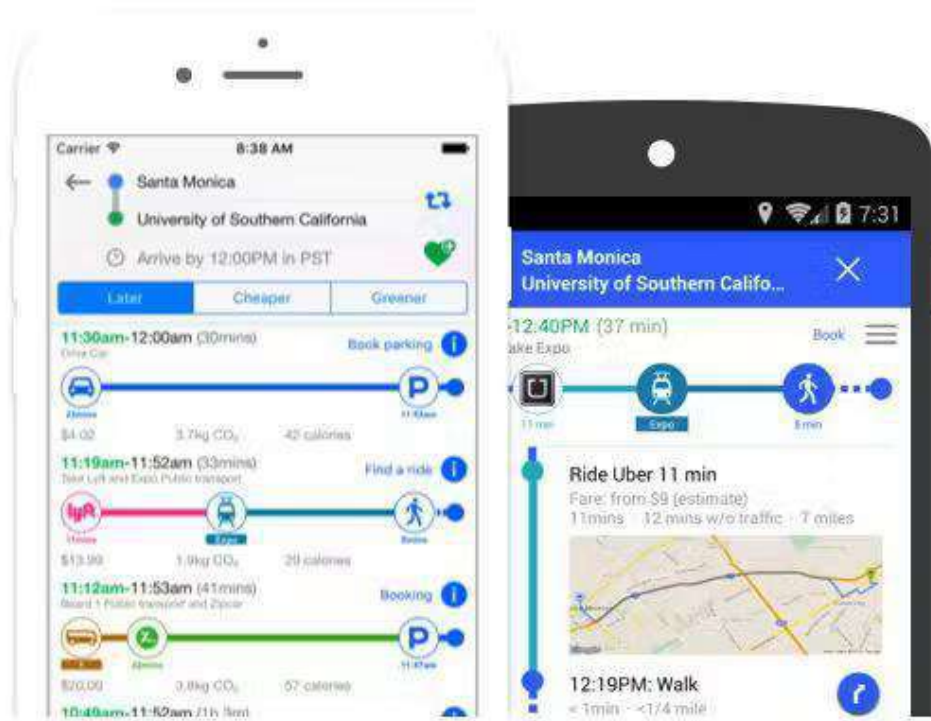
Global Examples of MaaS 2 – Singapore's Beeline

- **Crowdsourced Routing:** Commuters suggest and activate new bus routes.
- **Data-Driven Planning:** Utilizes analytics to optimize services.
- **Public-Private Collaboration:** Joint initiative by government and private operators.
- **Outcome:** Improved commuter satisfaction and service efficiency.

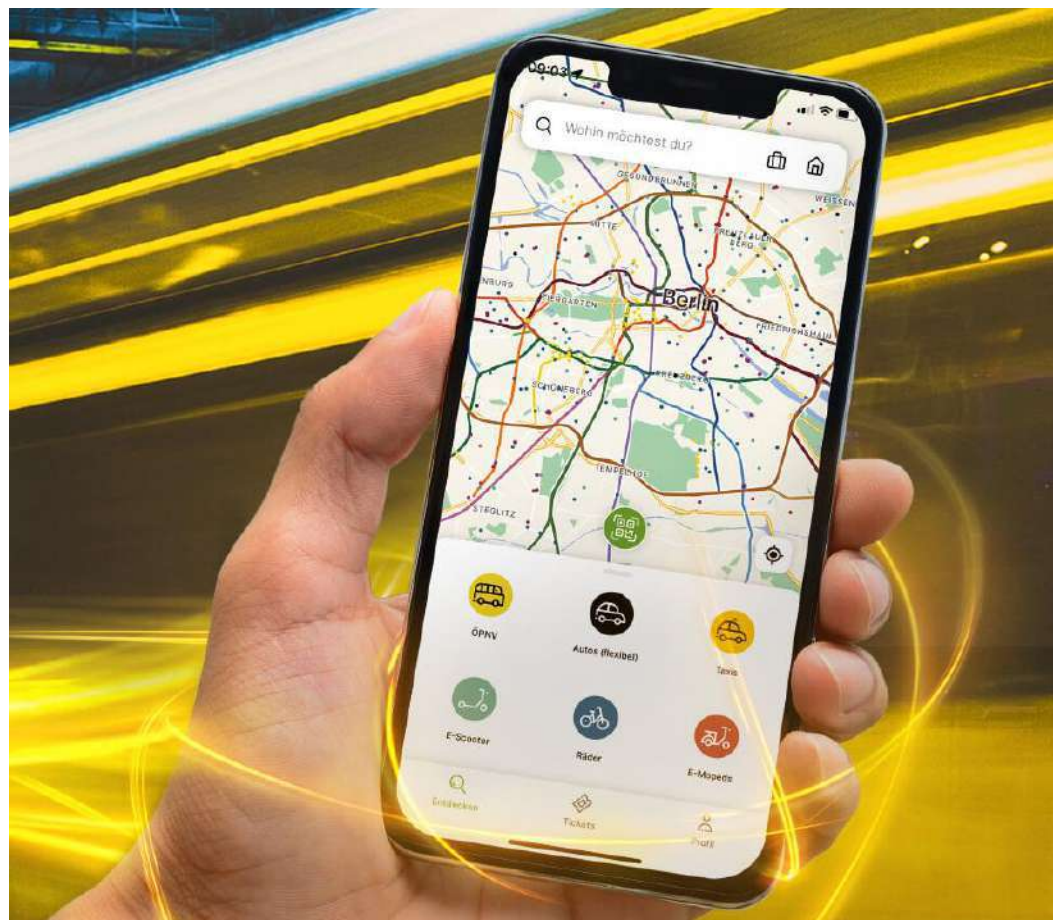


Global Examples of MaaS 3 – Los Angeles' Go LA

- **Multi-Modal Integration:** Combines public transit, ride-sharing, biking, and walking options.
- **Real-Time Information:** Provides up-to-date transit data.
- **User-Centric Design:** Personalized travel planning based on preferences.
- **Goal:** Encourage sustainable transportation choices.



Global Examples of MaaS 4 – Berlin's Jelbi App



- **Comprehensive Integration:** Public transport, e-scooters, bikes, car-sharing, taxis.
- **Single Platform:** Plan, book, and pay for all services in one app.
- **Sustainability Focus:** Over 80% of vehicles are emission-free.
- **Reach:** More than 230 mobility hubs across Berlin.

Global Examples of MaaS 5 – Tokyo's MaaS Pilot



- **Service Integration:** Railways, buses, taxis, shared mobility services.
- **Personalization:** Tailored route suggestions based on user preferences.
- **Real-Time Data:** Provides current transit information and congestion levels.
- **Objective:** Enhance urban mobility and user convenience.



Benefits and Challenges of MaaS

Benefits:

- Reduces reliance on private vehicles
- Enhances accessibility and convenience
- Promotes sustainable transport modes

Challenges:

- Data privacy and security concerns
- Regulatory and policy hurdles
- Integration of diverse service providers

Autonomous Urban Transport Systems

Overview of Autonomous Transport

- **Definition:** Autonomous urban transport systems utilize self-driving vehicles—such as buses, shuttles, and taxis—equipped with advanced sensors and AI to navigate without human intervention.



Technologies Enabling Autonomy

Components:

- LiDAR and radar sensors
- GPS and real-time mapping
- Machine learning algorithms
- Vehicle-to-everything (V2X) communication



Advantages of Autonomous Transport

Benefits:

- Improved road safety by reducing human error
- Enhanced traffic efficiency and reduced congestion
- Increased accessibility for non-drivers
- Potential for 24/7 service availability



Global Implementations 1 - Karsan

Karsan Autonomous e-ATAK

- **Pioneering Technology:** First Level-4 autonomous electric midibus in Europe.
- Successfully navigated an 800-meter tunnel in Stavanger, Norway.
- Deployed in Finland (Tampere), Germany, and Switzerland.
- Equipped with LiDAR, RGB/thermal cameras, and IMU sensors for precise navigation.
- **Service Record:** Over 80,000 km driven autonomously, transporting more than 30,000 passengers.



Global Implementations 2 - Waymo

- **Service Overview:** Waymo One offers fully autonomous ride-hailing in Phoenix, San Francisco, Los Angeles, and Austin.
- **Expansion Plans:** Testing underway in Houston, San Antonio, and Orlando.
- Over 10 million paid rides completed.
- 250,000 weekly rides as of early 2025.
- **Technological Edge:** Utilizes a combination of LiDAR, radar, and cameras for navigation.



Global Implementations 3 - Navya



- Navya's autonomous shuttles in Lyon, France.
- **Product Highlight:** Autonom® Shuttle – a fully electric, driverless vehicle designed for first and last-mile transport.
- Integrated into Lyon's public transport network since 2016.
- Operational in over 21 countries across various urban and private settings.
- Carries up to 15 passengers.
- Operates at limited speeds for safety in pedestrian areas.
- **Technology:** Equipped with GNSS, LiDAR, and cameras for autonomous navigation.

Urban Air Mobility (UAM)

Introduction to UAM

- **Definition:** Urban Air Mobility (UAM) refers to the use of electric vertical take-off and landing (eVTOL) aircraft to transport passengers and goods within urban areas, aiming to alleviate ground traffic congestion.



Potential Applications of UAM

Use Cases:

- Air taxis for short-distance urban travel
- Emergency medical services
- Cargo and parcel delivery
- Connecting remote or underserved areas



Challenges and Considerations

Issues:

- Airspace management and regulation
- Infrastructure requirements (e.g., vertiports)
- Public acceptance and noise concerns
- Safety and reliability standards



Current Developments 1 – FAA (USA)

- **New Aircraft Category:** Introduced “powered-lift” classification for eVTOLs, the first new category in nearly 80 years.
- **Pilot Certification:** Established Special Federal Aviation Regulation (SFAR) for pilot training and operation of air taxis.
- **Operational Blueprint:** Released Urban Air Mobility Concept of Operations (ConOps) Version 2.0, outlining integration into national airspace.
- **Infrastructure Planning:** Collaborating with NASA and DoD on simulations and testing for AAM implementation.



Current Developments 2 – EASA (Europe)

- **Regulatory Framework:** Issued Opinion No. 04/2024, setting certification standards for electric and hybrid VTOL aircraft.
- **Innovative Air Mobility Hub:** Launched a digital platform for stakeholders to exchange information on air taxis and drones.
- **U-Space Implementation:** Developing air traffic management services for low-altitude drone operations in urban areas.



Current Developments 3 – Volocopter & Joby

Volocopter:

- VoloCity eVTOL: Undergoing EASA certification; designed for urban air taxi services.
- Operational Trials: Conducted test flights in cities like Singapore and Dubai.



Source: <https://evtol.news>

Joby Aviation:

- FAA Approval: Received authorization for ElevateOS, its air taxi operating system.
- International Expansion: Performed first exhibition flight in Japan; secured \$250 million investment from Toyota.



Source: <https://www.urbanv.com>

Current Developments 4 – Urban V & FFG

- **Strategic Partnership:** UrbanV and Future Flight Global (FFG) formed an alliance to develop Advanced Air Mobility services.
- **Rome Initiative:** Launching AAM operations in Rome, with plans to expand to global markets.
- **Infrastructure Development:** Combining UrbanV's vertiport expertise with FFG's electric aircraft operations to build a comprehensive AAM ecosystem.

Electric Vehicles and Infrastructure Planning

Rise of Electric Vehicles (EVs)

- Global EV sales increased by 35% in 2023.
- Norway: Nearly 90% of new car sales are fully electric.
- India: Uttar Pradesh leads with over 400,000 EV registrations, primarily e-rickshaws.



Infrastructure Requirements

Needs:

- Widespread and accessible charging stations
- Integration with renewable energy sources
- Smart grid development for load management
- Urban planning accommodating EVs (e.g., parking, zoning)





Innovative Initiatives 1 - Delhi

- **Expansion of Charging Infrastructure:** Inaugurated 25 new low-cost EV charging stations in Mayur Vihar Phase-1, enhancing accessibility for residents.
- **Affordability:** Delhi offers some of the lowest EV charging rates in India, encouraging wider adoption.
- **Policy Goals:** Aims for 25% of new vehicle registrations to be electric by 2024, reinforcing its commitment to sustainable transportation.

Innovative Initiatives 2 - Barcelona



Source: <https://www.ecowatch.com>

- **MetroCharge Project:** Utilizes regenerative braking energy from metro trains to power EV charging stations, integrating public transit with EV infrastructure.
- **Energy Efficiency:** The system provides all energy needs for 28 of 163 subway stations, saving 6% of the metro's total energy consumption.
- **Sustainability:** Combines recovered braking energy with solar power, showcasing a multifaceted approach to green energy utilization

Innovative Initiatives 3 – San Francisco



Source: <https://chargedevs.com>

- **Curbside Charging Pilot:** Launched a program to install curbside EV charging stations, addressing the needs of residents without off-street parking.
- **Public-Private Partnership:** Collaborated with companies like Urban EV, It's Electric, and Voltpost to expand charging infrastructure.
- **Climate Goals:** Aims to install at least 1,700 public chargers by 2030, supporting the city's target of net-zero emissions by 2040

Innovative Initiatives 4 – Nagpur



- **Residential Charging Stations:** MIHAN housing society installed exclusive EV charging stations for residents, featuring both DC fast chargers and standard AC points.
- **Community Engagement:** The initiative was spearheaded by the housing society's managing committee, reflecting growing environmental consciousness at the community level.
- **Citywide Expansion:** Nagpur Municipal Corporation plans to increase public charging stations from 83 to 150 by 2027, aligning with the city's EV Readiness Plan.

Policy and Planning Considerations

Strategies:

- Incentivizing EV adoption through subsidies and tax benefits
- Developing comprehensive EV infrastructure plans
- Ensuring equitable access to charging facilities
- Collaborating with private sector for infrastructure development



Group Discussion: Feasibility of applying smart solutions in small cities

Group Discussion: Feasibility of Applying Smart Solutions in Small Cities 1

Discussion Objectives:

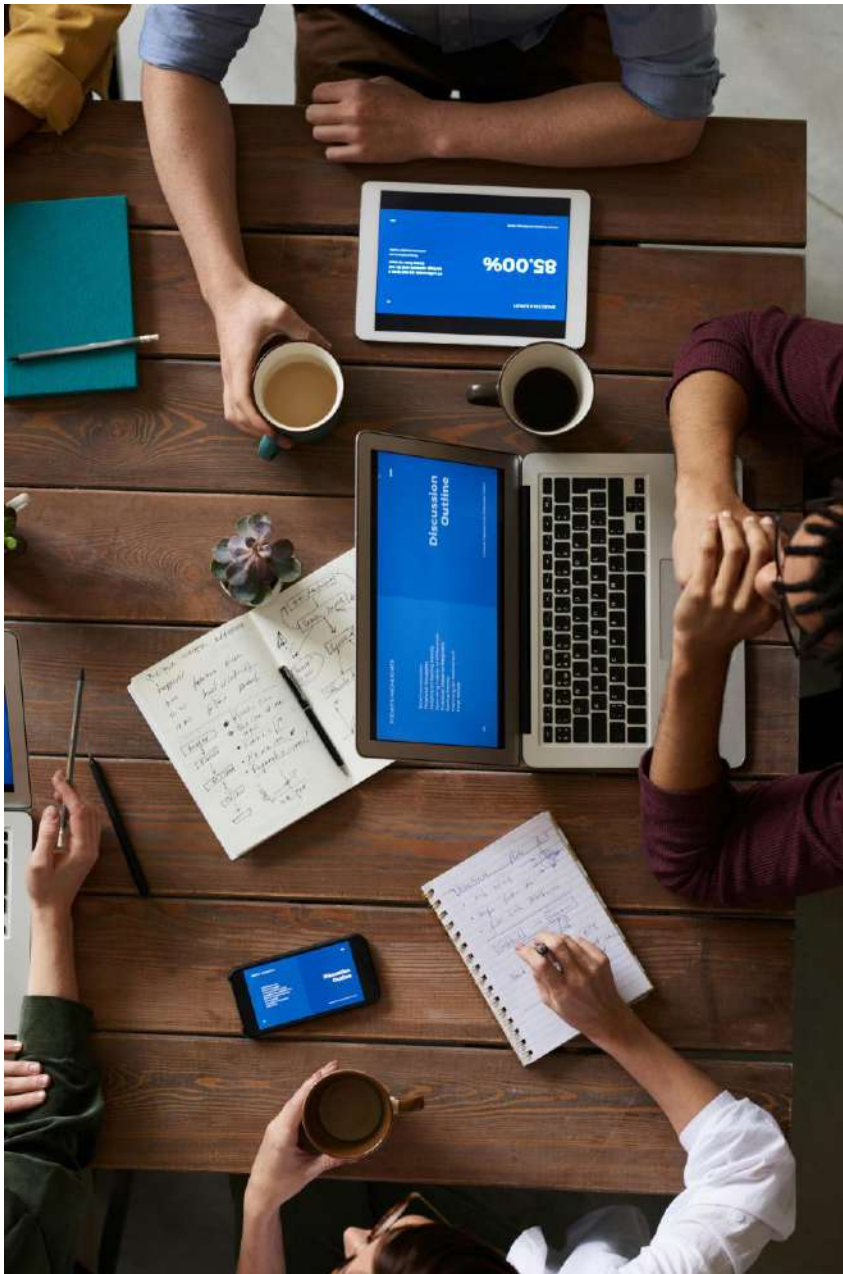
- Evaluate the applicability of MaaS, autonomous transport, UAM, and EV infrastructure in small city contexts.
- Identify potential challenges and opportunities unique to smaller urban areas.
- Develop strategic approaches for implementing smart mobility solutions.



Group Discussion: Feasibility of Applying Smart Solutions in Small Cities 2

Guiding Questions:

- What are the specific mobility challenges faced by small cities?
- How can smart transport technologies address these challenges?
- What are the resource and infrastructure constraints?
- How can community engagement be fostered in adopting new technologies?



Group Discussion: Feasibility of Applying Smart Solutions in Small Cities 3

Instructions:

- Form groups of 4-6 participants.
- Select a small city (real or hypothetical) and assess its readiness for smart transport solutions.
- Develop a brief action plan outlining steps for implementation.
- Present findings and recommendations to the larger group.





Summary & Key Takeaways



Innovation Is Transforming Urban Mobility



Integration Is Key



Autonomous & Aerial Solutions



EVs & Infrastructure Planning



Final Takeaway

Thank you!

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility
and Energy Efficiency

Sub Module 202: Energy Efficiency in
Urban Infrastructure

202 D: Smart Building Foundations & BAS
Architecture

Trainer:



Agenda

- What is a Smart Building?
- BAS Architecture and Functions
- Key Components and Protocols
- Integration, SRI and Interoperability
- Smart Renovation and Commissioning
- Data, Optimization, and Policy Links
- Reflection Questions

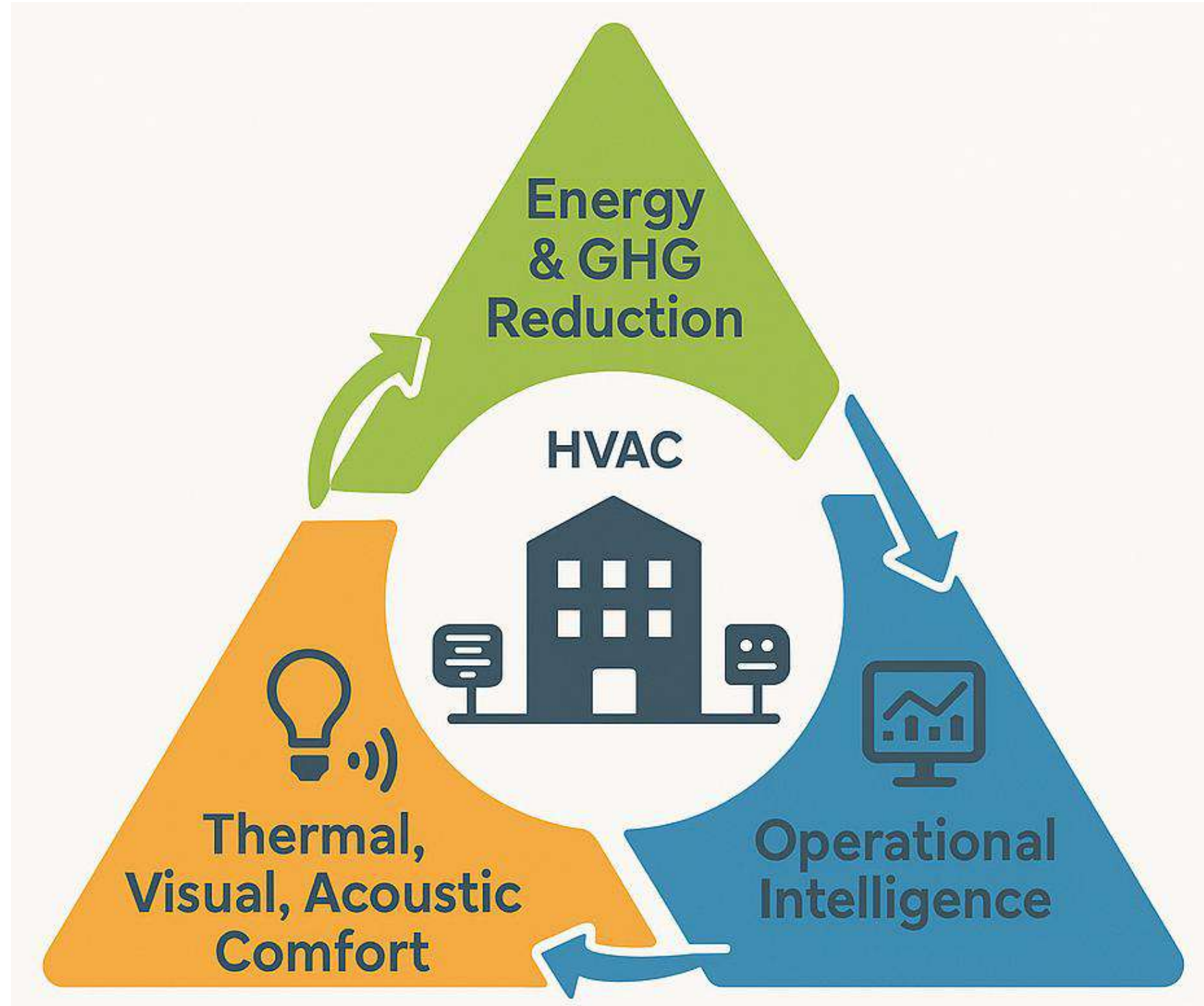
What Defines a Smart Building?

- Automated, responsive, connected systems
- Real-time interaction with environment
- Enhanced efficiency and occupant experience



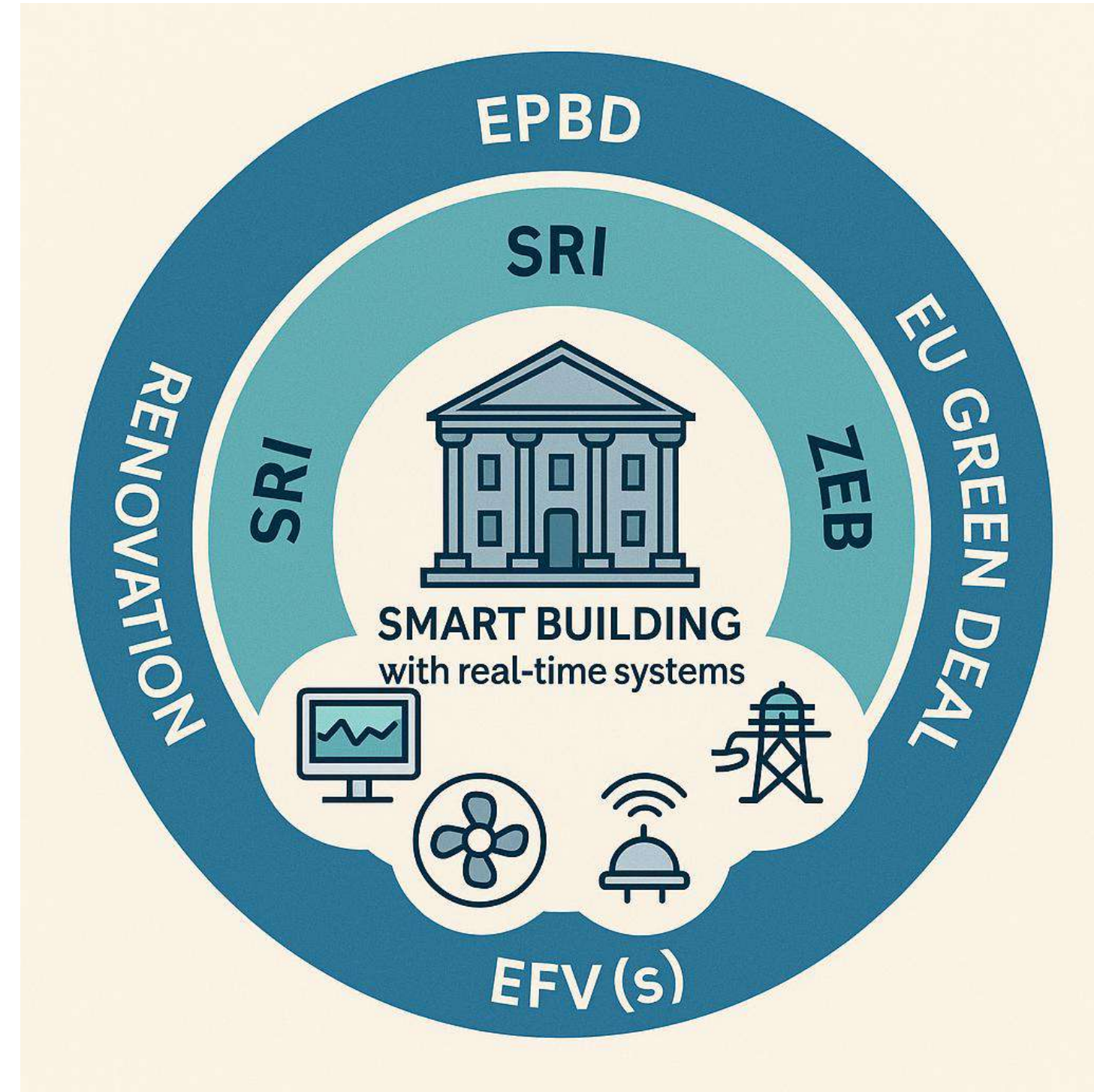
- Reduce GHG and energy use
- Improve thermal, visual, acoustic comfort
- Enable building intelligence

Design Goals of Smart Systems



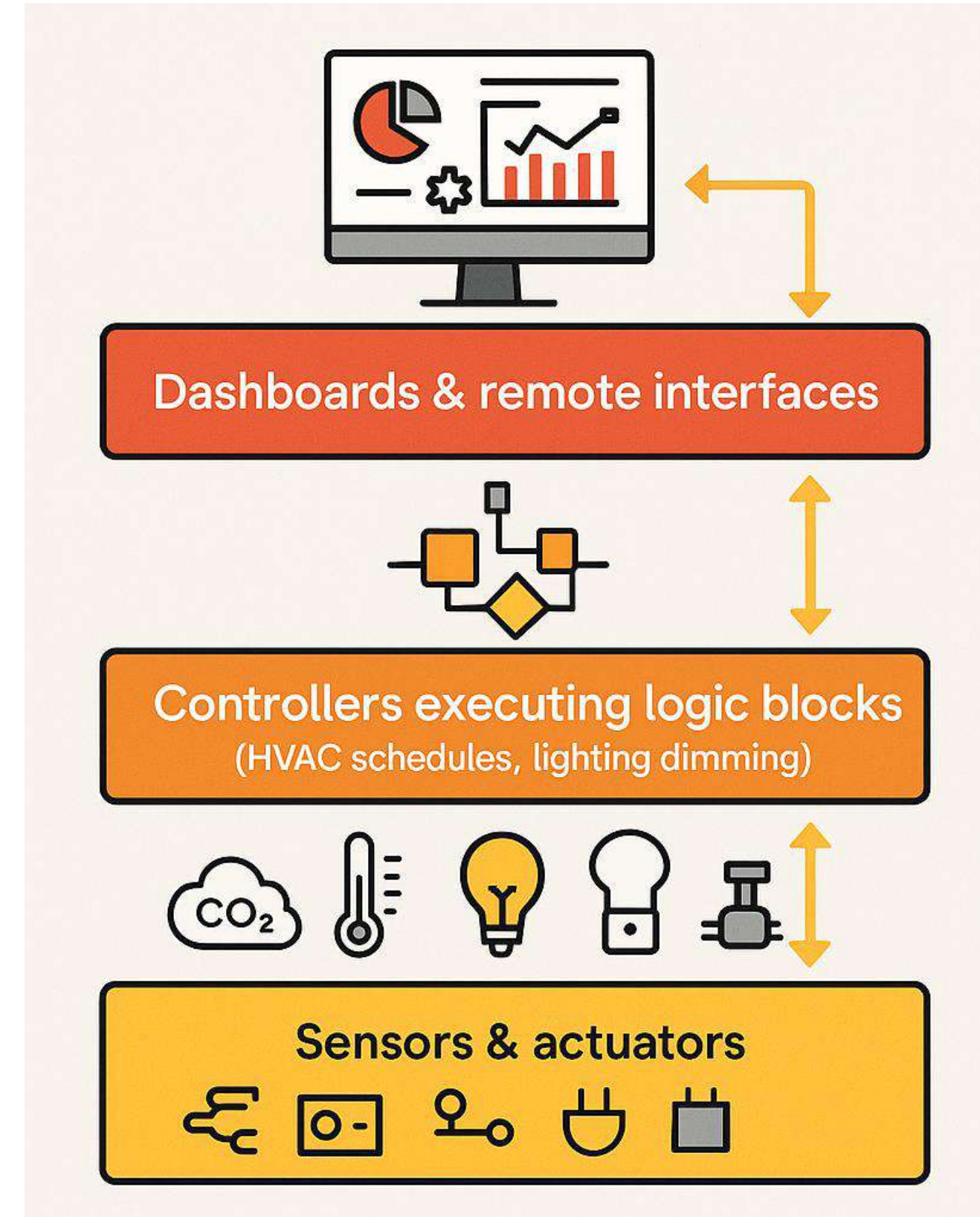
- EPBD Recast includes SRI
- Support ZEB, EPC, Level(s)
- Public buildings must lead adoption

Why Smart Buildings Matter for the EU



- Digital layer for HVAC, lighting, safety, access
- Centralized control of building systems
- Supports automation and optimization

What is a Building Automation System?



- Monitoring and scheduling
- Remote access and control
- Fault detection and diagnostics

Core Functions of BAS

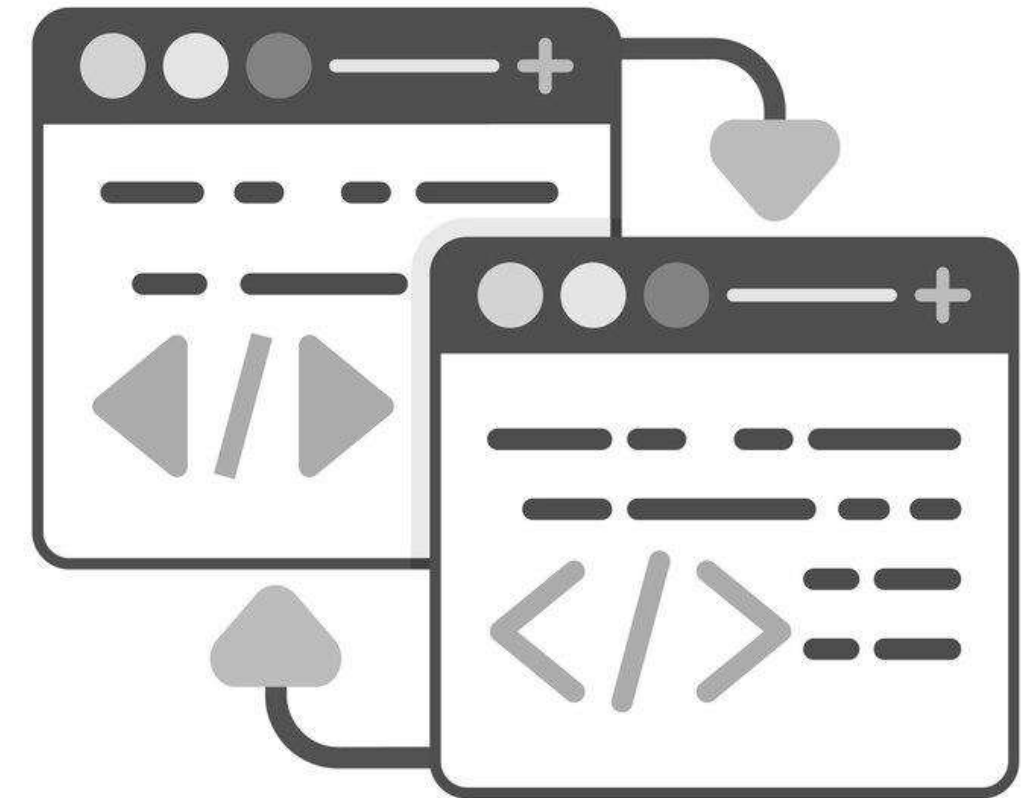
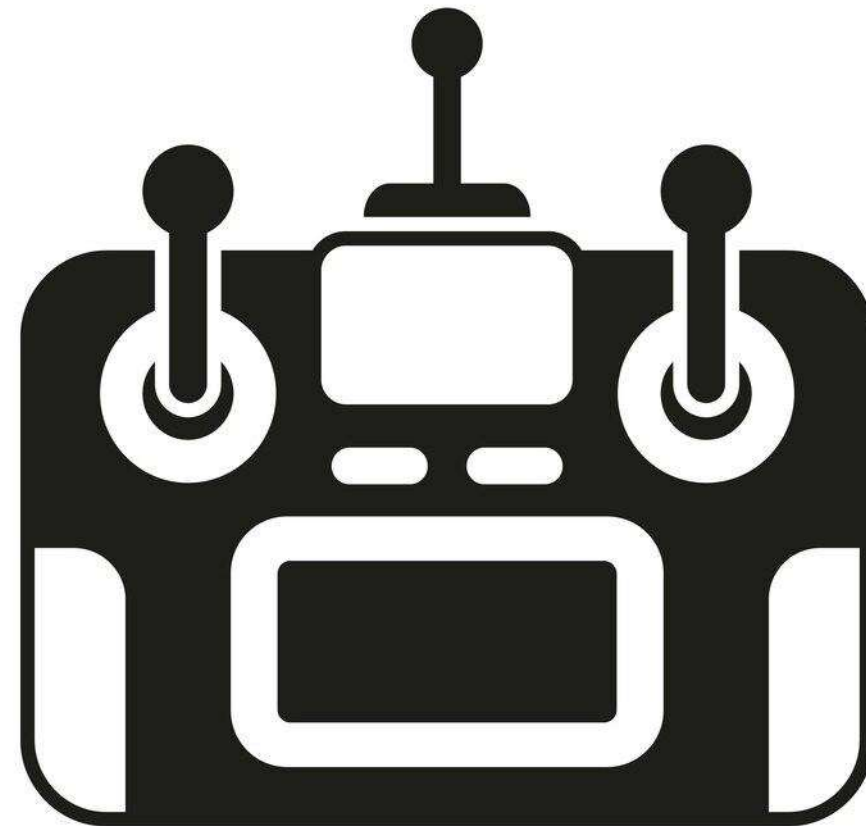


BAS vs BMS vs EMS

System	Key Focus	Components
BAS	Real-time control	HVAC, Lighting, Access, Shading
BMS	Centralized management	Fault detection, Fire Safety, Dashboards
EMS	Energy analytics & strategy	Meters, Carbon Reports, Portfolio Dashboards

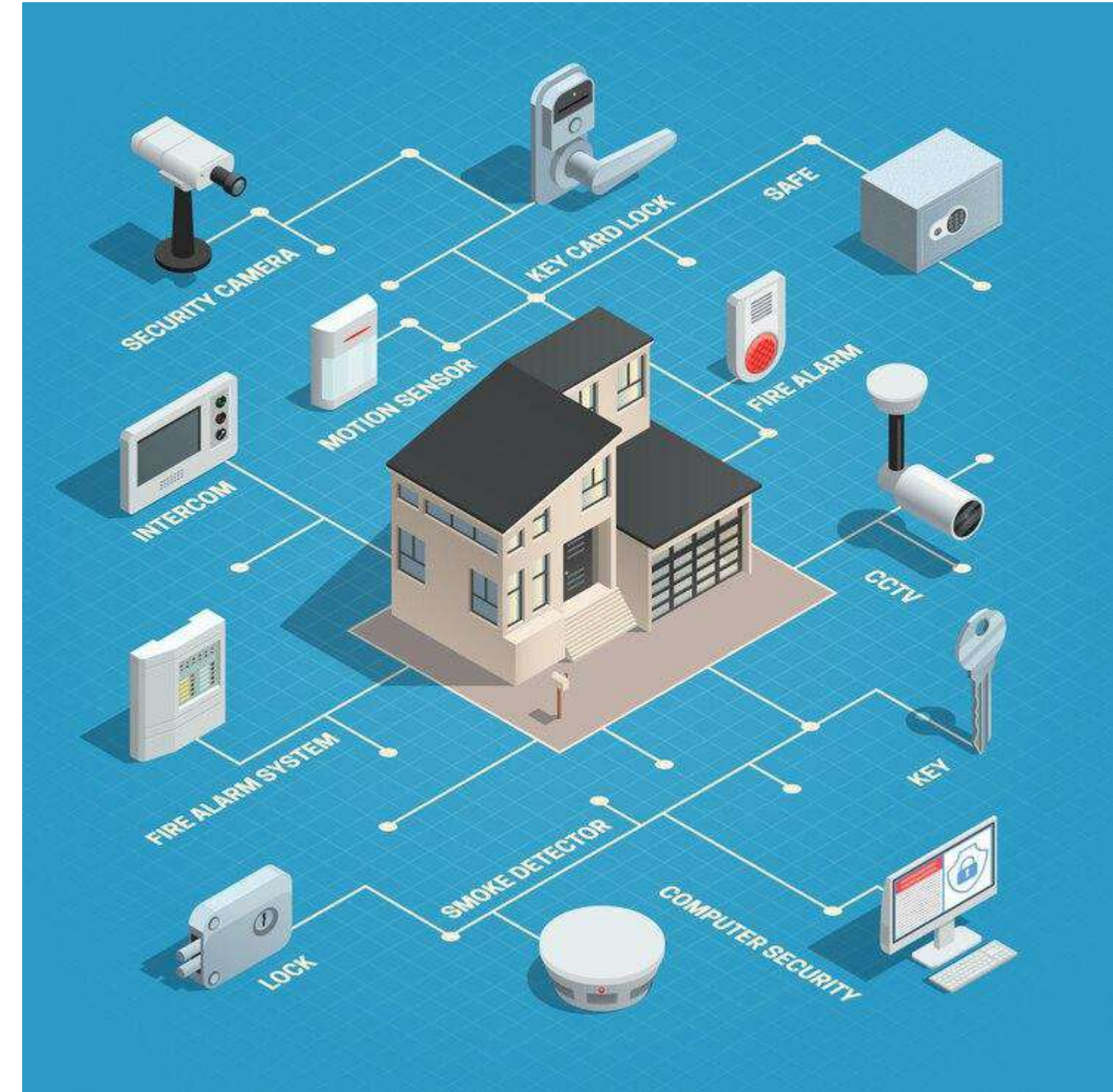
Key Components in BAS

- Sensors (CO₂, temp, presence)
- Controllers and actuators
- User interface and software



- Trigger ventilation, lighting, security
- Support comfort and safety
- Critical to smart responsiveness

Sensor Use Cases



Controllers and Logic Programming

- Setpoints, PID loops, safety interlocks
- Logic trees for scenario response
- Local + centralized control layers



Open vs Proprietary Protocols

Open Protocols



Proprietary Systems

- Vendor-locked
- Limited interoperability



EU Preference →
Open, Secure, Interoperable

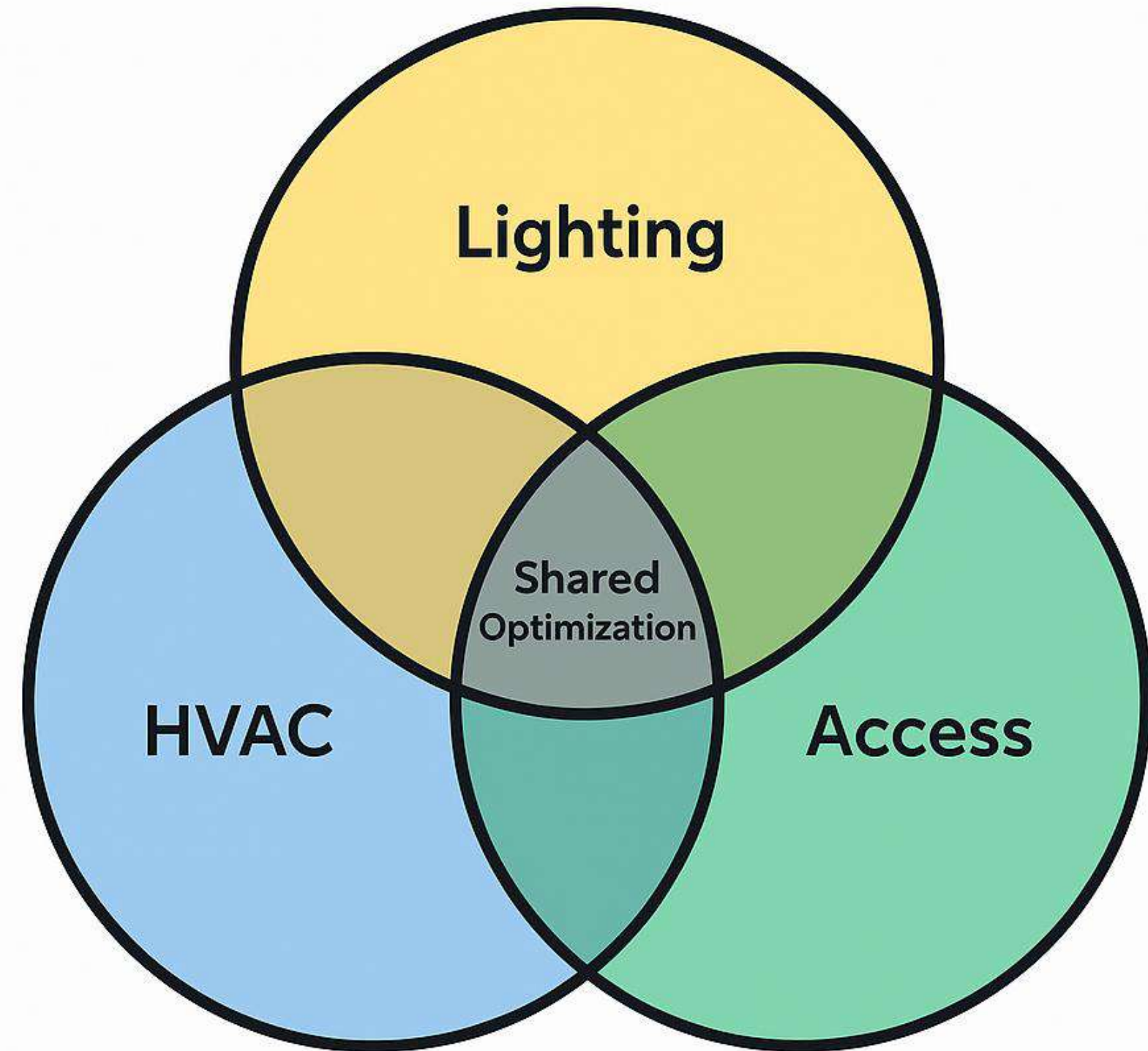
- Real-time visualization of zones
- Mobile and browser-based control
- Role-based access and alerts

Interface Tools: Dashboards



- Avoid silos, improve performance
- Unified control = better coordination
- Scalable logic for future tech

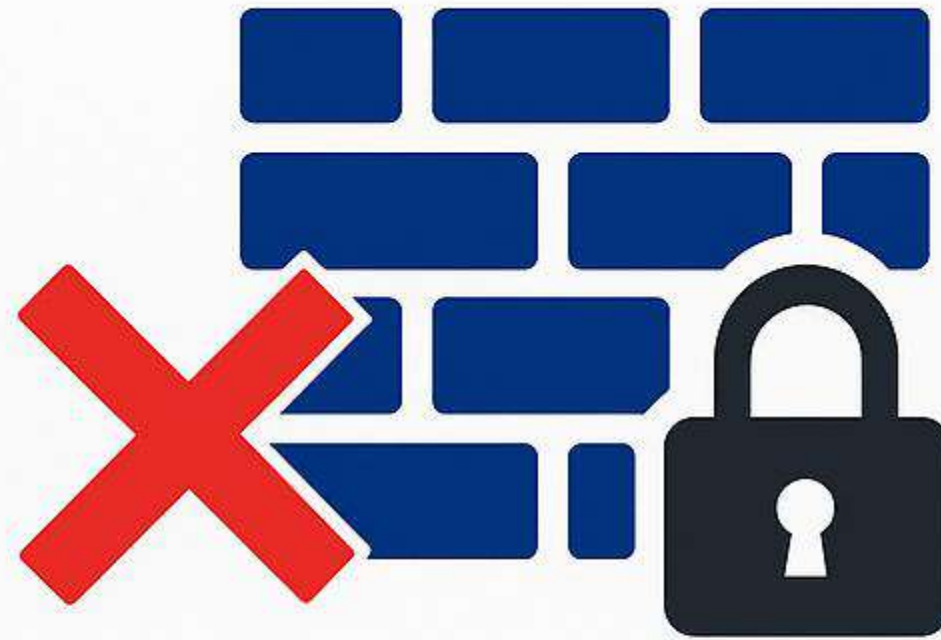
System Integration Benefits



Interoperability Challenges



**Legacy systems,
protocol clashes**



**IT/OT firewalls,
cyber risk**



**Lack of skilled
integrators**

Smart Readiness Indicator (SRI)

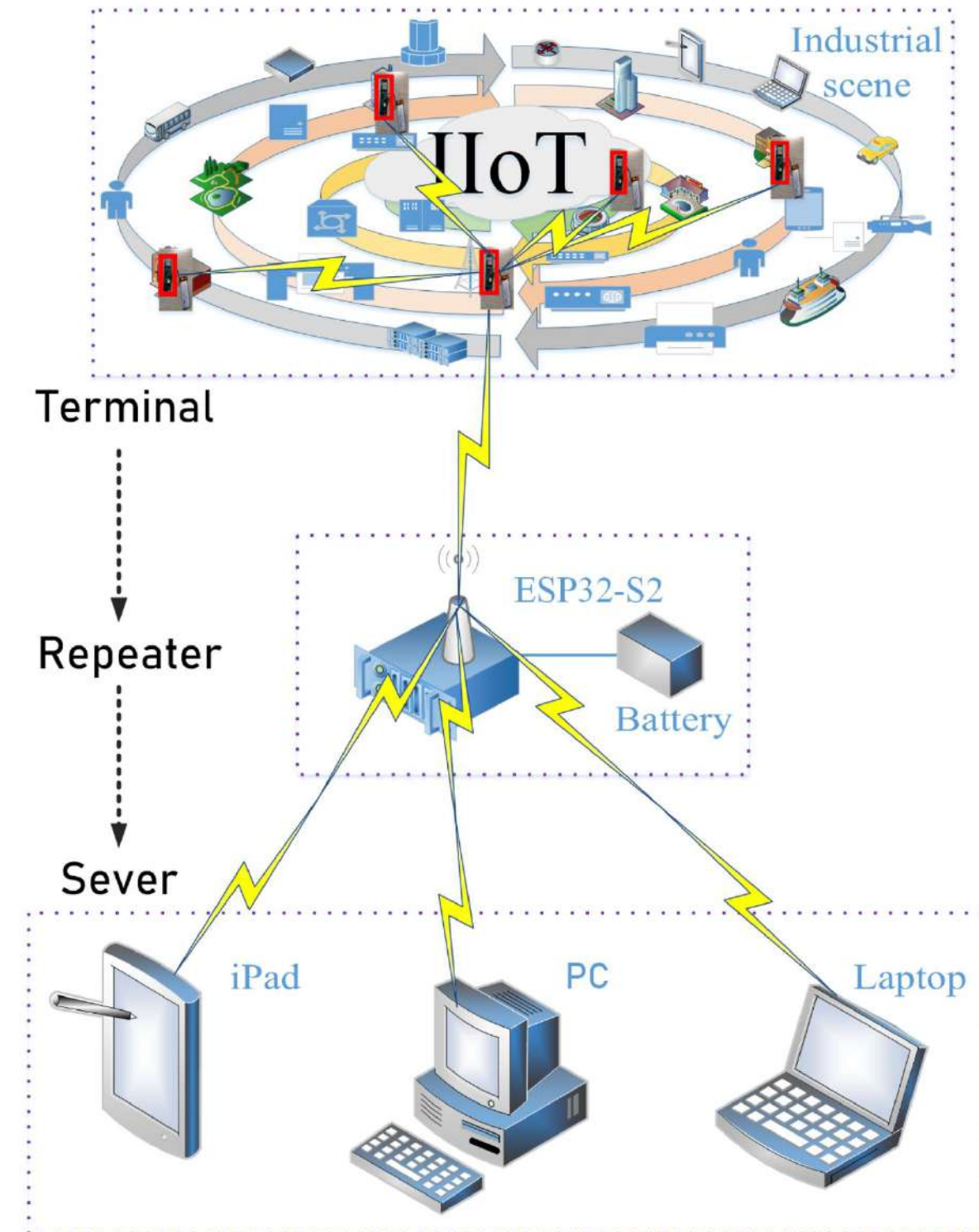
- Scores buildings on smart capabilities
- Domains: automation, optimization, reactivity
- Used in passports/logbooks + EPC upgrades



Source: REHVA

- Cloud = remote insight and updates
- Edge = real-time, local resilience
- EU projects use hybrid approaches

Cloud + Edge BAS Trends



<https://www.mdpi.com/1999-5903/15/5/171>

Smart Retrofitting Approaches

- Wireless or IP-based retrofits
- Step-by-step sensor + controls layering
- Integrate with envelope upgrades

Landline /
CellphoneDNAKE
Smart Pro AppDNAKE
Smart Life App

S213K



Power

12V

12V

RJ45



Router with 4G SIM Card

Commissioning and Quality Assurance

- Pre-functional + performance testing
- System calibration and validation
- Handover includes interface checks



- Trend analysis + auto-adjustment
- Anomaly detection = proactive O&M
- Input for Level(s), PHPP, EPC upgrades

Data Use for Optimization



How SRI Links to Level(s)

- Both focus on performance + user impact
- Support lifecycle and post-occupancy tracking
- Used in green finance frameworks



Conclusion & Takeaways

- Smart buildings = EU-ready performance
- BAS is foundational to ZEB operation
- Open + interoperable = futureproof



Reflection Questions

- Which BAS feature matters most for your role?
- What stands in the way of smart integration?



Smart Retrofitting: Wireless & IP Protocols

STEP2CleanPLAN

- Wireless: Zigbee, LoRa, BLE enable retrofit zones
- IP-based BAS reduces conduit and cabling needs
- Gateways bridge legacy and smart protocols



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility
and Energy Efficiency

Sub Module 202: Energy Efficiency in
Urban Infrastructure

202 H: Cybersecurity and Interoperability
for Smart Building Systems

Trainer:

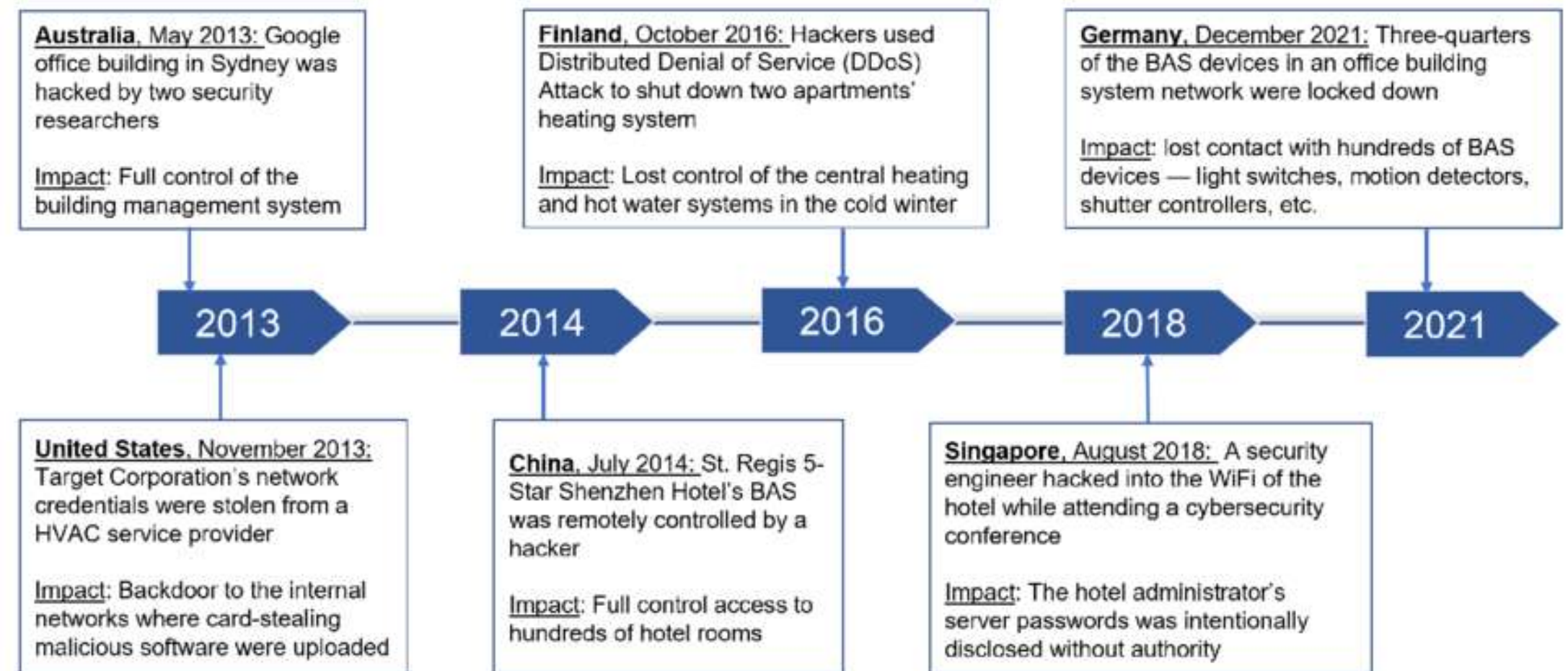


Agenda

- Cyber Threats in Smart Buildings
- BAS/IoT Vulnerabilities & Attack Vectors
- Protocol Conflicts & Interoperability Gaps
- Cybersecurity Standards & Semantic Governance
- Designing for Security & Lifecycle Monitoring
- Future-Proofing & Risk-Based Modernization
- Conclusion & Reflection

Why Cybersecurity Now?

- IoT adoption → attack surfaces grow
- FM systems now expose operations
- Breaches impact safety, comfort, data



<https://www.researchgate.net/profile/Guowen-Li-5/publication/369131862/figure/fig4/AS:11431281236665506@1713279746038/Timeline-of-recently-reported-cyberattacks-on-buildings-and-their-physical-impacts.png>

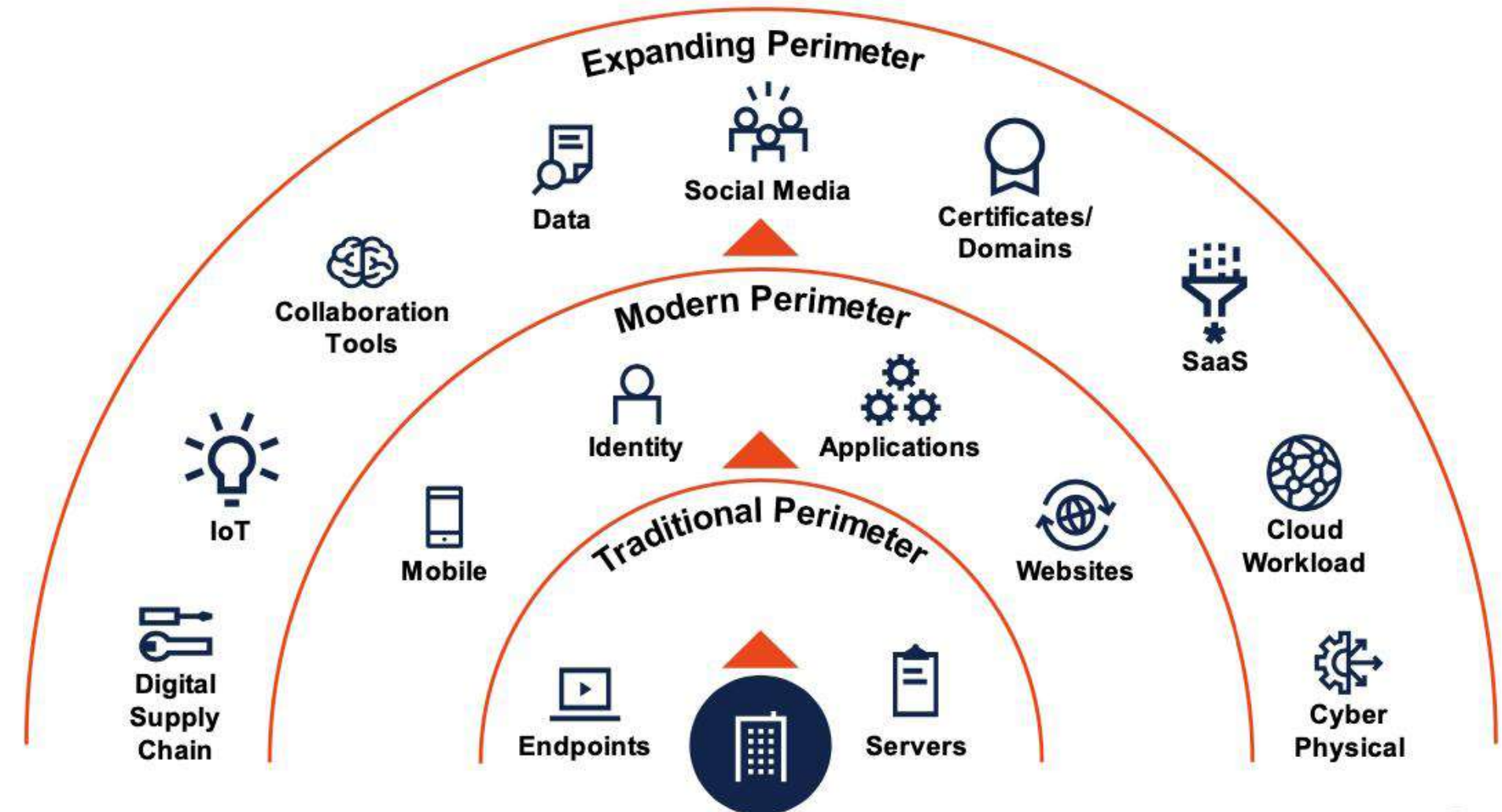
Vulnerabilities in BAS & IoT Systems

- Flat networks → lateral attacks
- Default credentials & open ports
- Unpatched firmware + outdated protocols



IoT Weaknesses in Smart Buildings

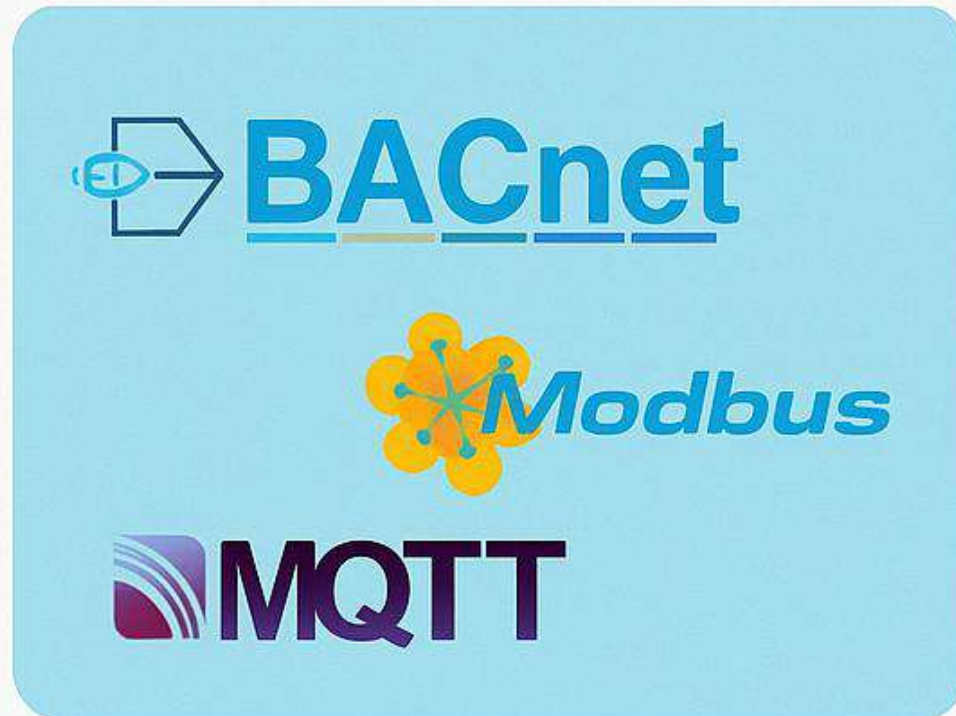
- Cloud dashboards poorly secured
- MQTT replay & fallback disruption
- Edge-to-cloud trust gaps



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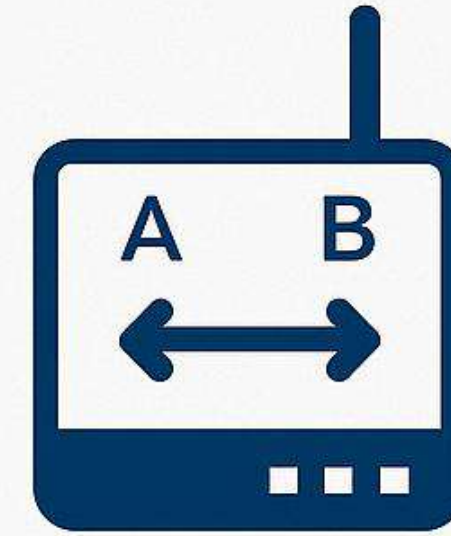
Protocol Misalignment Risks



- no standard handoff



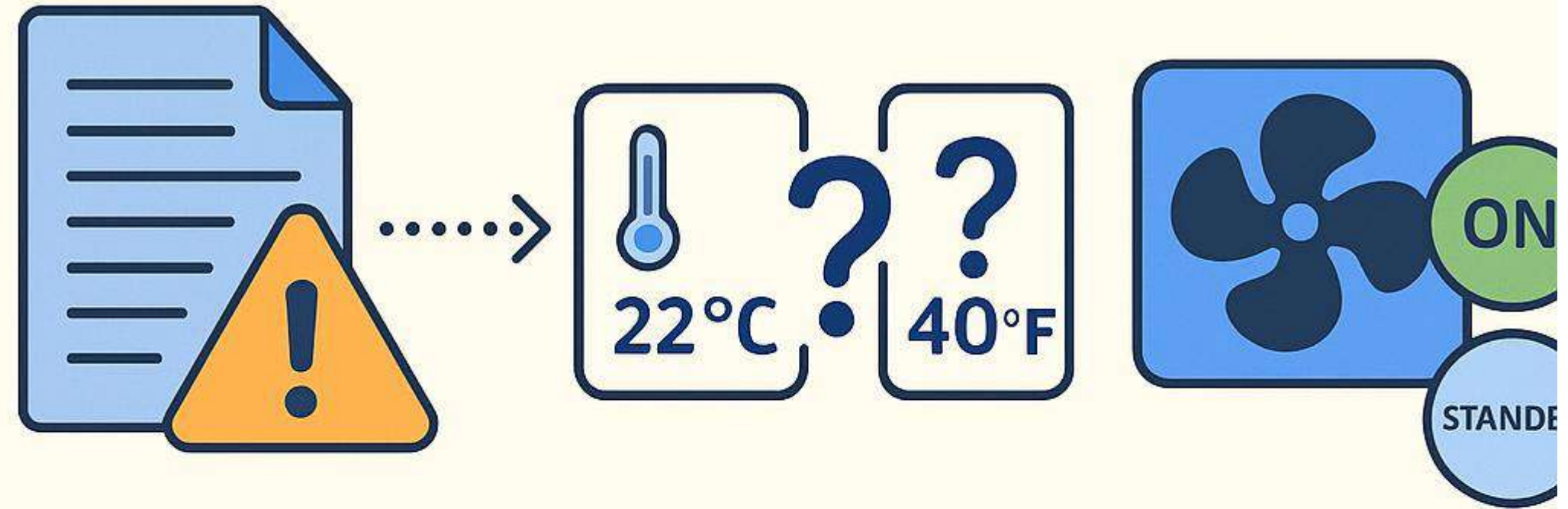
Translation loss
& point
mismatch



Gateways =
single points
of confusion

Semantic Conflicts in Integration

- Units, tags, meanings lost in translation
- Room temp vs duct temp confusion
- Fan status: binary vs enum



- Units, tags, meanings lost in translation
- Room temp vs duct temp confusion
- Fan status: binary vs enum

Units, tags, meanings lost in translation

Governance Failures & Blind Spots

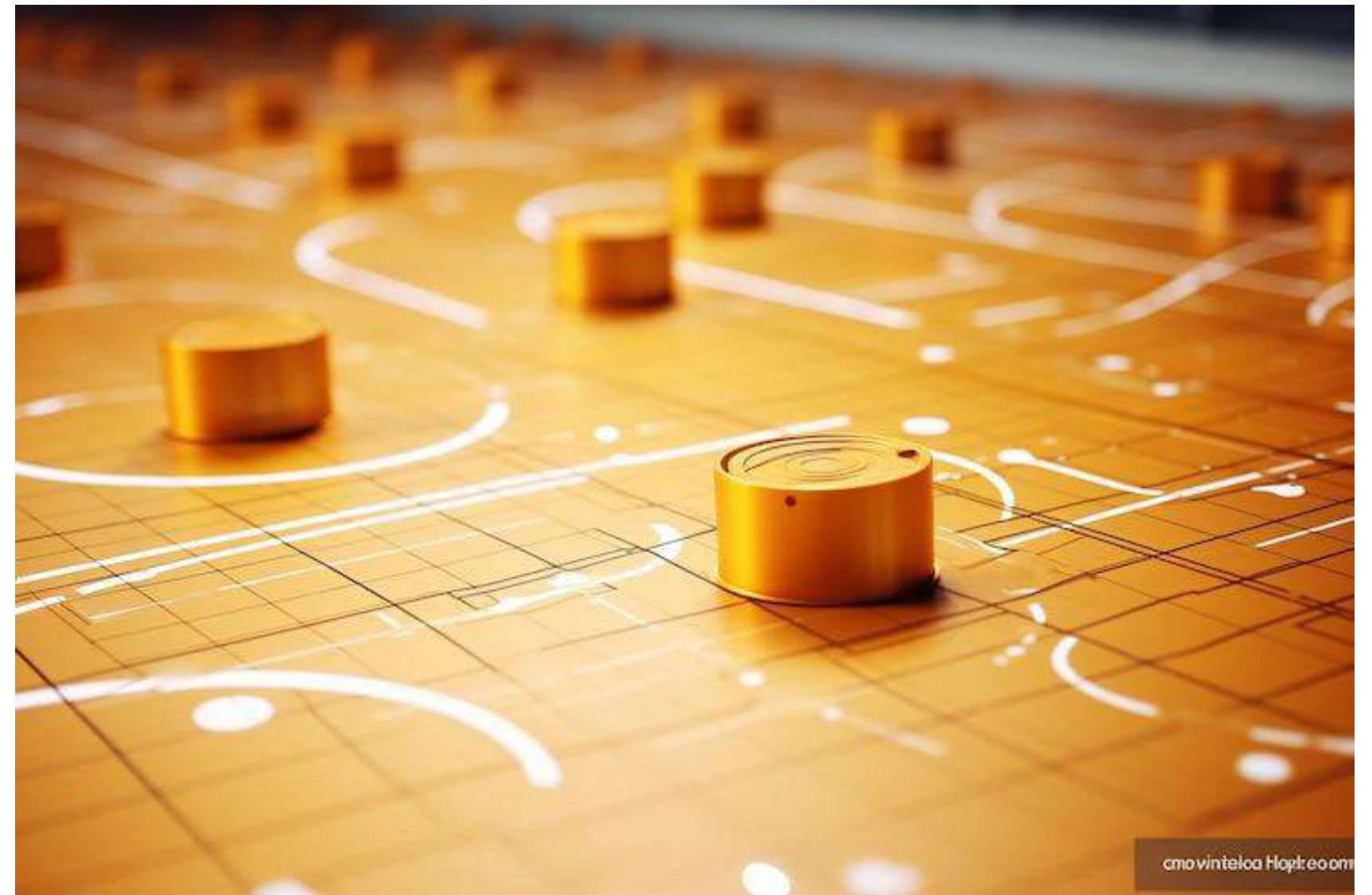
- No integration plan → overlapping access
- Inconsistent naming → misfire APIs
- Semantic gaps = unmonitored zones



Cybersecurity Standards for Smart Buildings

STEP2CleanPLAN

- IEC 62443: BAS lifecycle approach
- NIST CSF: Identify, Protect, Detect...
- ISO 27001: InfoSec management for FM
- BACnet/SC: Secure encrypted communication



Semantic Frameworks for Governance

- Brick Schema & Haystack = access + audit
- Support for RBAC + API validation
- Semantic integrity → system accountability



Designing a Secure BAS Architecture

- Segment with VLANs, firewalls, RBAC
- Patch lifecycle & encrypted logging
- Use protocol filtering at edges



RBAC & Auditability

- Tech vs Admin → limited permissions
- Audit trails, logs, traceability
- NIST, ISO, IEC support role models



Real-Time Monitoring & Incident Response

STEP2CleanPLAN

- IDS, SIEM, log analysis in FM context
- Behavior monitoring of edge devices
- Incident playbooks and tabletop drills



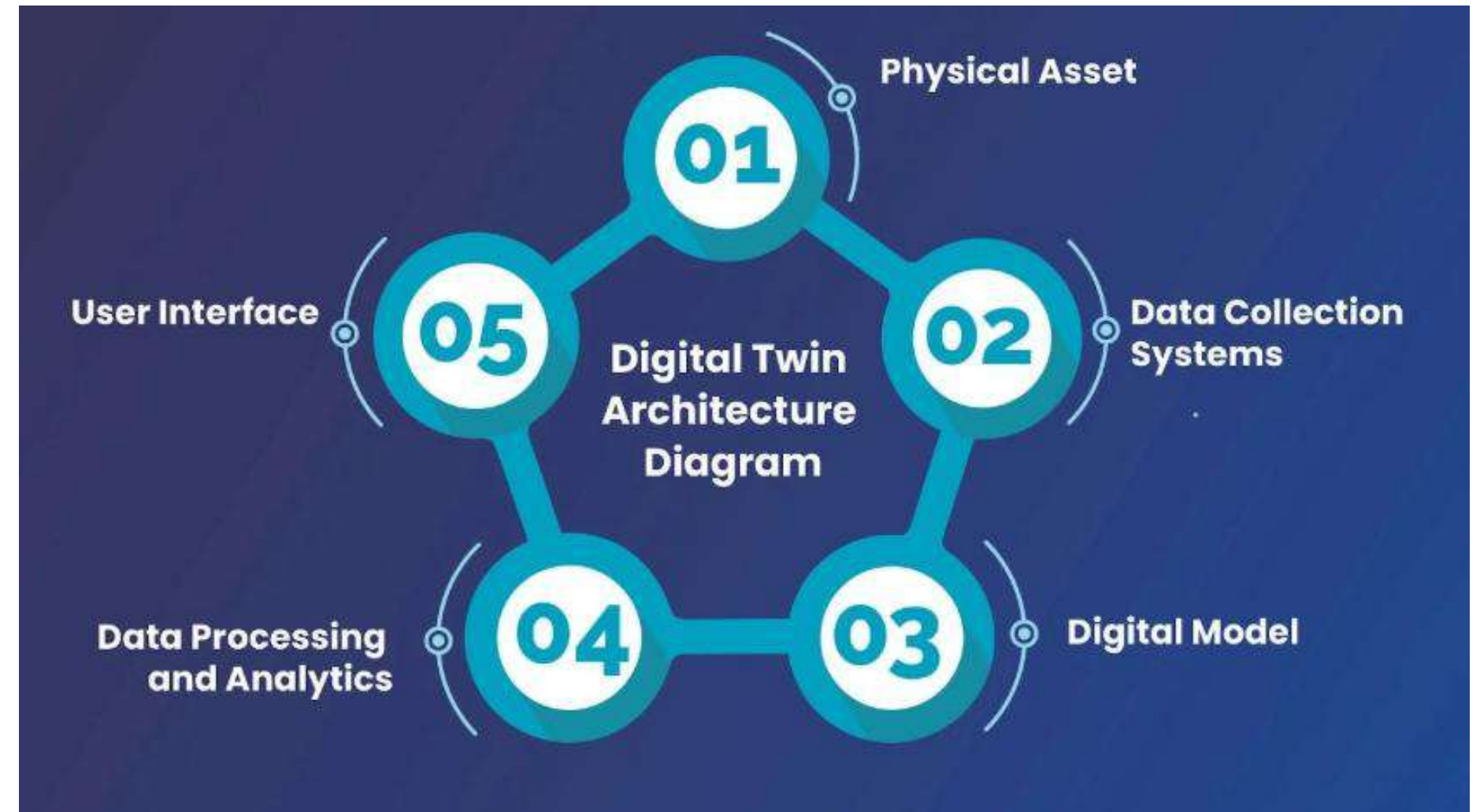
Legacy Systems: Risk & Containment

- Segment, isolate, filter bridges
- Upgrade roadmap + risk heatmap
- Legacy ≠ ignored



Security by Design & Digital Twins

- Model, test, simulate security workflows
- Embed tag integrity & behavioral baselines
- Train teams with simulation insight



Ongoing Adaptation & Governance

- Patch, monitor, retrain policies regularly
- Review post-event failures
- Iterate design with new threats



Conclusion: Design for Resilience

- Security → performance + continuity
- Interoperability → clarity + maintainability
- Govern with foresight, not patchwork



Reflection Prompts

- What risks exist due to protocol misalignment?
- How can your team support RBAC and segmentation?
- What upgrade priority should be mapped first?



Modernization Roadmap for Smart Buildings

STEP2CleanPLAN

- Legacy → VLAN segmentation
- Intermediate: protocol filter gateways
- Future: encrypted, semantic twins



- Scan & detect threats
- Patch & document
- Train & retest teams
- Review policy post-incident

Lifecycle Update Flow



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility
and Energy Efficiency

Sub Module 202: Energy Efficiency in
Urban Infrastructure

202 I: Data Analytics, Fault Detection &
GIS Integration

Trainer:

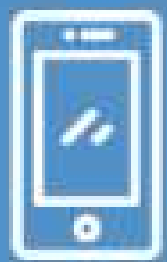


Agenda

- Data in Smart Building Operations
- KPIs, Dashboards, and Visualization
- Fault Detection & Diagnostics (FDD)
- Predictive Maintenance and Alerts
- GIS Mapping for Urban Efficiency
- Conclusion & Reflection

Why Data Analytics Matters

- Transforms raw data into insights
- Improves energy, comfort, uptime
- Supports long-term performance planning



- Logging: local or cloud
- APIs, middleware, storage
- Feeds dashboards and analytics

Smart Data Infrastructure



What Are KPIs in Smart Buildings?

Energy Performance

- Energy Use Intensity (EUI)
- kWh/m²/year
- Benchmark vs. Design

Occupancy & Usage

- Zone Occupancy
- Occupant Density
- Schedule Alignment

Comfort Metrics

- Temperature
- CO₂ Levels
- Humidity
- Occupant Satisfaction

GHG & Sustainability

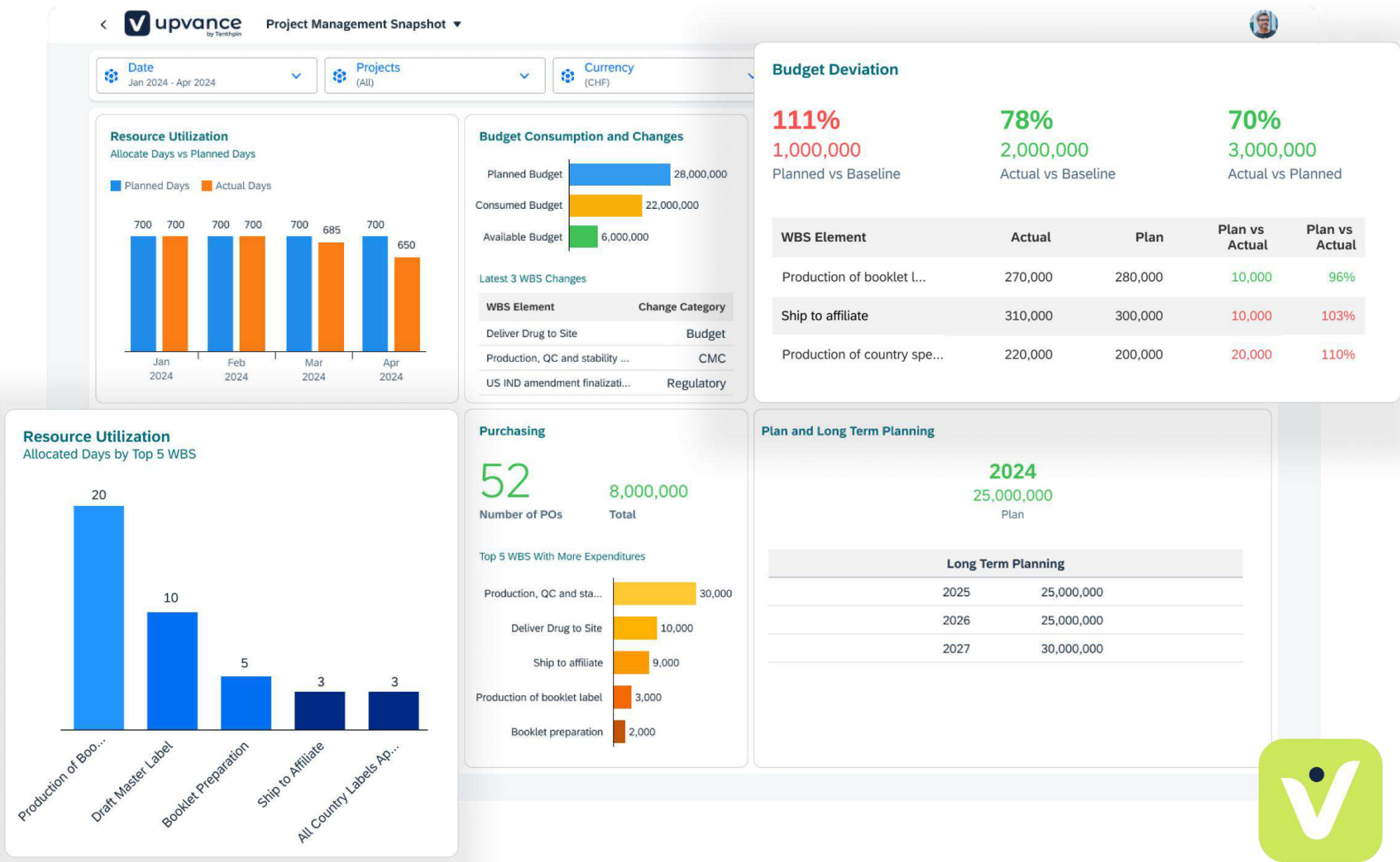
- GHG Emissions
- Renewable Ratio
- Carbon Intensity

Operational Uptime

- System Availability
- Runtime Hours
- Fault Frequency

Dashboards and UI Design

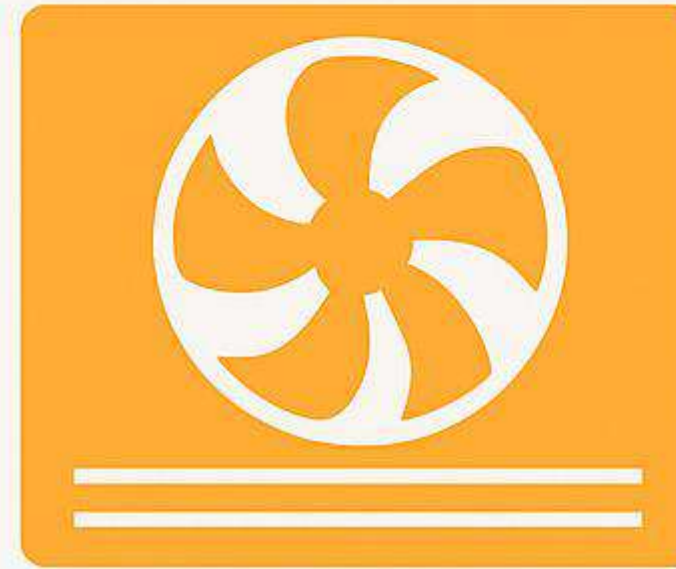
- Clarity over complexity
- User segmentation: FM vs admin
- Mobile vs desktop logic



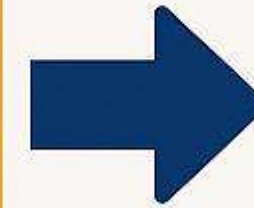
- Detects performance deviation
- Compares expected vs actual operation
- Flags energy waste or failure

What is FDD?

EXPECTED



- Performance deviation



ACTUAL

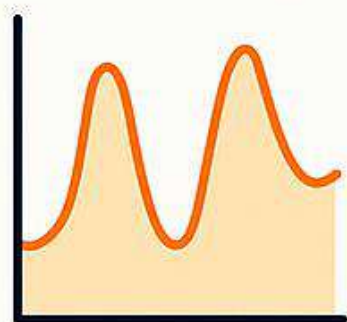


- Performance deviation
- Increased energy use
- System fault

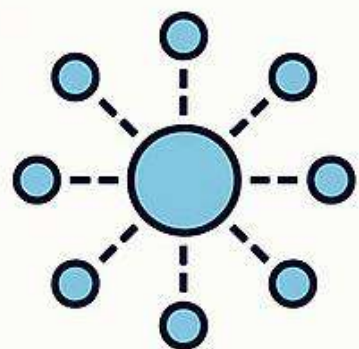
FDD Rule Types



Static rules
(if $X > Y...$)



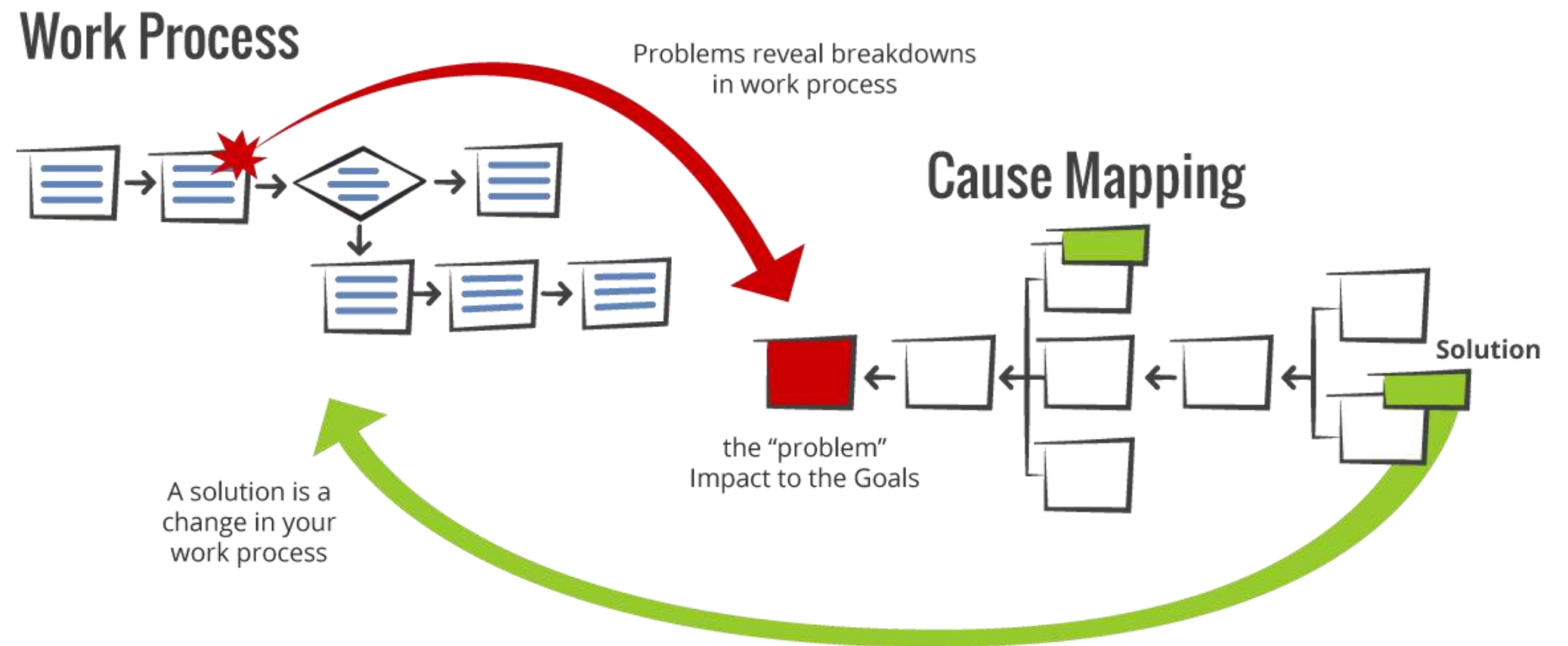
Pattern-based
(e.g. chiller curves)



AI-based
(ML anomaly detection)

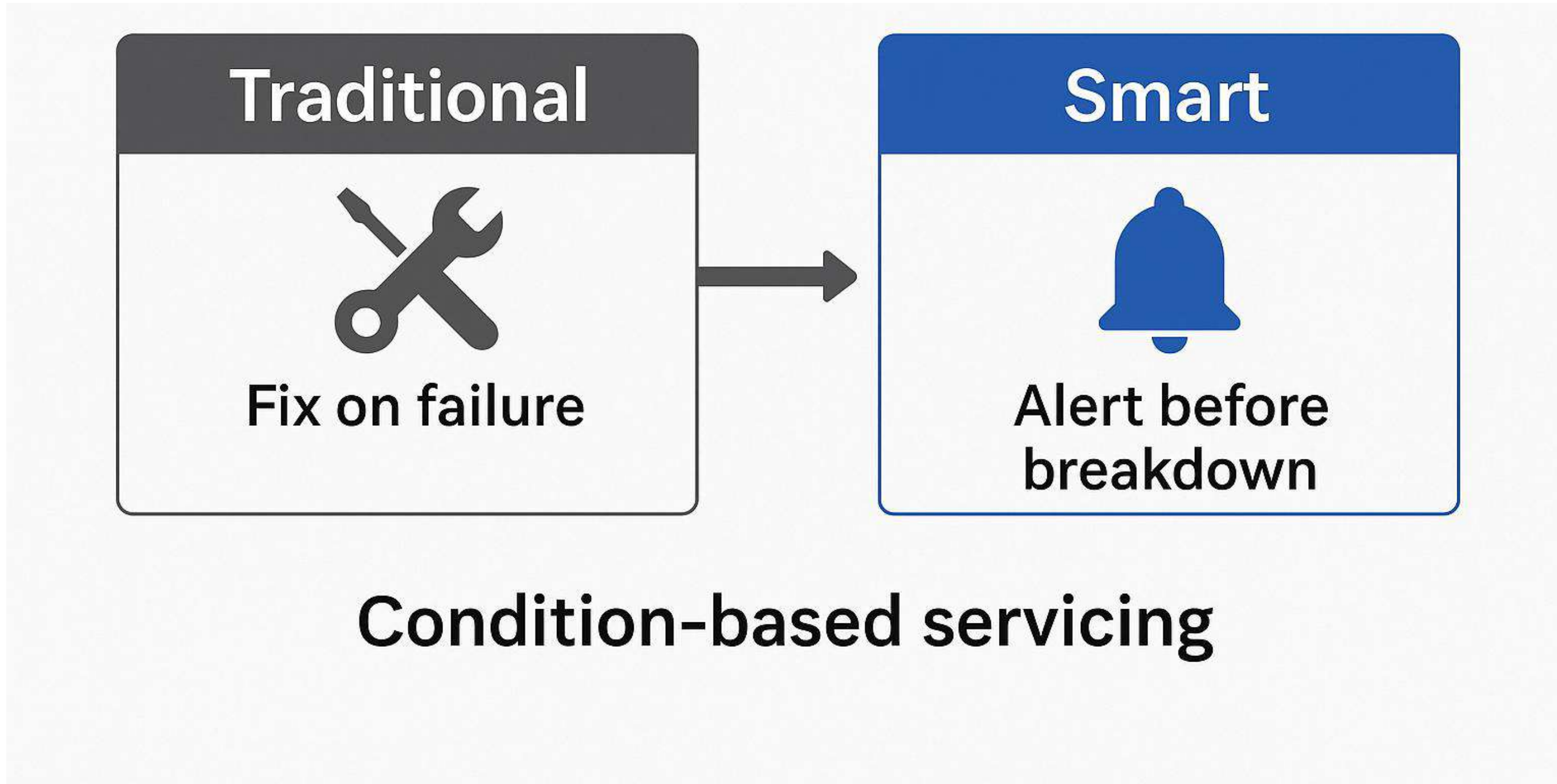
Root Cause Mapping

- Sensor anomaly vs equipment issue
- Control override vs actual fault
- Commissioning logs as reference

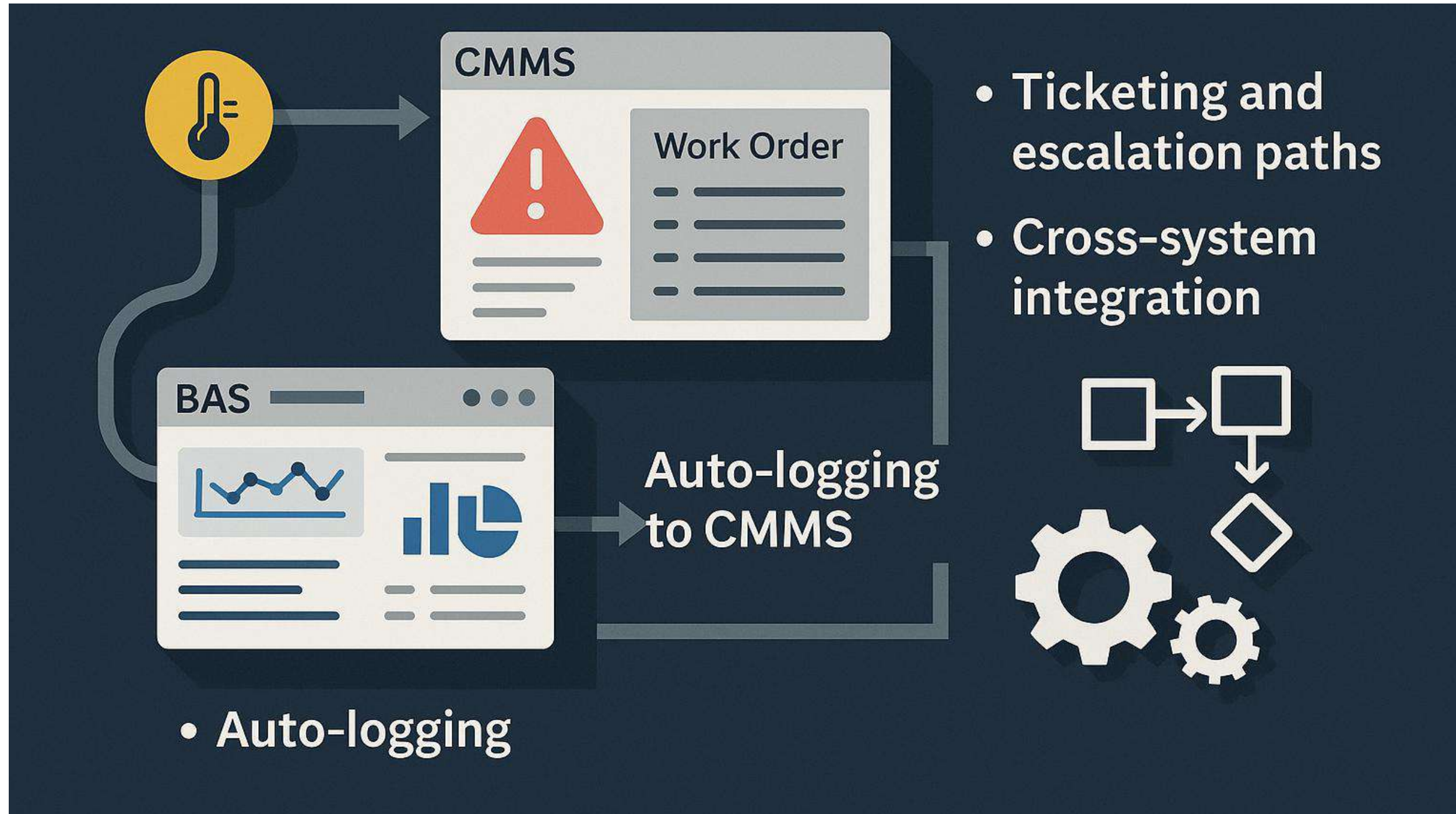


From Reactive to Predictive Maintenance

STEP2CleanPLAN



Data-Driven Workflows

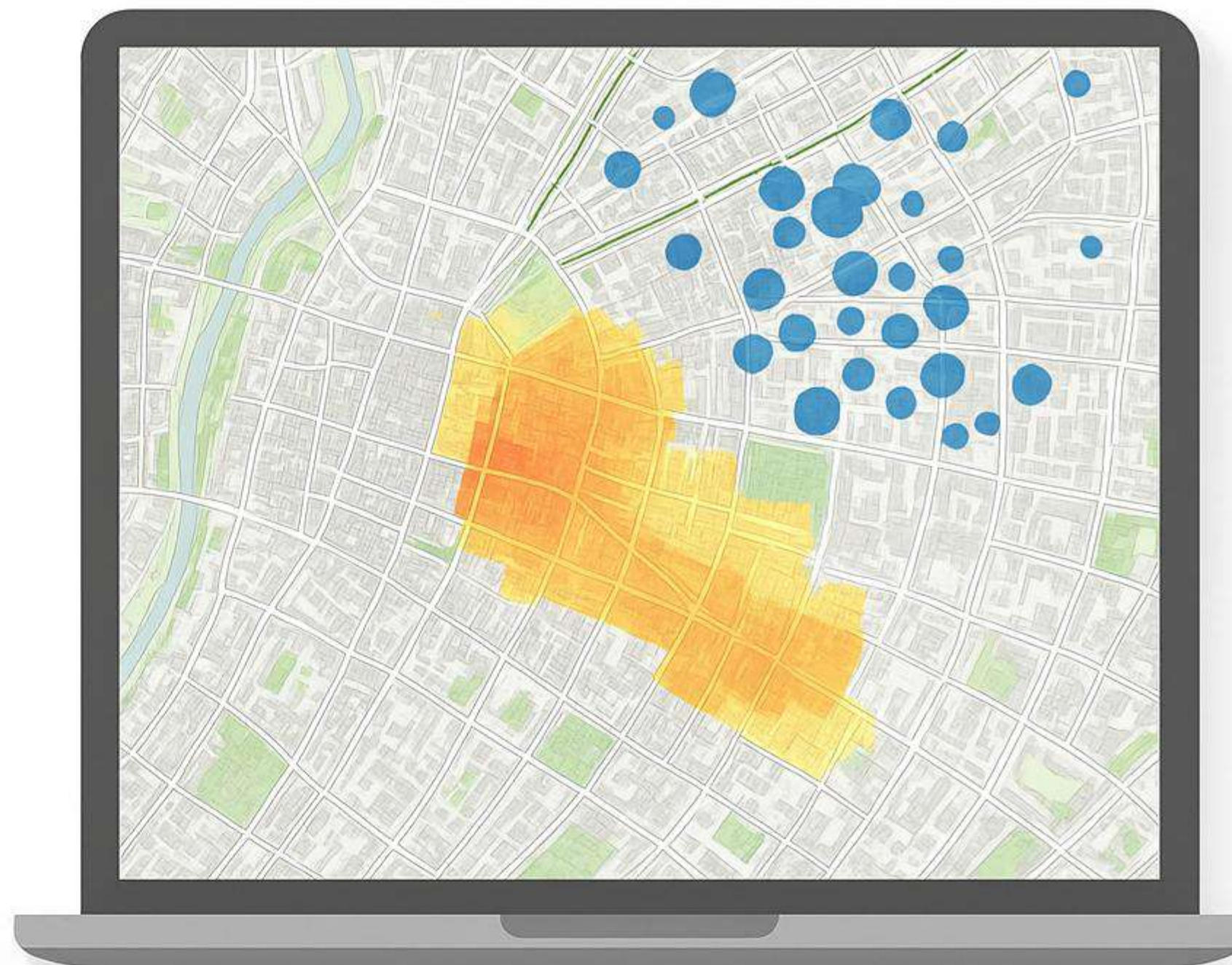


What is GIS in the Built Environment?

Geospatial layering
of assets

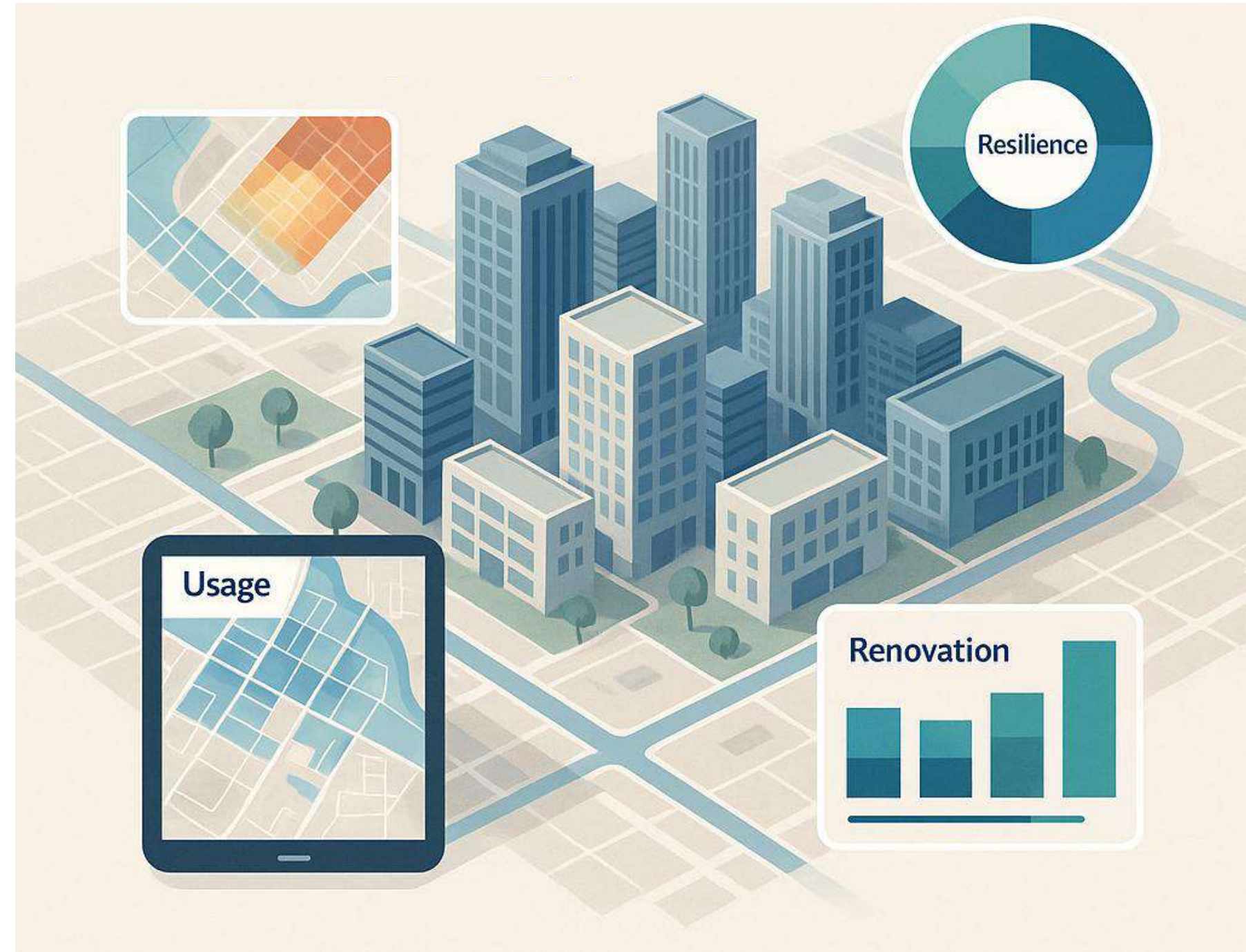
Environmental +
building data fusion

Used in city planning
+ facility strategy



- Maps usage, solar access, resilience
- Connects micro data to macro scale
- Links zoning, energy, renovation

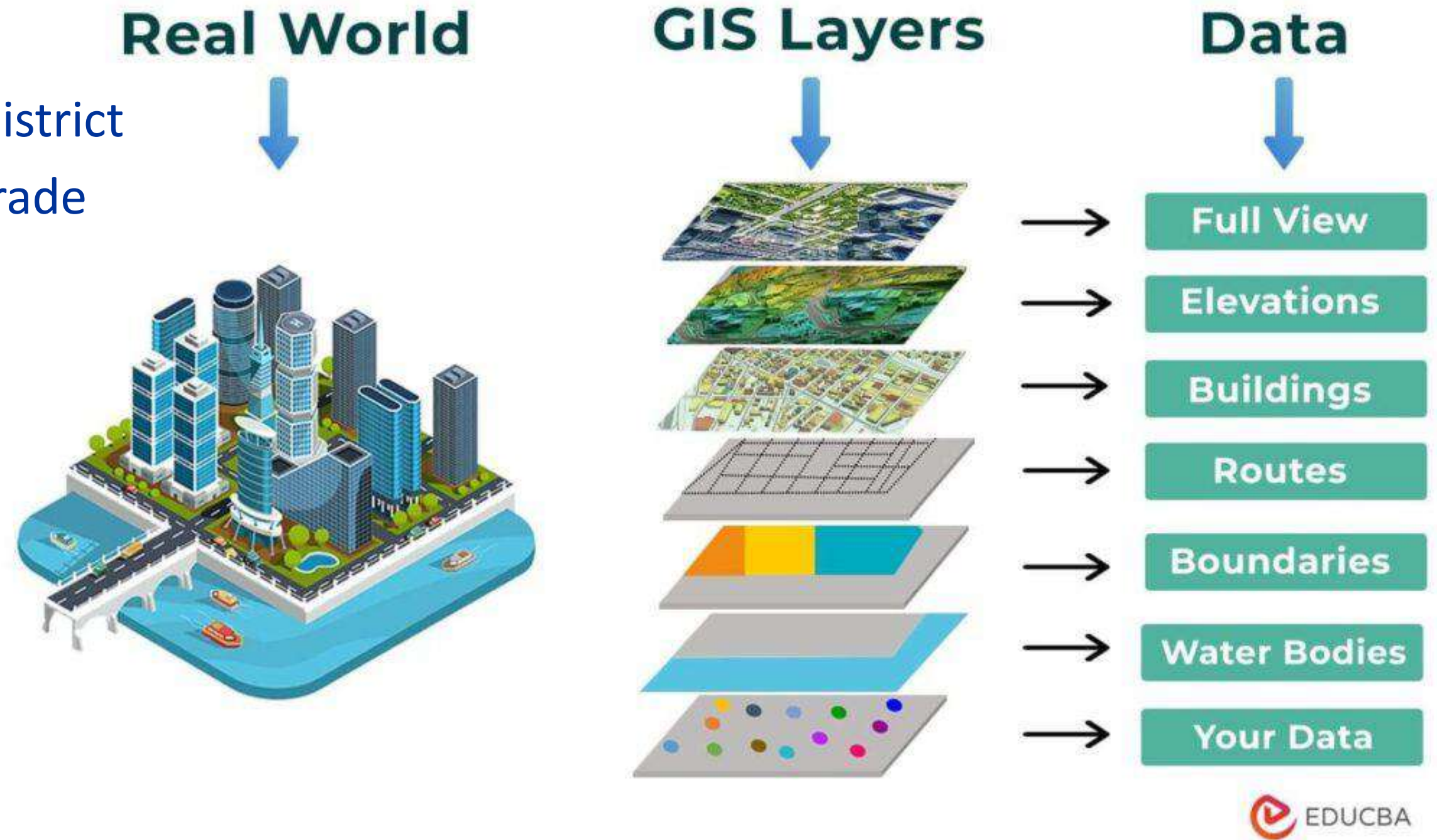
GIS in Smart Building Planning



GIS & Equity, Climate Action

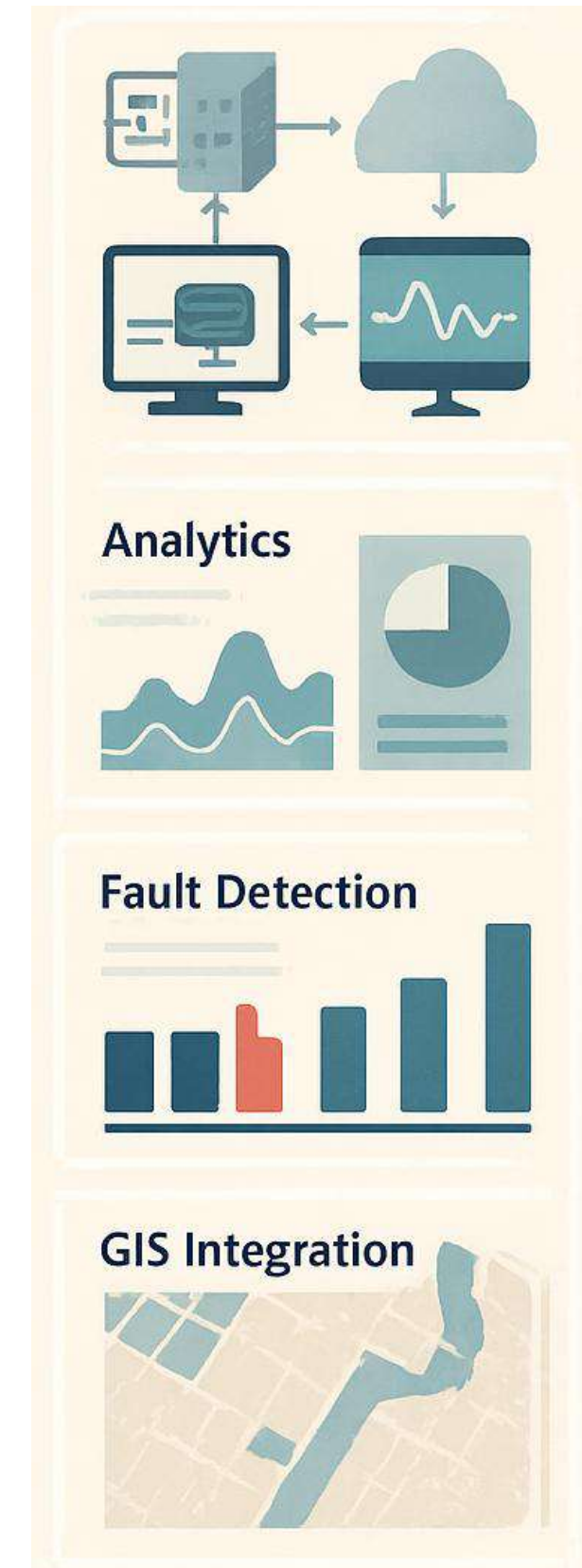
STEP2CleanPLAN

- Access to cooling/ventilation by district
- Target underserved areas for upgrade
- Support just transition policies



Conclusion: Data for Smarter Performance

- Analytics drive ZEB-readiness
- FDD and GIS → smarter investment
- Digital + spatial integration is key



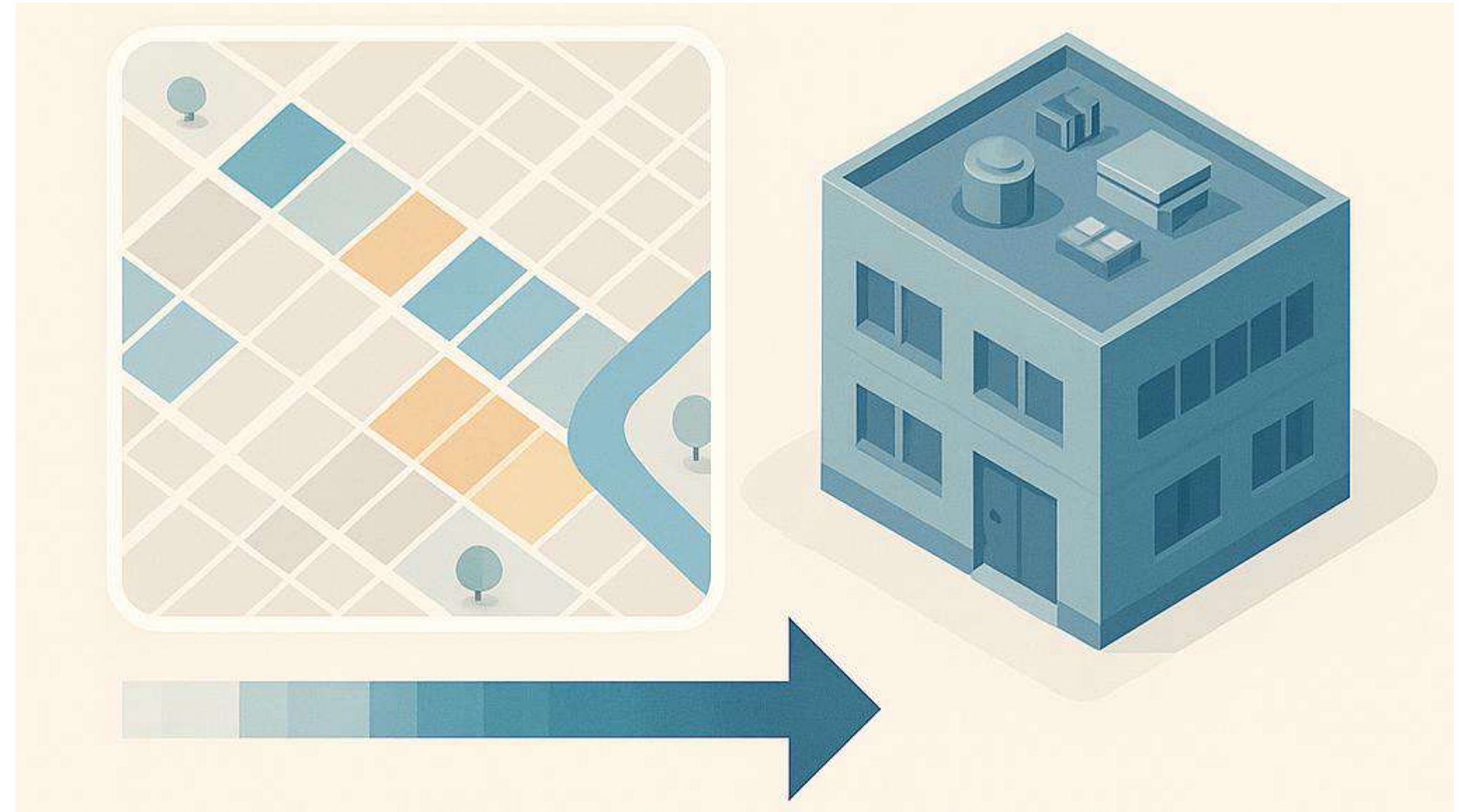
Reflection Questions

- Which data stream is most useful in your region?
- How is fault detection handled in your context?



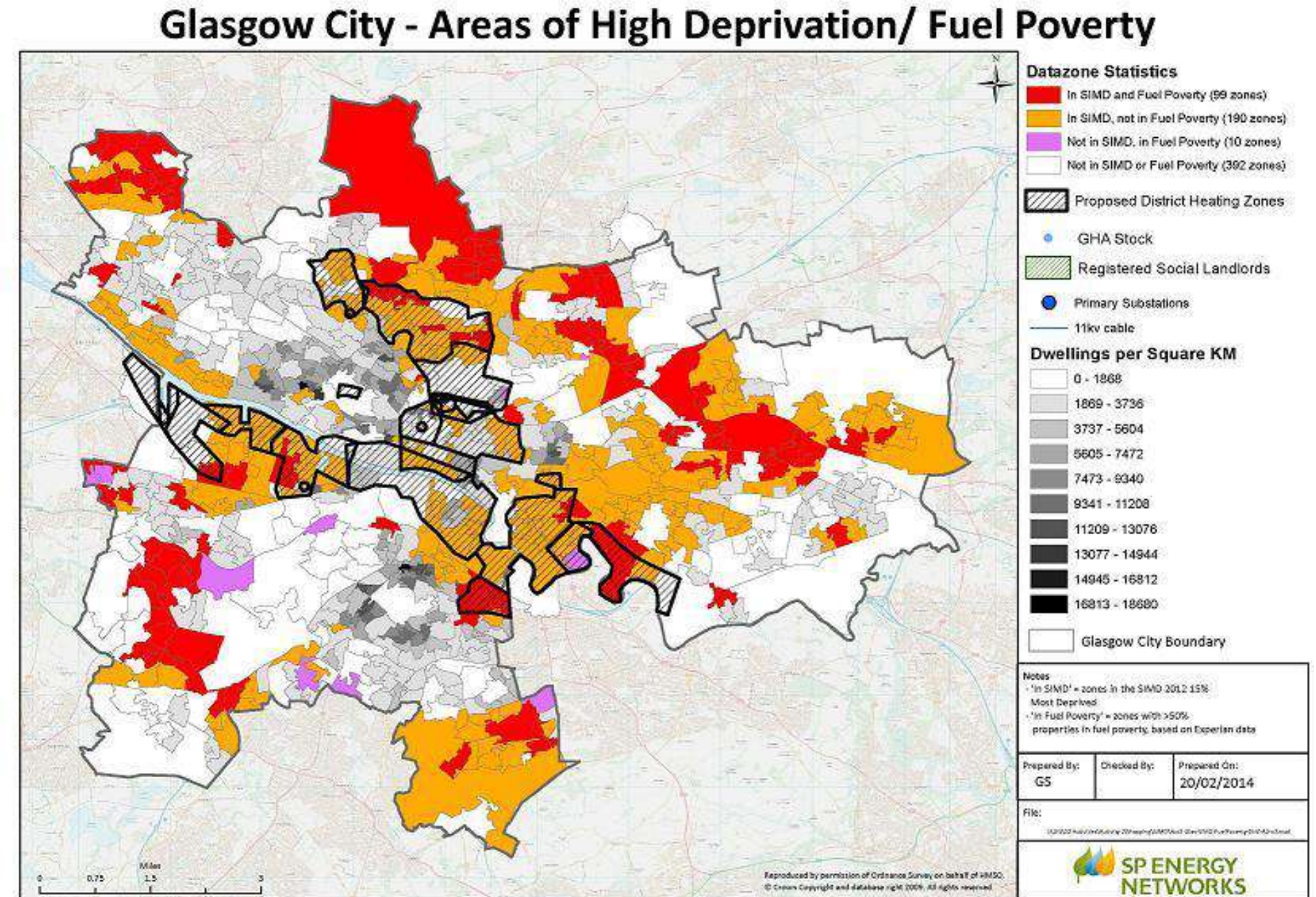
GIS + BIM Integration: Building to District

- GIS: zoning, solar access, utility overlays
- BIM: component-level asset modeling
- Together: lifecycle + spatial performance



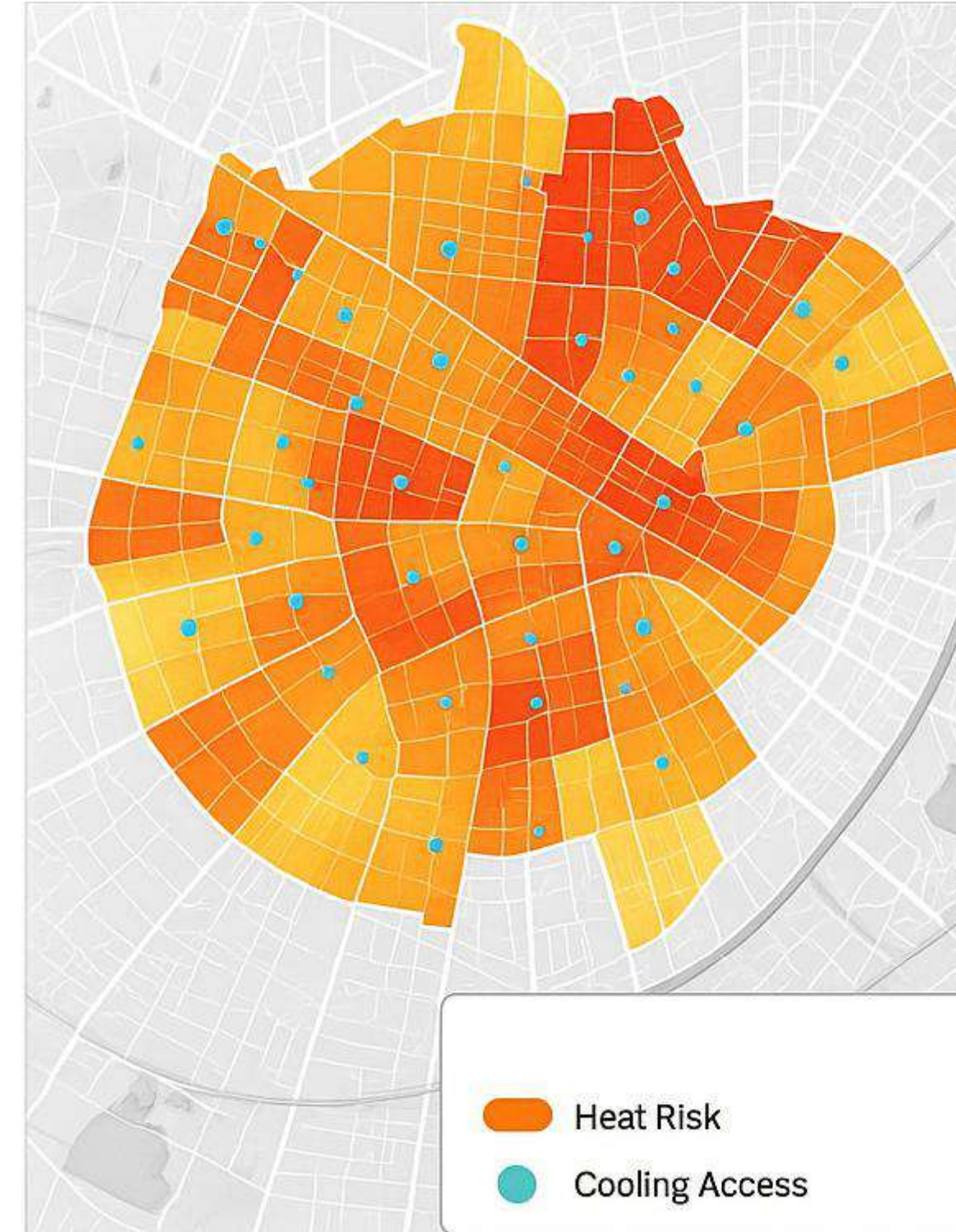
Citywide Energy Use Heatmap

- Darker zones: high energy intensity buildings
- Highlight retrofit priority areas
- Supports equity & climate goals



- Map cooling access + heat risk by neighborhood
- Target heat islands with retrofit priority

Climate Vulnerability Mapping



Emerging Issue: Data Governance in Smart Cities

STEP2CleanPLAN

- Who owns sensor data in public buildings?
- How is it anonymized, stored, reused?
- Policy frameworks lag behind tech capacity



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban
Mobility and Energy Efficiency

Sub Module 202: Energy Efficiency
in Urban Infrastructure

202 G: GIS Integration, Portfolio
Benchmarking & Spatial Analytics

Trainer:



Agenda

- GIS in Smart Buildings
- Smart Data Layers & System Integration
- Portfolio Benchmarking with Context
- Case Examples: Greece, Finland, France
- Future Scenarios & Spatial Equity
- Conclusion & Reflection

- Visual context for decisions
- Links assets, space, and data
- Acts as bridge across scales

GIS as a Strategic Tool



<https://www.esri.com/arcgis-blog/products/arcgis-online/announcements/whats-new-arcgis-online-december-2018>

- Policies: EPBD, ZEB mandates
- Data: IoT, CMMS, BMS matured
- Scale: Sites → cities → countries

Why GIS Now?



- Comfort: CO₂, temp, RH, light
- Energy: EUI, peaks, carbon intensity
- Occupancy: sensors, Wi-Fi, schedules
- Asset info: IDs, condition, tickets

Core GIS Data Layers



From Layers to Insight

STEP2CleanPLAN



+



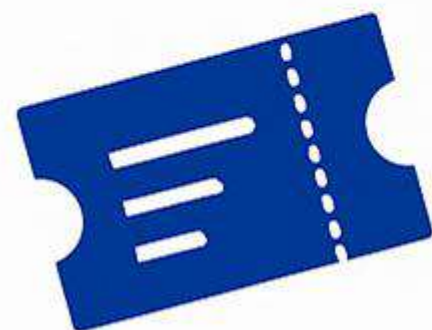
retrofit zones



+



override issues



+



dispatch logic

Connecting GIS to Building Systems

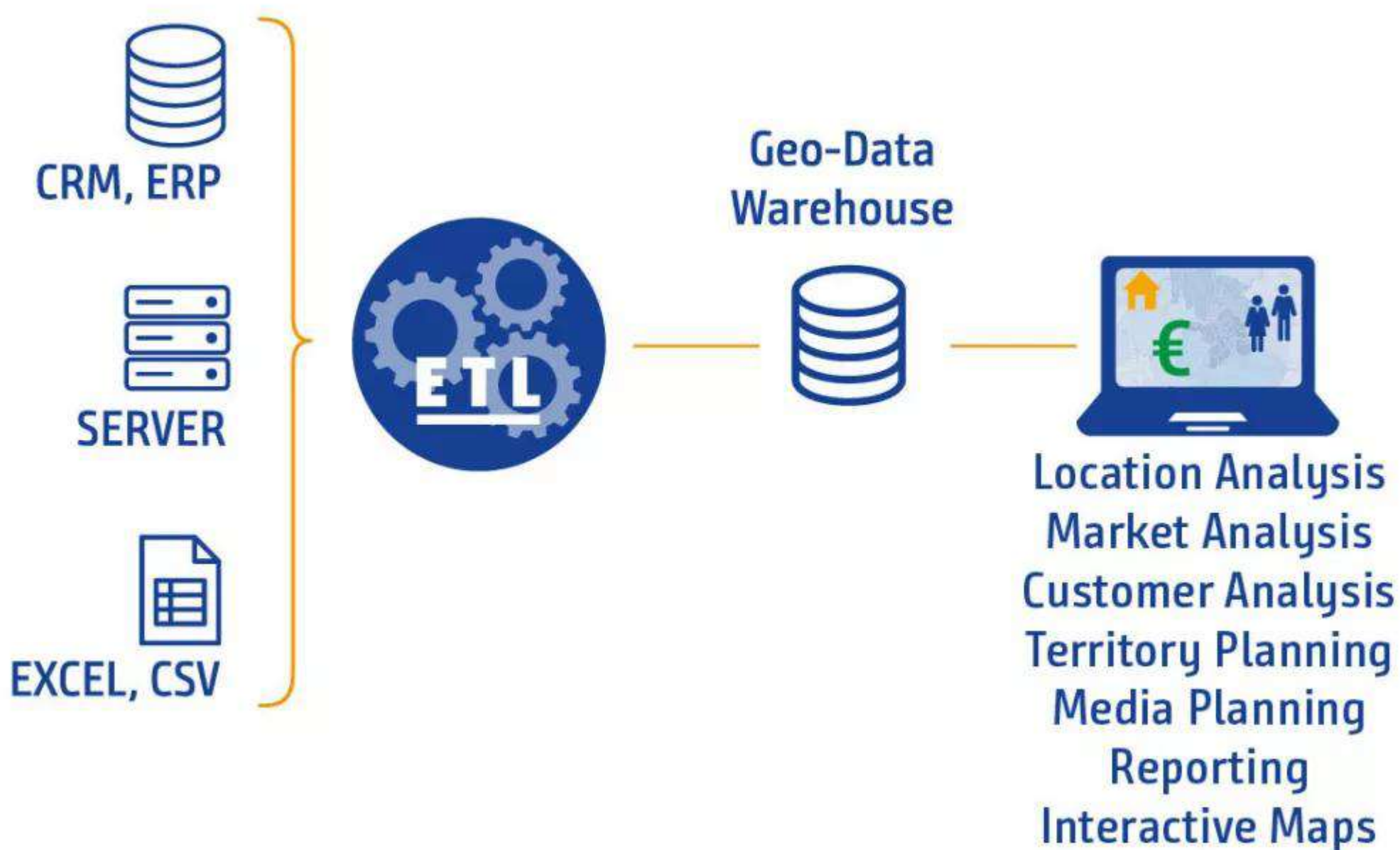
- BAS/BMS: overrides, trends, faults
- CMMS: fault tickets & dispatch
- Synchronize IDs & timestamps



<https://www.xyht.com/sponsored/gis-implementation-in-construction-techniques-and-benefits/>

Use Cases from Integration

- Cluster faults by equipment type/age
- Identify override zones during heatwave
- Optimize dispatch by location/SLA



CMMS Workflow from FDD

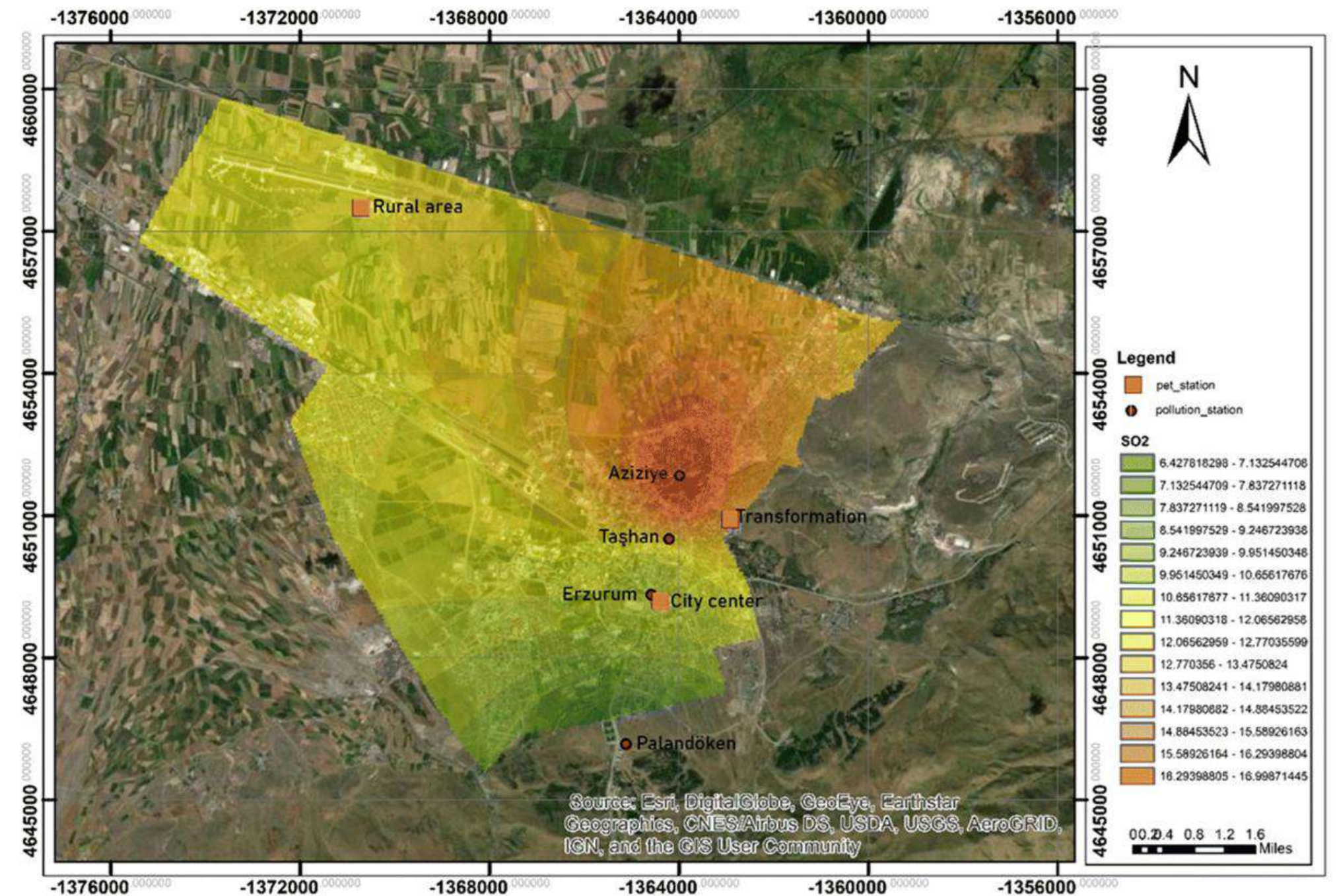
- Fault flags via FDD logic
- Auto-ticket in CMMS w/ zone ID
- GIS confirms location, closeout logged



Portfolio Context for Decision-Making

STEP2CleanPLAN

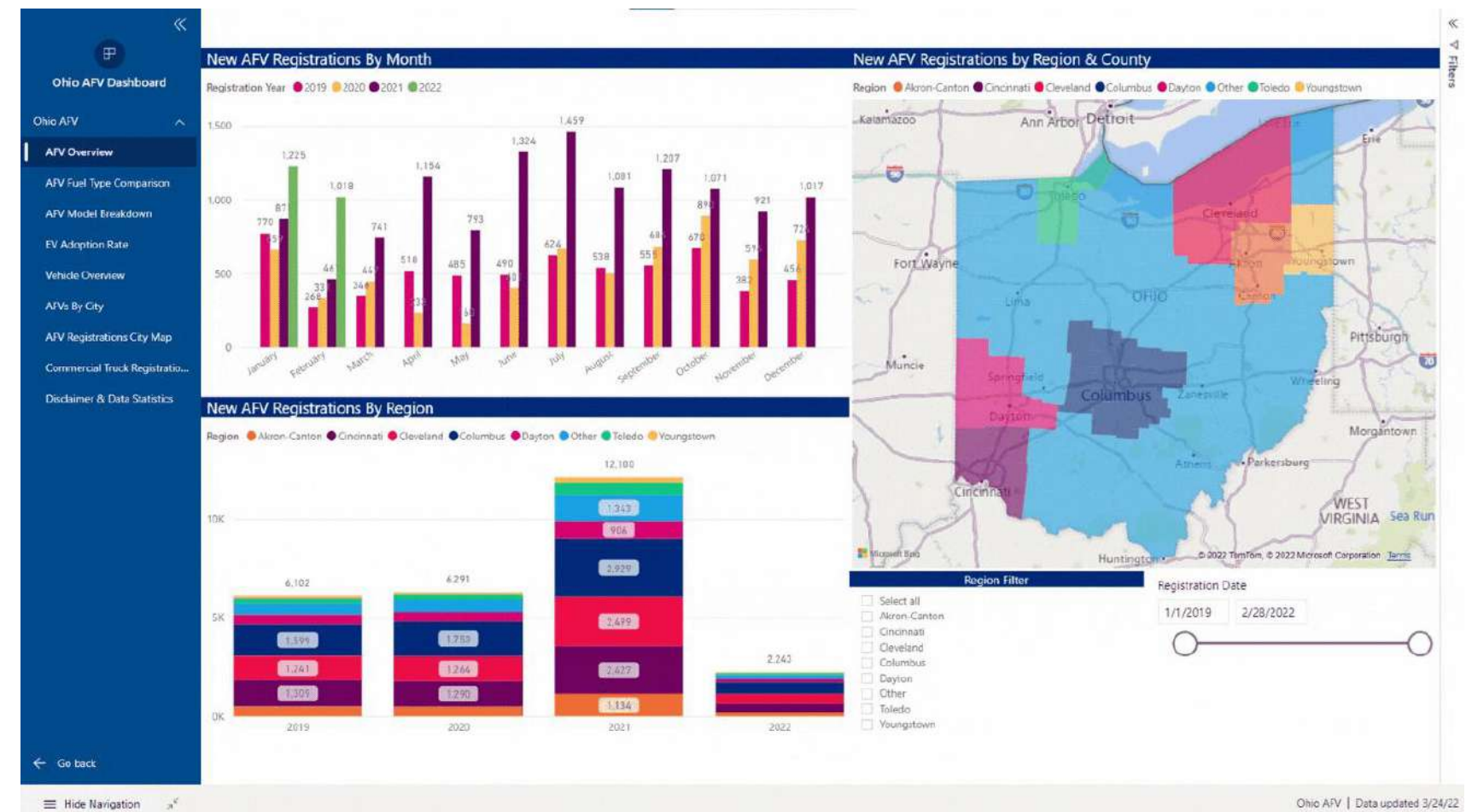
- Normalize 100+ sites with filters
- Overlay zoning + complaints + retrofits
- Identify risk or opportunity clusters



<https://link.springer.com/article/10.1007/s11356-021-14082-3>

From Benchmark to Retrofit Logic

- Compare retrofit ROI across building types
- Use spatial indicators to set priorities
- Visualize decisions with outcome maps



<https://experience.arcgis.com/experience/ba606f0b1a984e48a736f003aefc42c7>

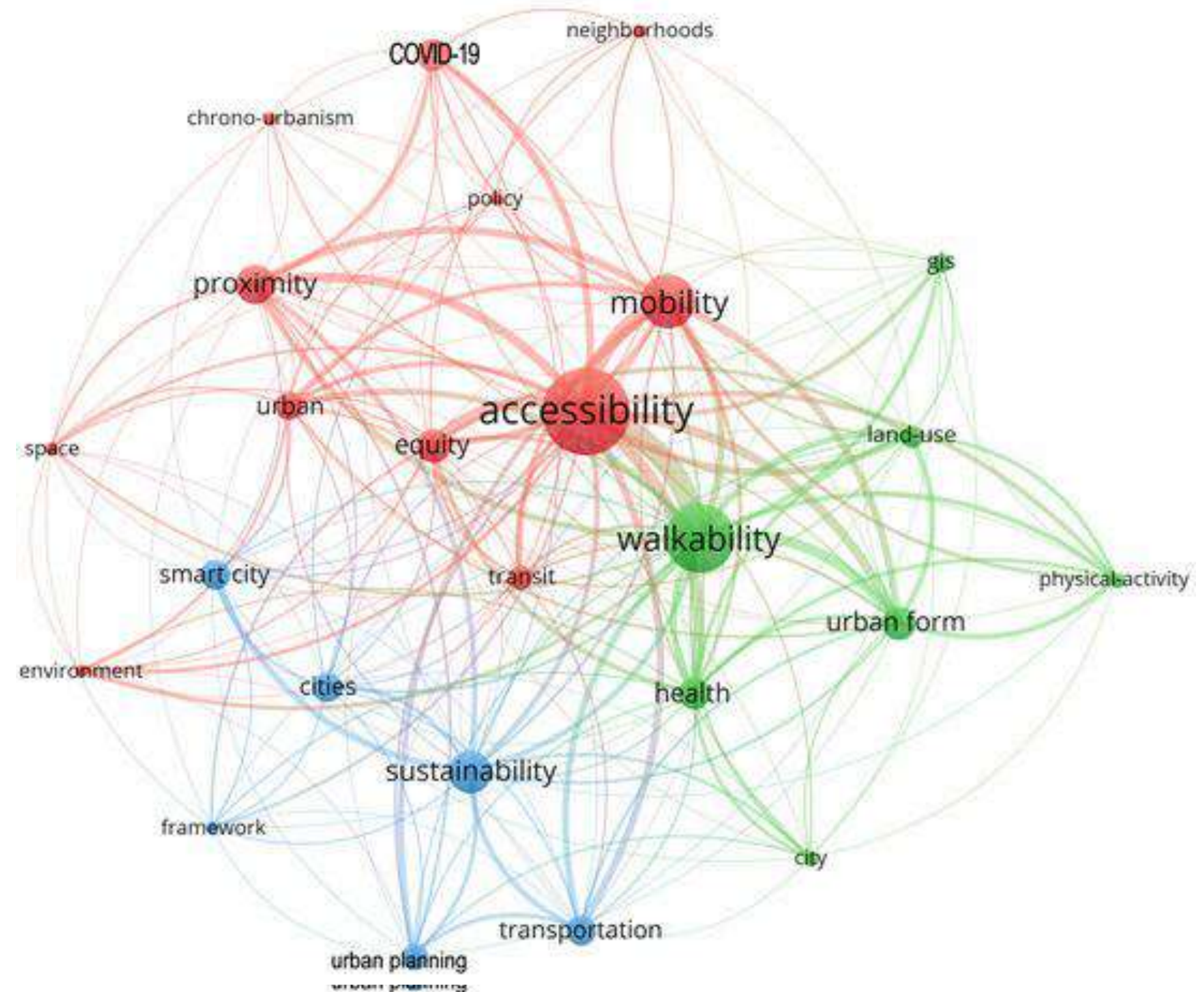
Case: West Attica – Schools Retrofit

- Mapped HVAC comfort violations + CO₂
- Zones near coast prioritized
- Aligned GIS with funding timeline



- 1,300+ buildings live-tracked
- Equity overlays inform capital budget
- Supports 15-minute city access goals

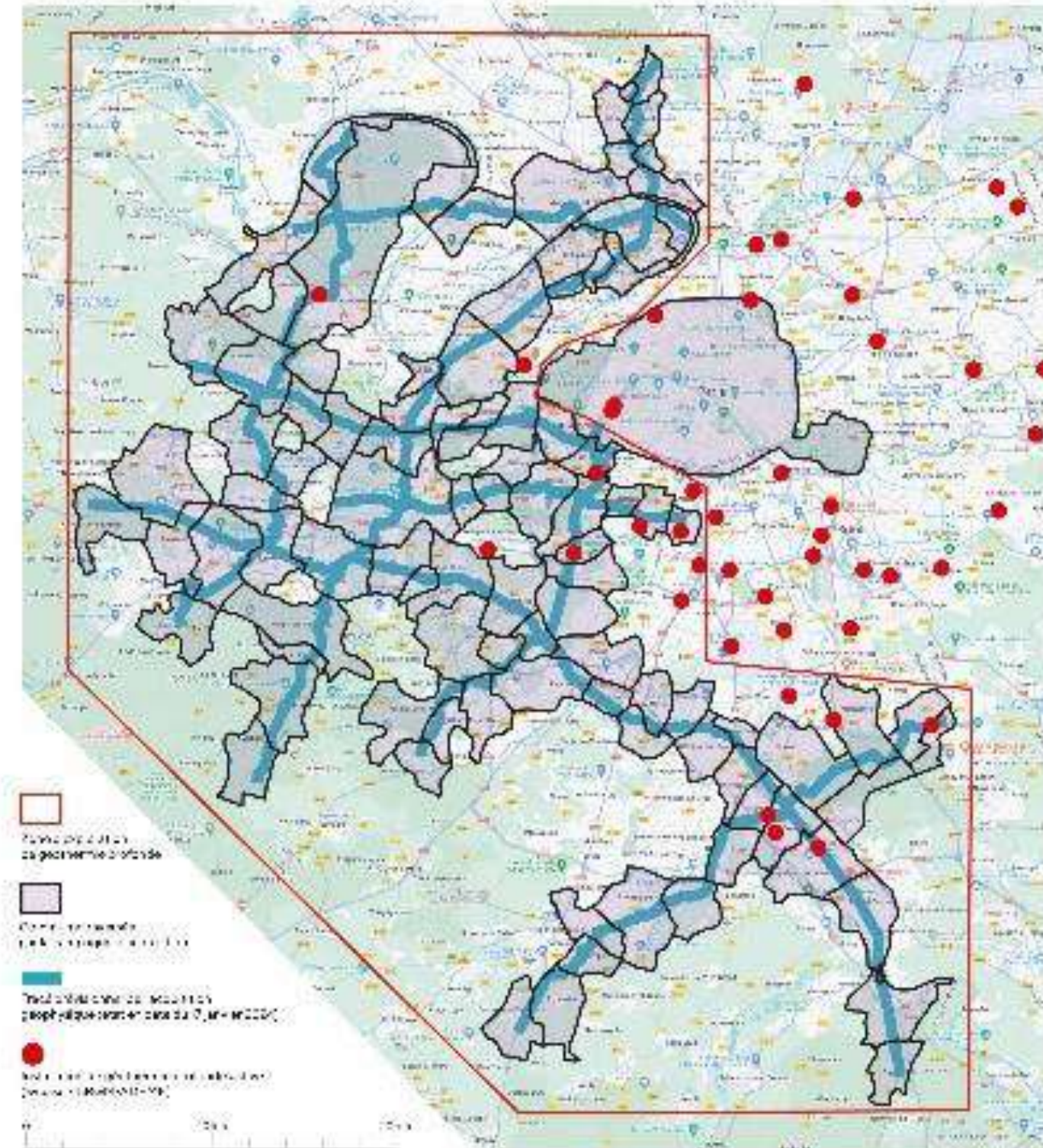
Case: Helsinki Smart Portfolio



<https://www.mdpi.com/2624-6511/7/4/83>

- 230K buildings, mapped EPC + retrofits
- Public + policy users access portal
- Spatial logic for national retrofit waves

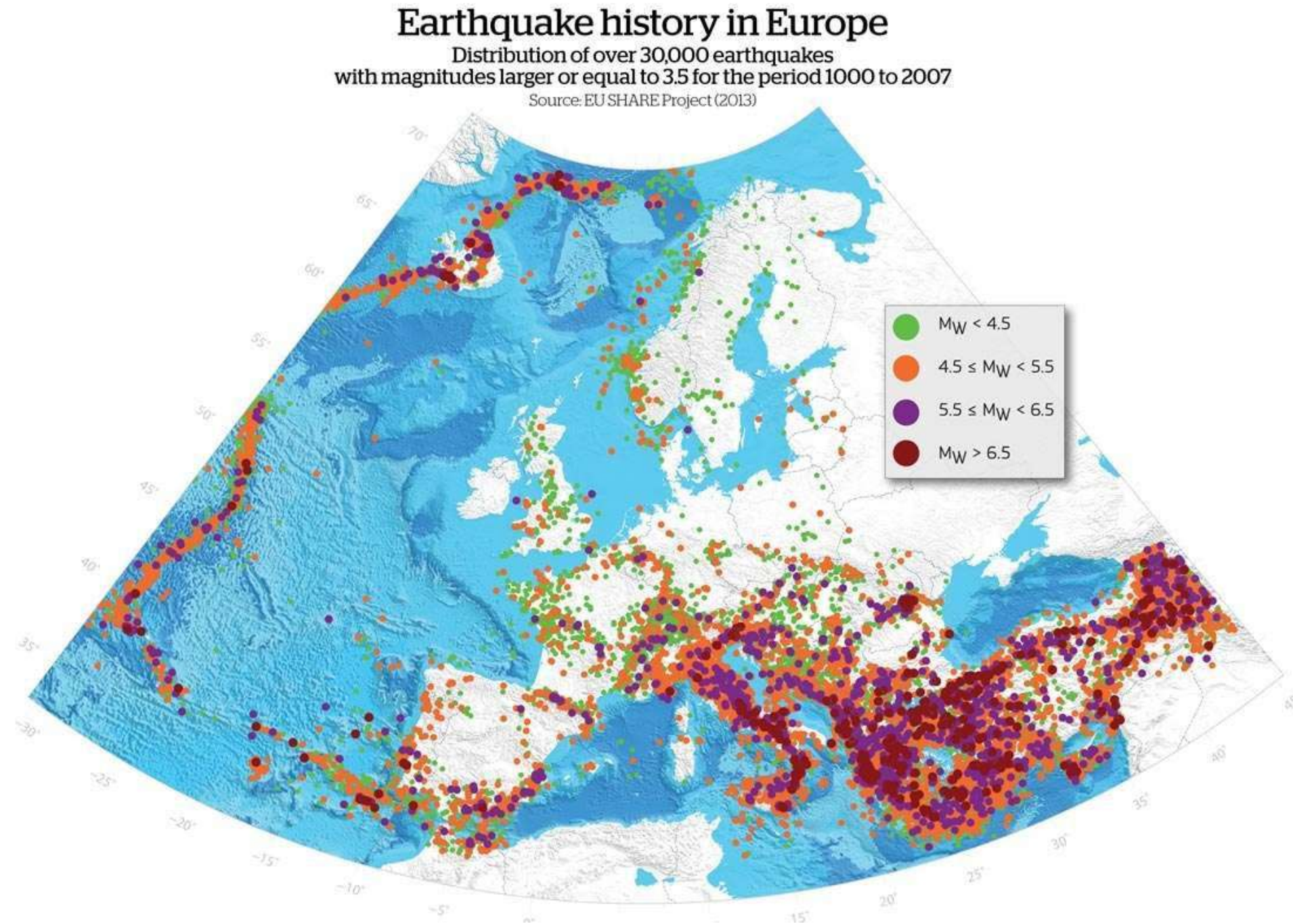
Case: ADEME (France) Retrofit Map



<https://www.geothermies.fr/comprendre/innovation/les-projets/2023-2025-geoscan-ile-de-france-ademe-region-ile-de-france-brgm>

GIS + AI: Predictive Targeting

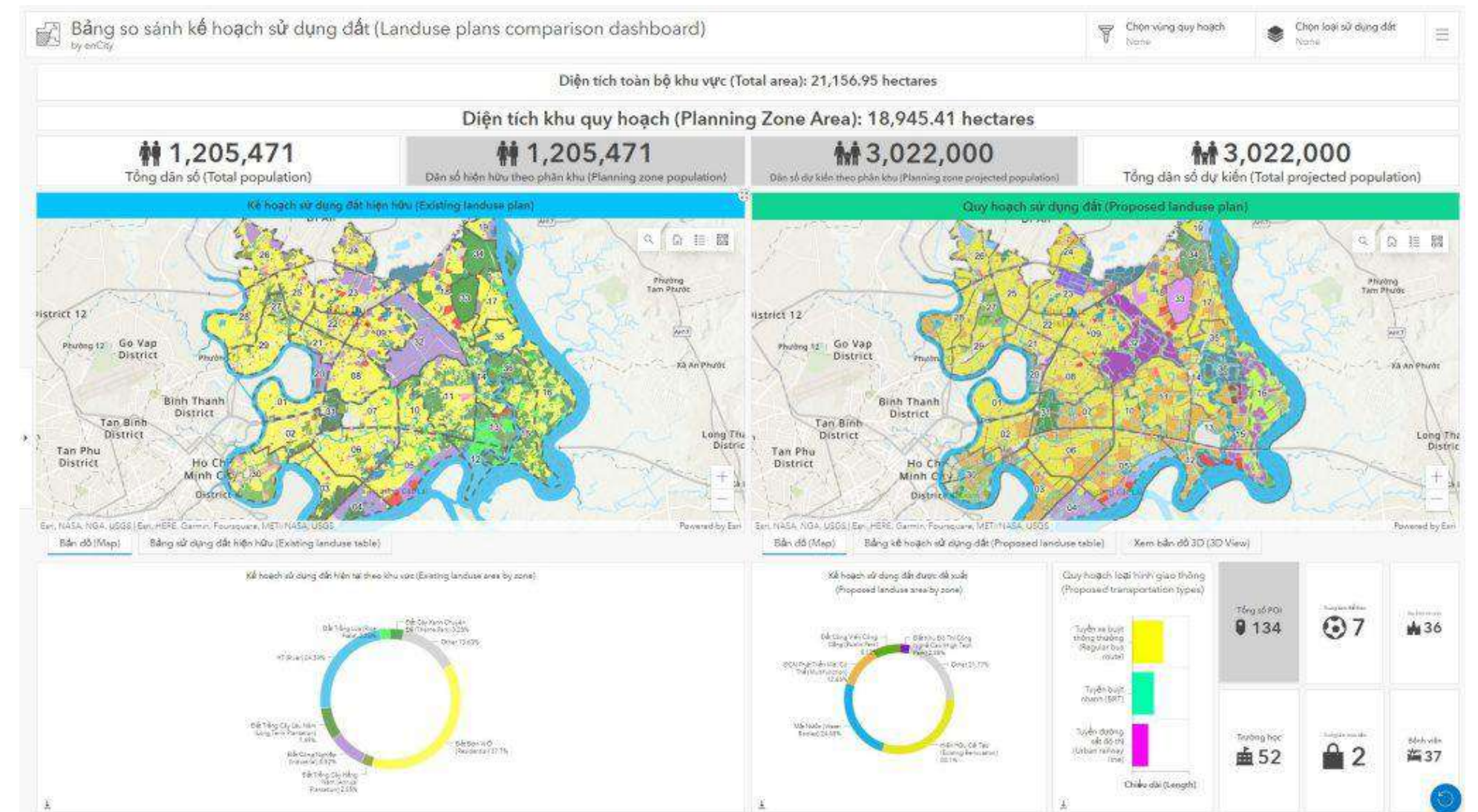
- Train patterns from fault/CO₂ data
- Predict retrofit payback and risk
- Auto-flag priority zones



<https://geographical.co.uk/science-environment/danger-zones-mapping-earthquakes-in-europe>

GIS as Urban Operating System

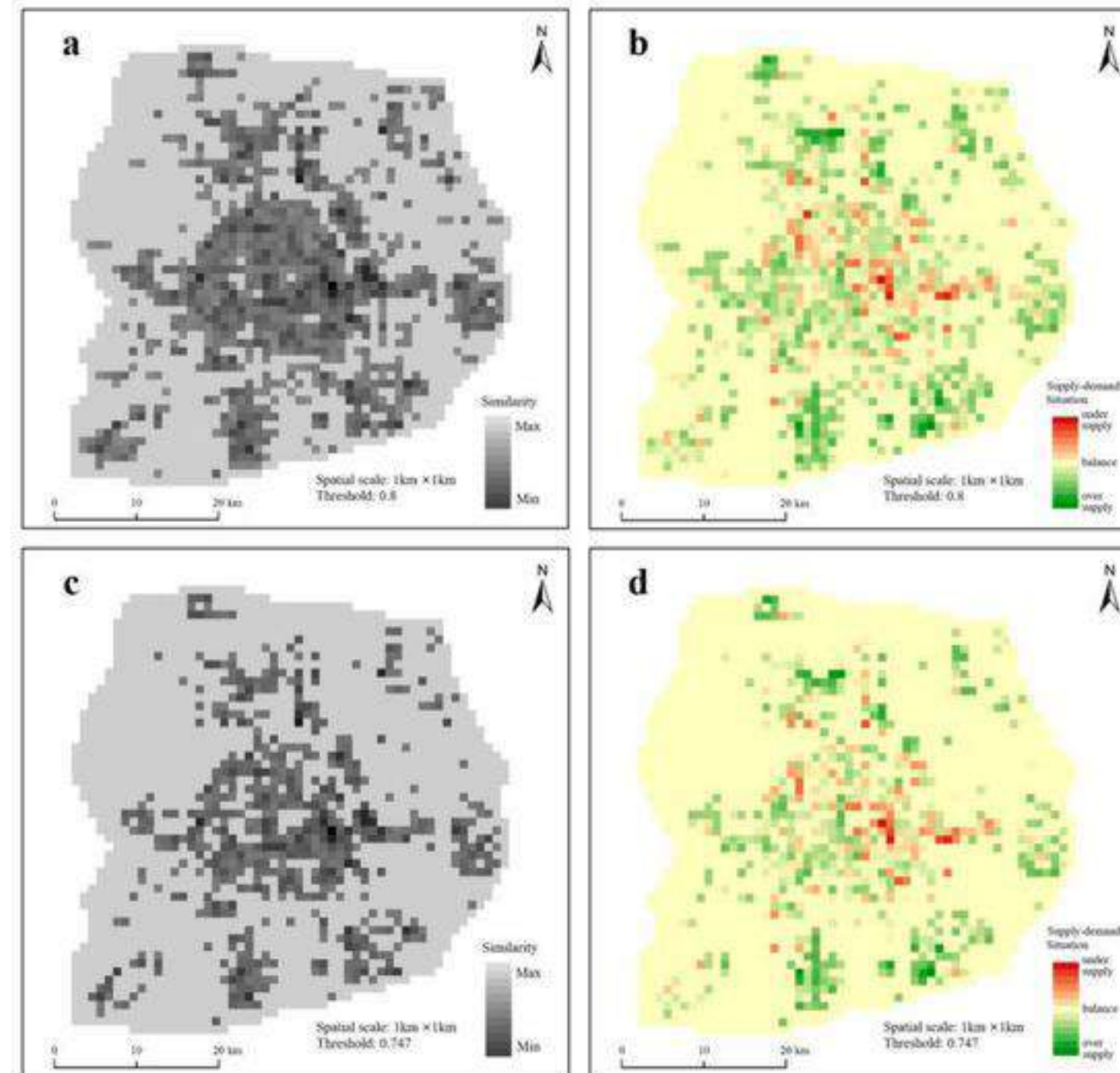
- Integrate zoning, transport, demand data
- EVs, comfort, building carbon in one map
- Core layer of digital twin governance



<https://encity.co/online-gis-dashboard-for-planning-management-and-stakeholder-engagement/>

- Map access vs upgrades by income area
- Monitor repair lag by region
- Equity filters for capital spending

Spatial Equity in Smart Planning

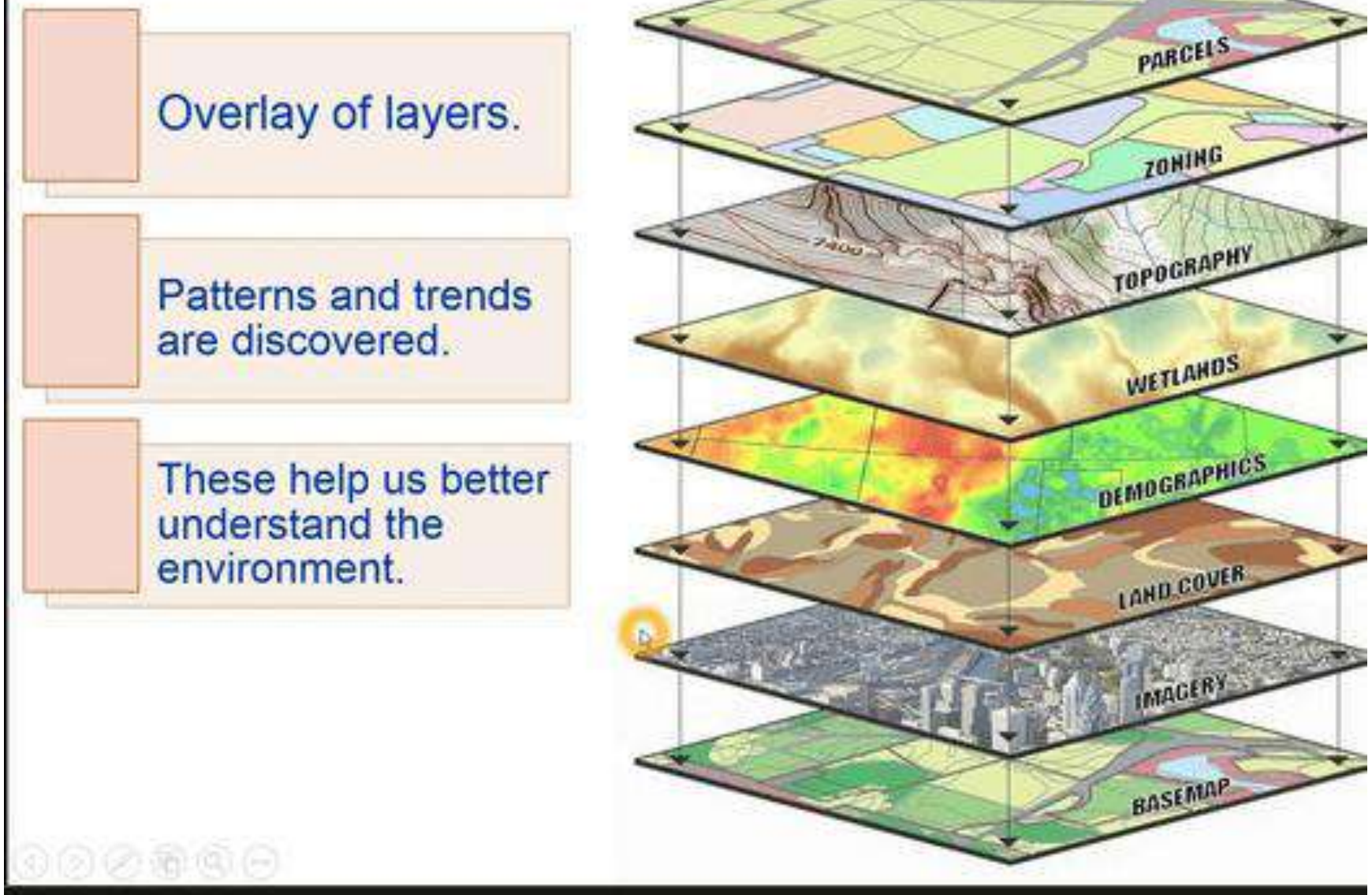


<https://www.mdpi.com/2220-9964/14/4/157>

Conclusion: GIS Enables Visual Intelligence

- See patterns, set priorities, build equity
- Combine tech + policy + people via space
- Plan smarter, act sooner

The GIS Data Model



<https://ignitarium.com/introduction-to-gis-geographical-information-system-data-its-visualization-and-processing-techniques/>

Reflection Prompts

- Which of your decisions could GIS improve?
- Where could equity be spatially mapped?



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 202: Energy Efficiency in Urban Infrastructure

202 A: Introduction to Zero Emission Buildings, nZEB Goals, and EU Directives

Trainer:



Agenda

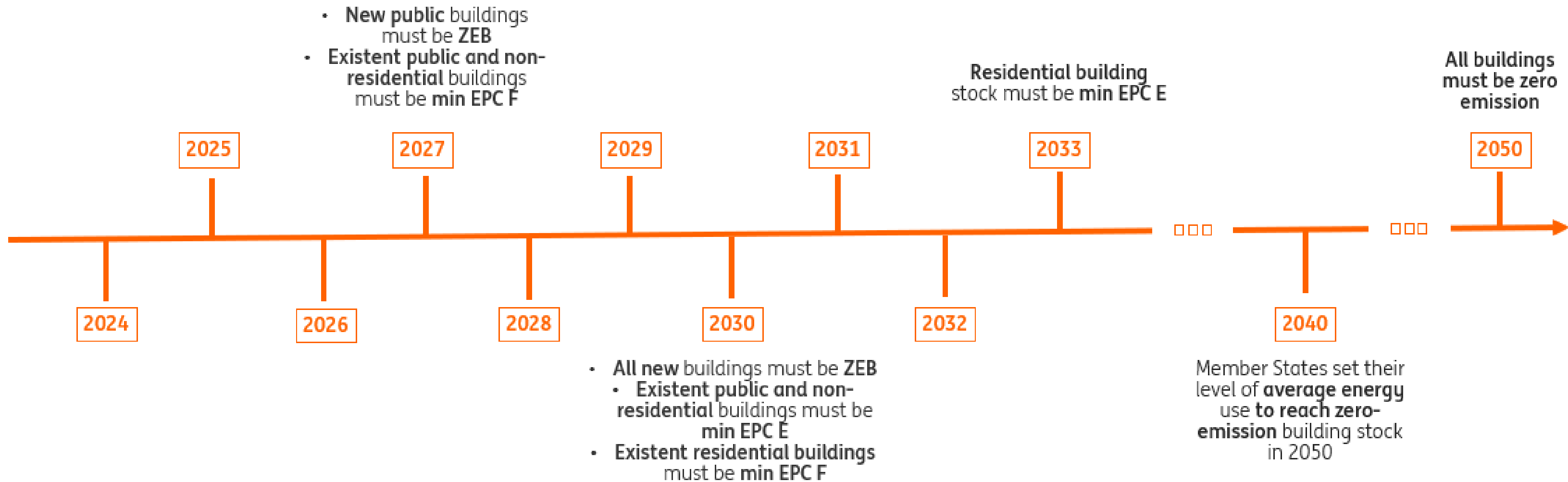
- Why Zero Emission Buildings?
- nZEB, ZEB & Passive House Frameworks
- Policy Landscape (EPBD, Taxonomy, Renovation Wave)
- Metrics & Compliance Tools
- Implementation & National Approaches
- Passive House & Legal Alignment
- Conclusion & Reflection

Why Zero Emission Buildings?

- 40% of EU energy use
- 36% of EU GHG emissions
- Buildings are central to 2050 neutrality



EPBD Recast Milestones



Source: European Commission, ING

From Efficiency to Emissions

- Old model: focus on demand
- New model: operational GHG
- Legislative and technical evolution



Performance Tiers Overview

Feature	nZEB	ZEB	Passive House (PH)
Legal Status	National Mandate	EU Directive (EPBD)	Voluntary Certification
Focus	Energy Efficiency	Operational GHG Emissions	Comfort & Demand Reduction
Verification	EPC	GHG Metrics & PED	PHPP + On-Site Testing
Renewables	Partial (varies)	Required (zero-emission)	Optional (usually included)

nZEB in Practice

- Estonia: 100 kWh/m²/year
- Ireland: 45–60 kWh/m²/year
- Broad national variation



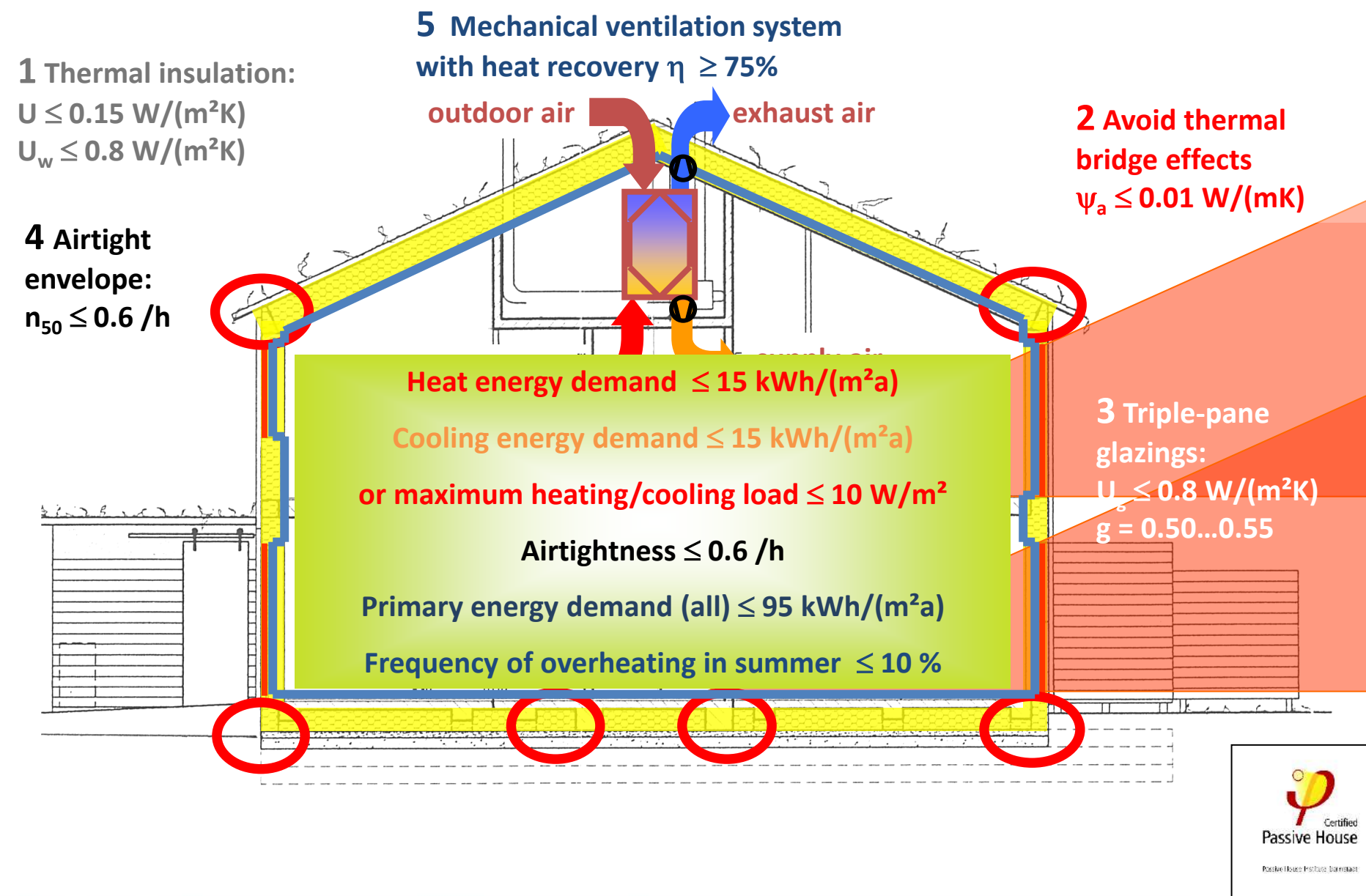
ZEB by Definition – EPBD Annex III

- Zero operational GHG emissions
- Efficient envelope and systems
- Carbon-free residual energy



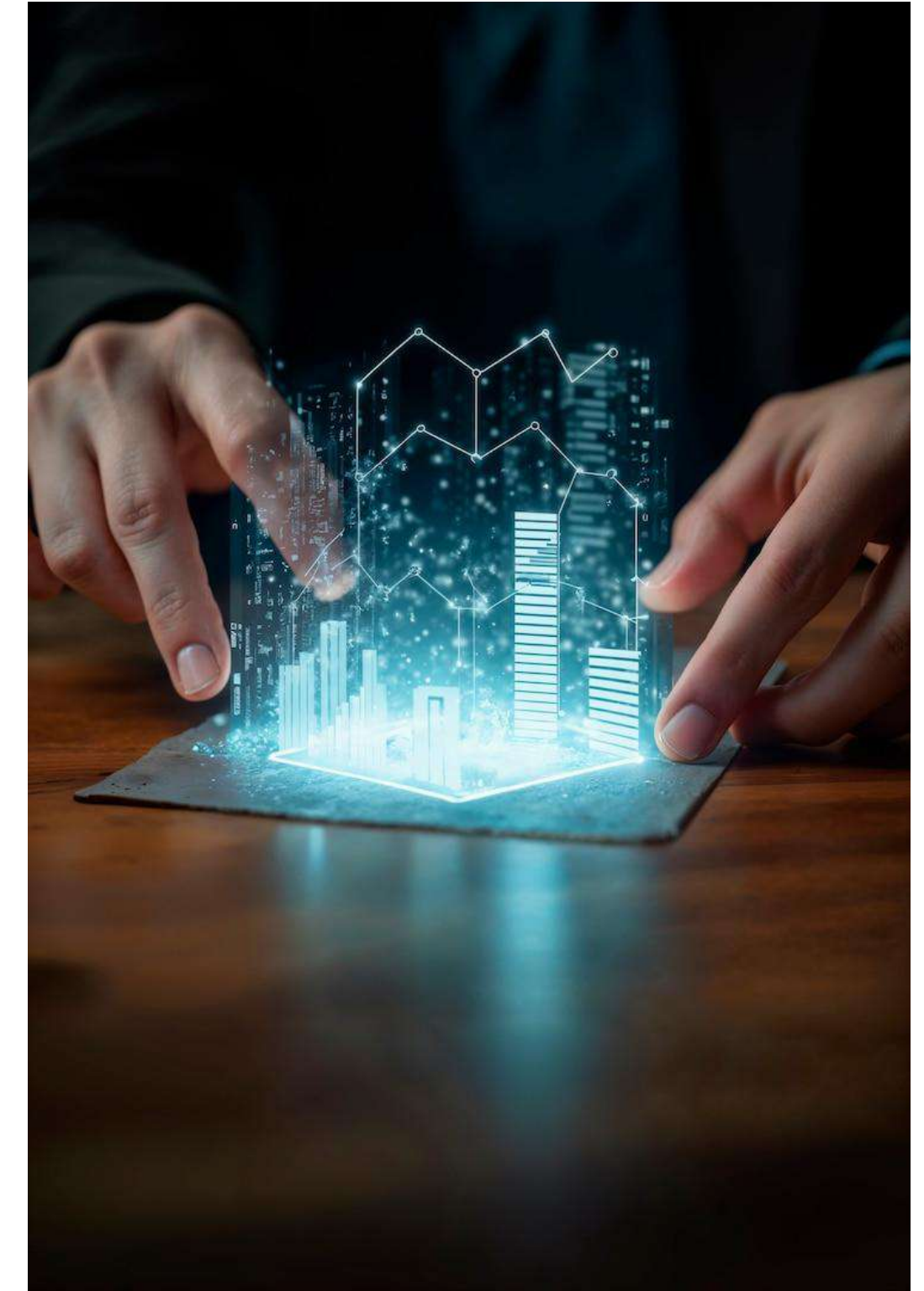
Passive House Criteria

- For cold – temperate region



EPBD Recast (2021)

- ZEB as standard → Policy shift
- Operational GHG focus → Central metric: $\text{kgCO}_2\text{eq/m}^2\text{/year}$
- Digital tools introduced → Renovation passports,
Smart Readiness Indicator, digital logbooks



EPBD 2024 Update

Pillar	Description
 MEPS Enforcement	Minimum Energy Performance Standards enforced for lowest-performing 15–20% of buildings
 Public Mandates Expanded	All new public buildings must be ZEB by 2028, renovations mandated
 Design Guidance Strengthened	Integrated tools: Renovation Passports, Logbooks, SRI, lifecycle thinking

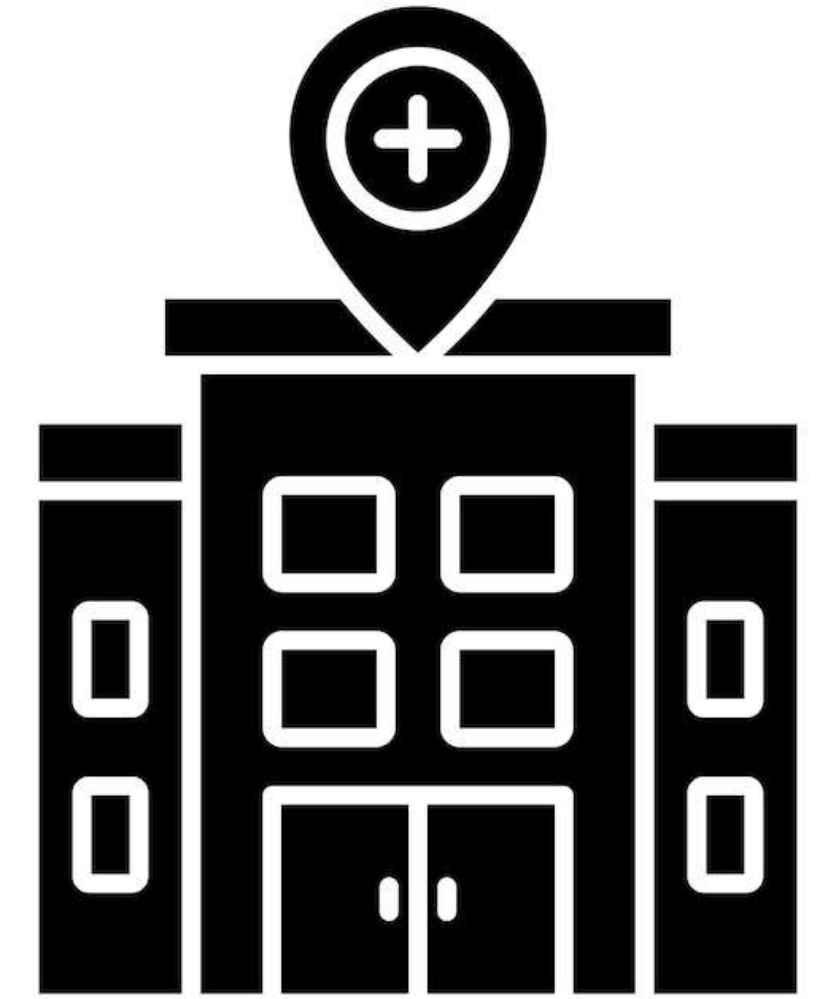
EU Taxonomy & Green Finance

- PED 10% below nZEB
- Lifecycle emissions required
- Supports climate-proof investments



Renovation Wave Strategy

- 35M building renovations by 2030
- Focus: schools, housing, hospitals
- Scale + quality = main aims



Measuring Real Performance

- Gap between design vs reality
- Smart meters, commissioning needed
- Post-occupancy data emphasized



Operational GHG as a Metric

- $\text{kgCO}_2\text{eq/m}^2/\text{year}$ = primary metric
- Based on national emission factors
- Defined by building type + zone



- PED: primary energy demand
- Renewable ratio: site/nearby preferred
- Combined for ZEB evaluation

PED & Renewable Share



Compliance Tools

Tool Category	Logo/Icon	Description
EPC Tools		Used for national certification and basic energy modeling (e.g. UK, Ireland)
PHPP		Design tool for ultra-low energy and comfort assurance
Dynamic Simulations		Used for high-resolution, hourly simulations and public project validation

Post-Building Validation



nZEB Variability Across EU

- Denmark: 20–30 kWh/m²/year
- Spain: 60–80 kWh/m²/year
- Estonia: up to 120 kWh/m²/year



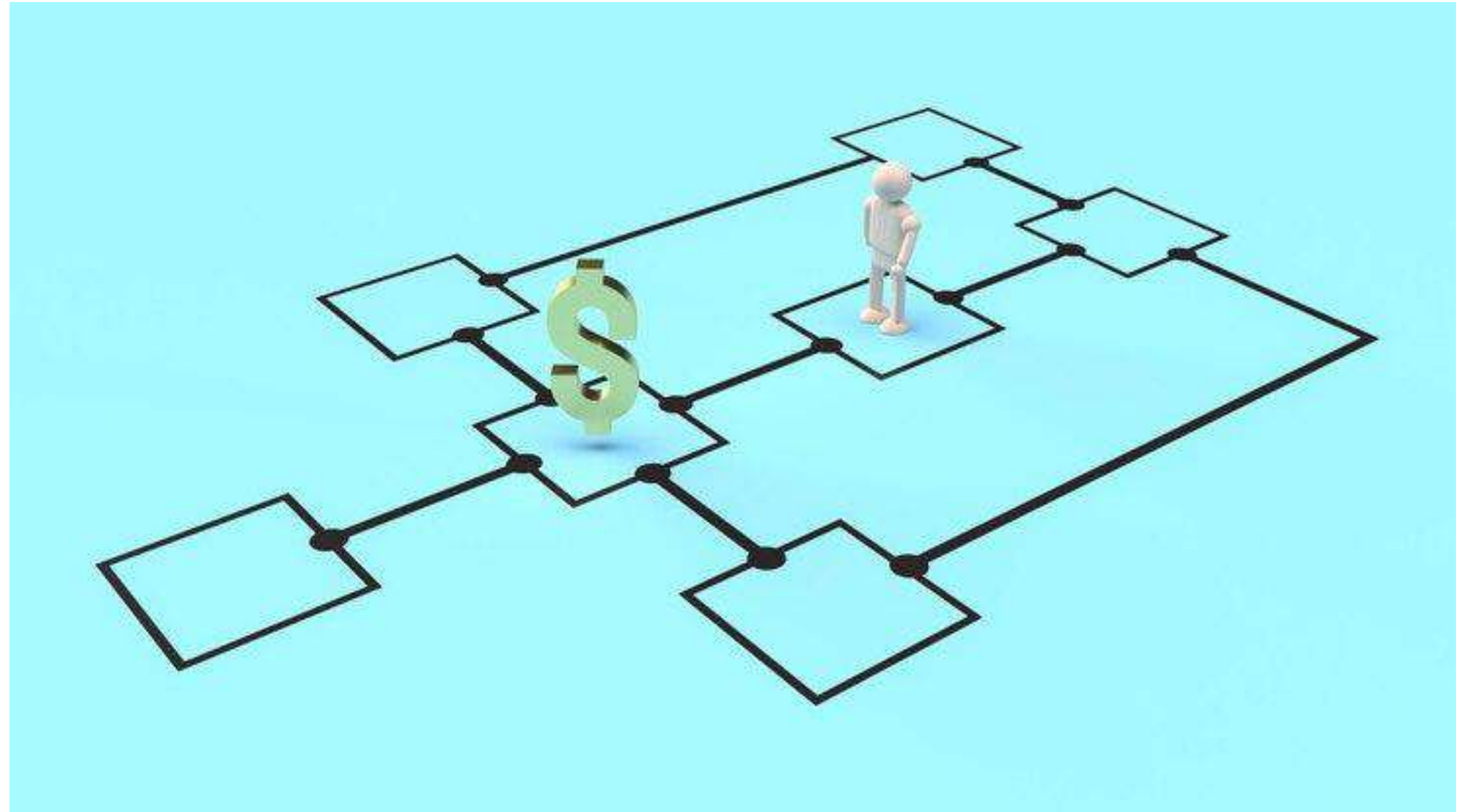
ZEB Early Movers

- Austria: GHG-linked subsidies
- Netherlands: BENG method
- France: RE2020 carbon budgets



- Labor shortage, enforcement gaps
- Lack of verification infrastructure
- Unclear financial ROI

Implementation Barriers



Best Practices Emerging

- One-stop shops (FR, LT)
- Digital EPC + BIM (FI)
- Public procurement drivers (DE)



Passive House: Voluntary Model

- Envelope-first, demand-led
- Proven tools + QA
- No legal mandate



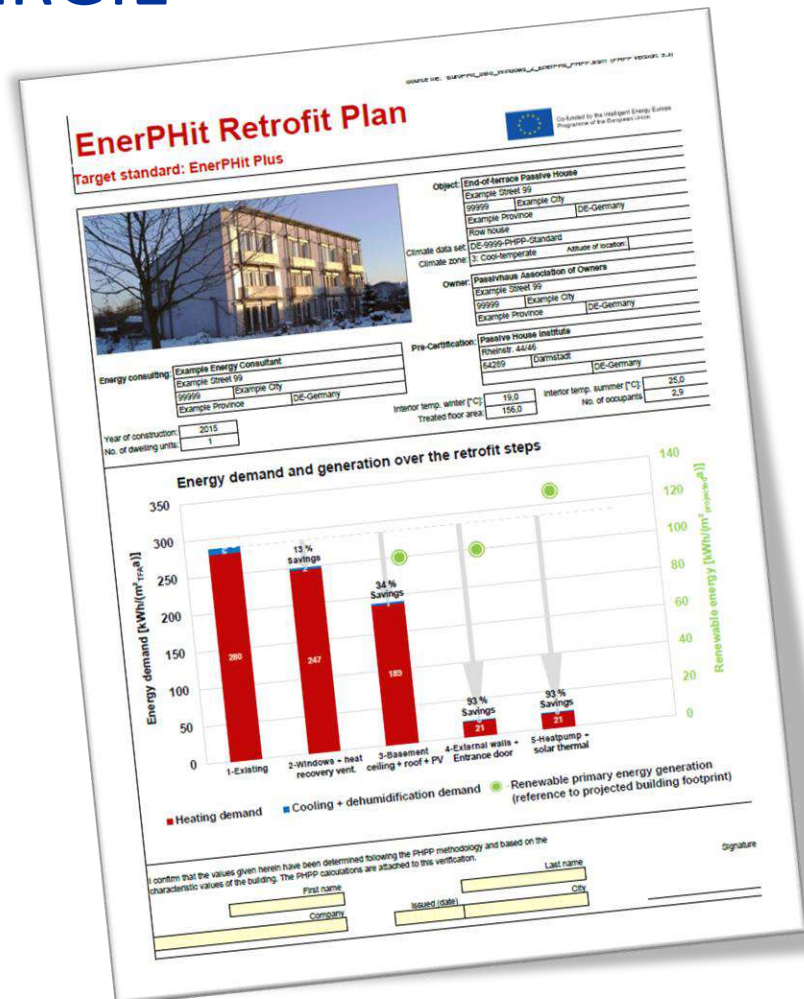
Policy vs Design Frameworks

ZEB (Policy Framework)	Passive House (Design Framework)
 GHG compliance goal	 Comfort + demand reduction goal
 EPC / emissions thresholds	 PHPP (design simulation)
 Regulated (EPBD)	 Voluntary (PHI)
 Focus on operational carbon	 Focus on demand, comfort, quality
 Compliance = documentation	 Compliance = modeling + testing

Beyond Passive: Advanced Voluntary Standards

STEP2CleanPLAN

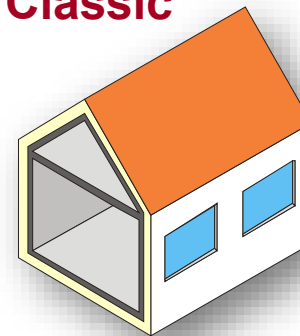
- PH Plus, PH Premium
- EnerPHit for retrofits
- Active House, MINERGIE



Basic requirement

Very low heating/cooling demand $\leq 15 \text{ kWh}/(\text{m}^2\text{a})$

Classic



Plus



Premium

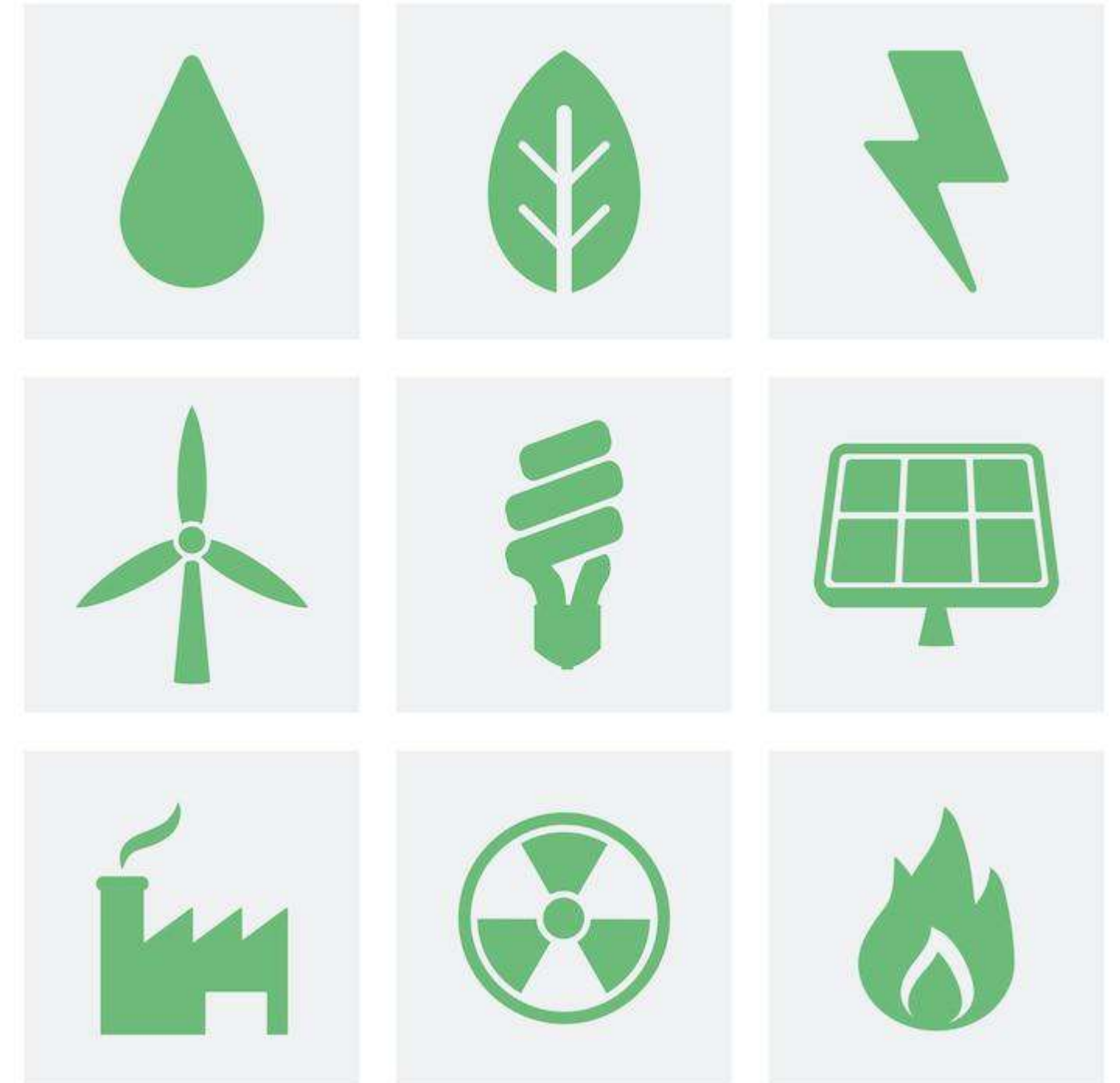


+ Generation of renewable energy
+ higher (PER) energy efficiency

© PHI

- ZEB: regulatory shift
- National variety persists
- Which metric drives change: energy, GHG, or comfort?

Conclusion & Reflection



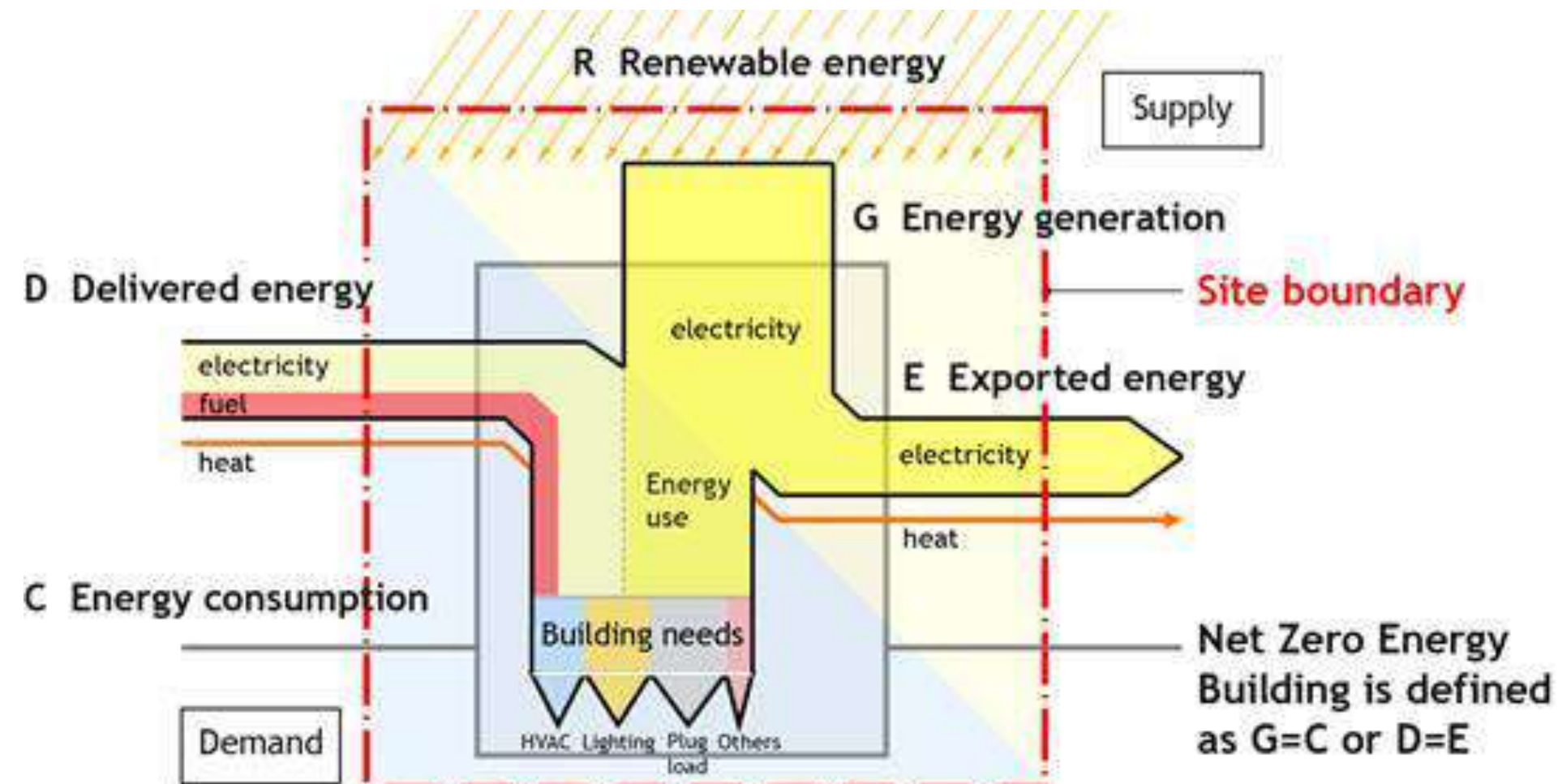
ZEB Early Movers – Country Examples

- France – RE2020 includes carbon budgets for all new buildings
- Netherlands – BENG: primary energy, airtightness, and daylight factors
- Austria – Ties subsidies to operational GHG performance



Understanding GHG & PED Thresholds

- GHG: kgCO₂eq/m²/year – set by building type and climate zone
- PED: Primary Energy Demand – max site+source energy
- Combined to define ZEB performance boundaries



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 202: Energy Efficiency in Urban Infrastructure

202 B: Passive House Design Principles

Trainer:

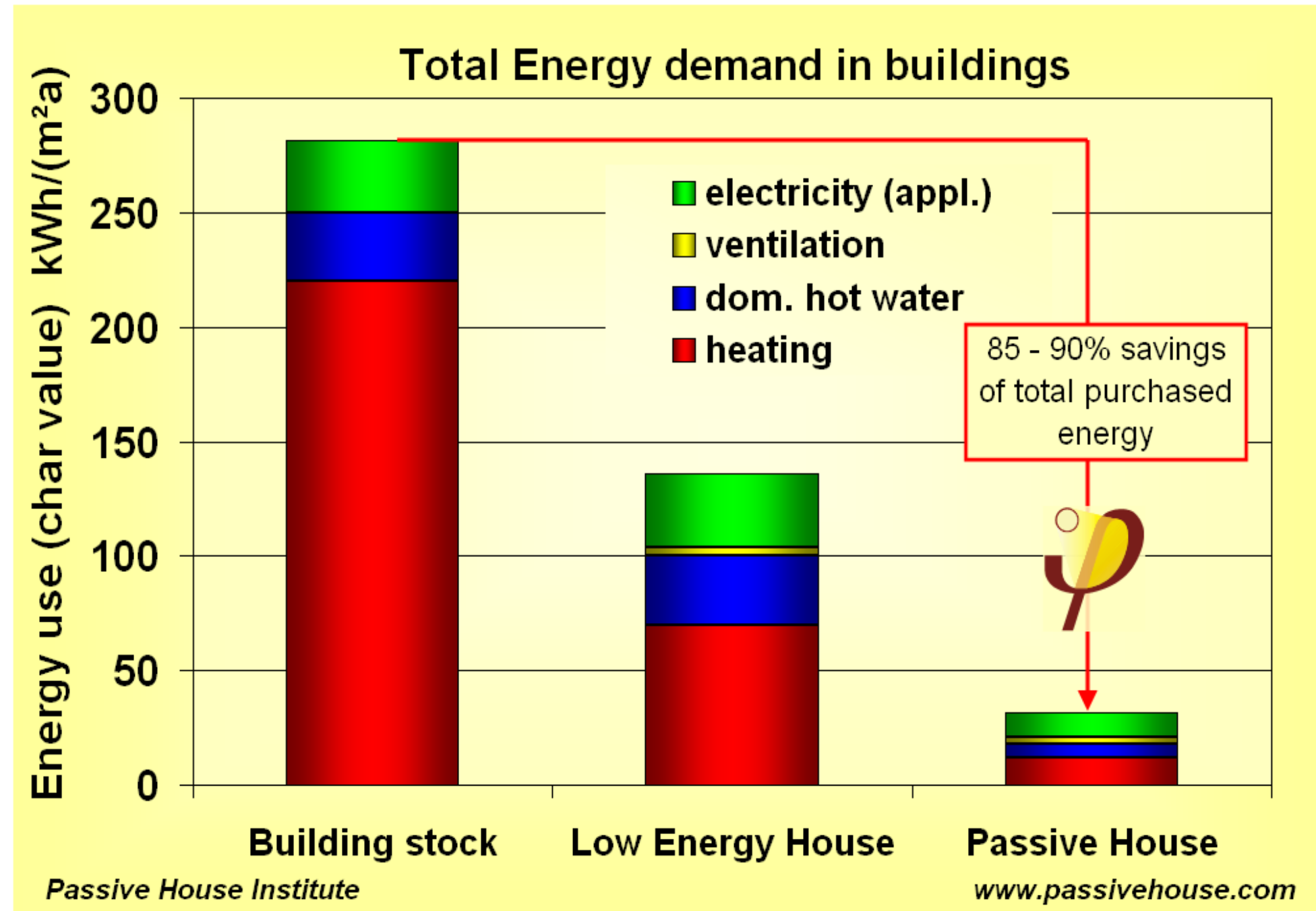


Agenda

- Why Passive House Matters
- Core Performance Metrics
- PHPP Tool Overview
- Case Study Applications
- EU Compliance Interactions
- Conclusion & Reflection

- Voluntary, high-performance design
- Reduces demand before renewables
- Aligns with EU ZEB goals

Why Passive House Matters?

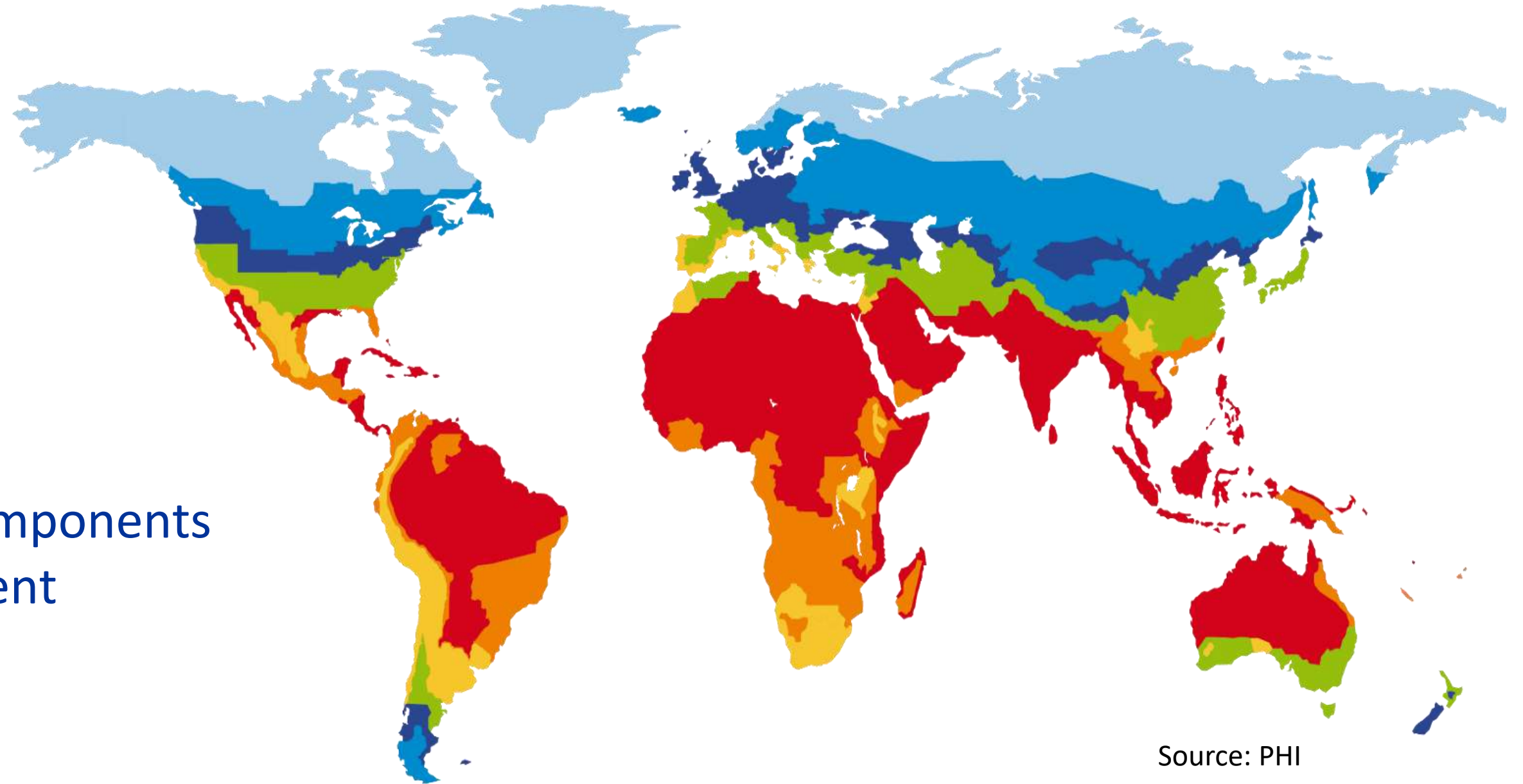


Source: PHI



- The values of all certified components are available in the component database and in PHPP

Passive House Criteria

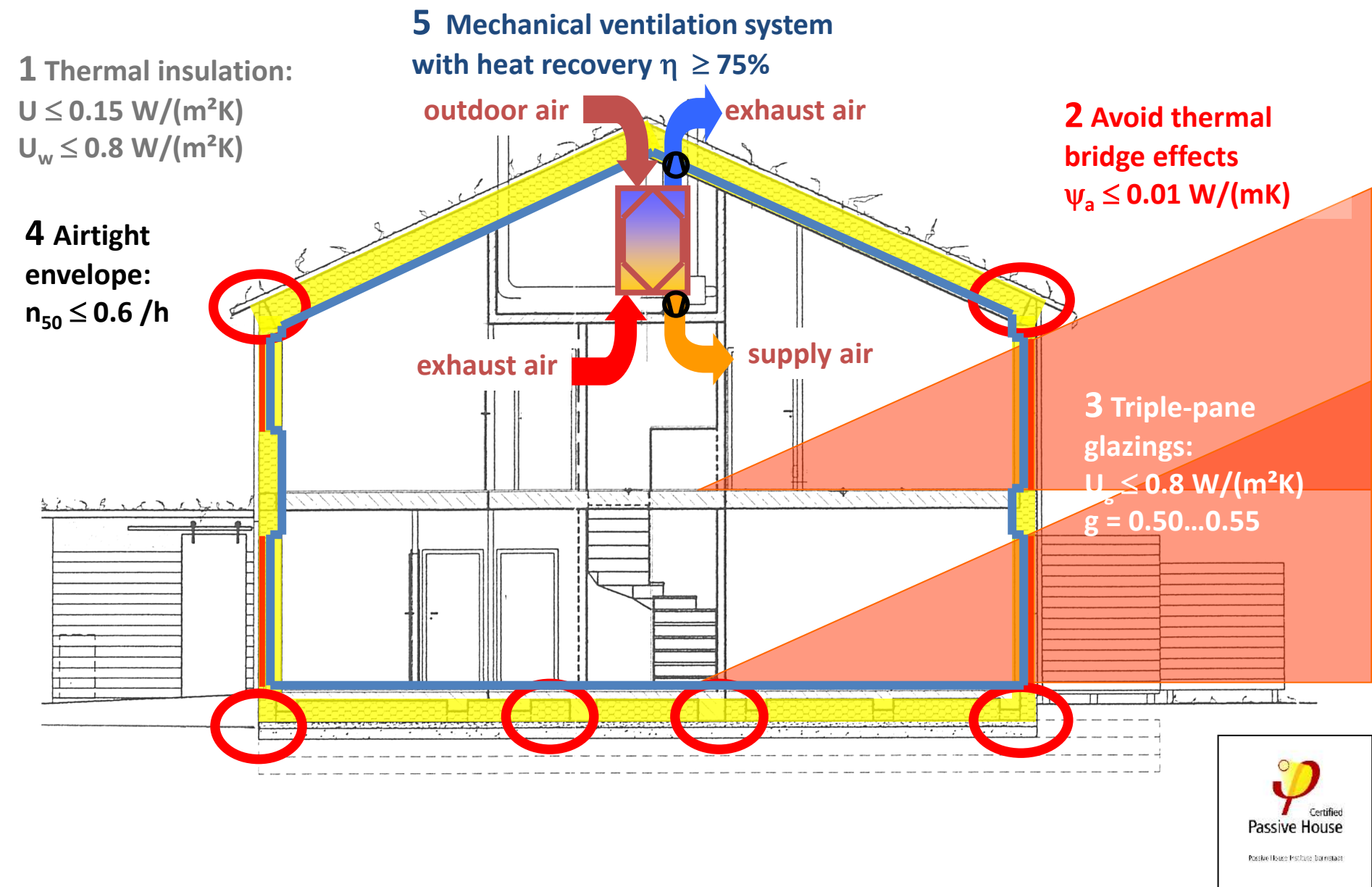


Source: PHI

	Arctic	Cold	Cool-temperate	Warm-temperate	Warm	Hot	Very hot
Walls (opaque)	0.09	0.12	0.15	0.3	0.5	0.5	0.3
Glazing type recommended	Vacuum / 4-glazed low-e	3- or 4-glazed low-e	3-glazed low-e	3-glazed low-e	2-glazed low-e	2-glazed anti-sun	3-glazed anti-sun
U _w , installed MAX (vertical)	0.45	0.65	0.85	1.05	1.25	1.25	1.05

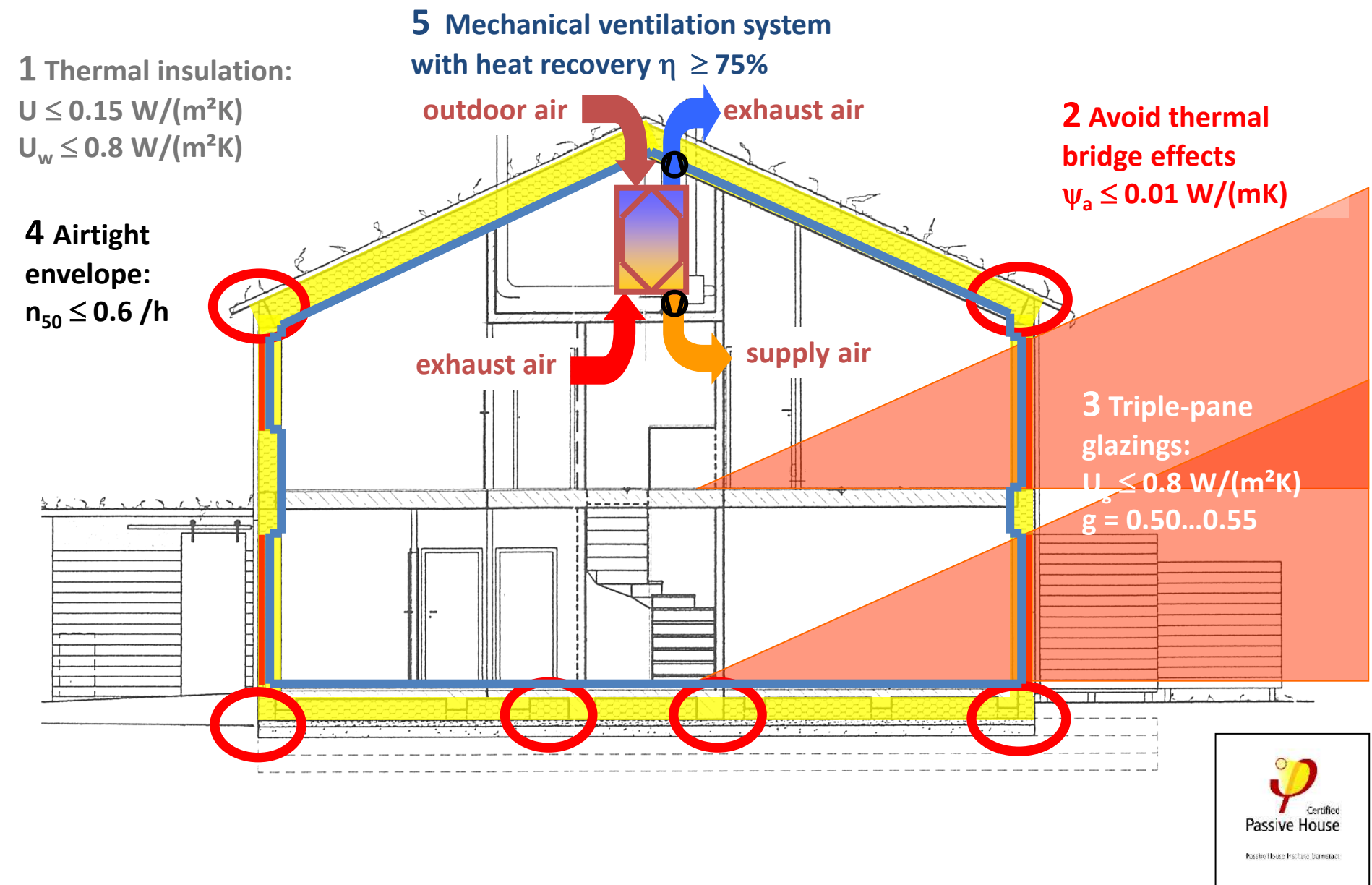
Passive House Criteria

- For cold – temperate region
- $\leq 15 \text{ kWh/m}^2/\text{year}$ heating & cooling
- $\leq 0.6 \text{ ACH @ } 50 \text{ Pa}$
- $\text{PER} \leq 60 \text{ kWh/m}^2/\text{year}$ or
 $\text{PE} \leq 95 \text{ kWh/m}^2/\text{year}$



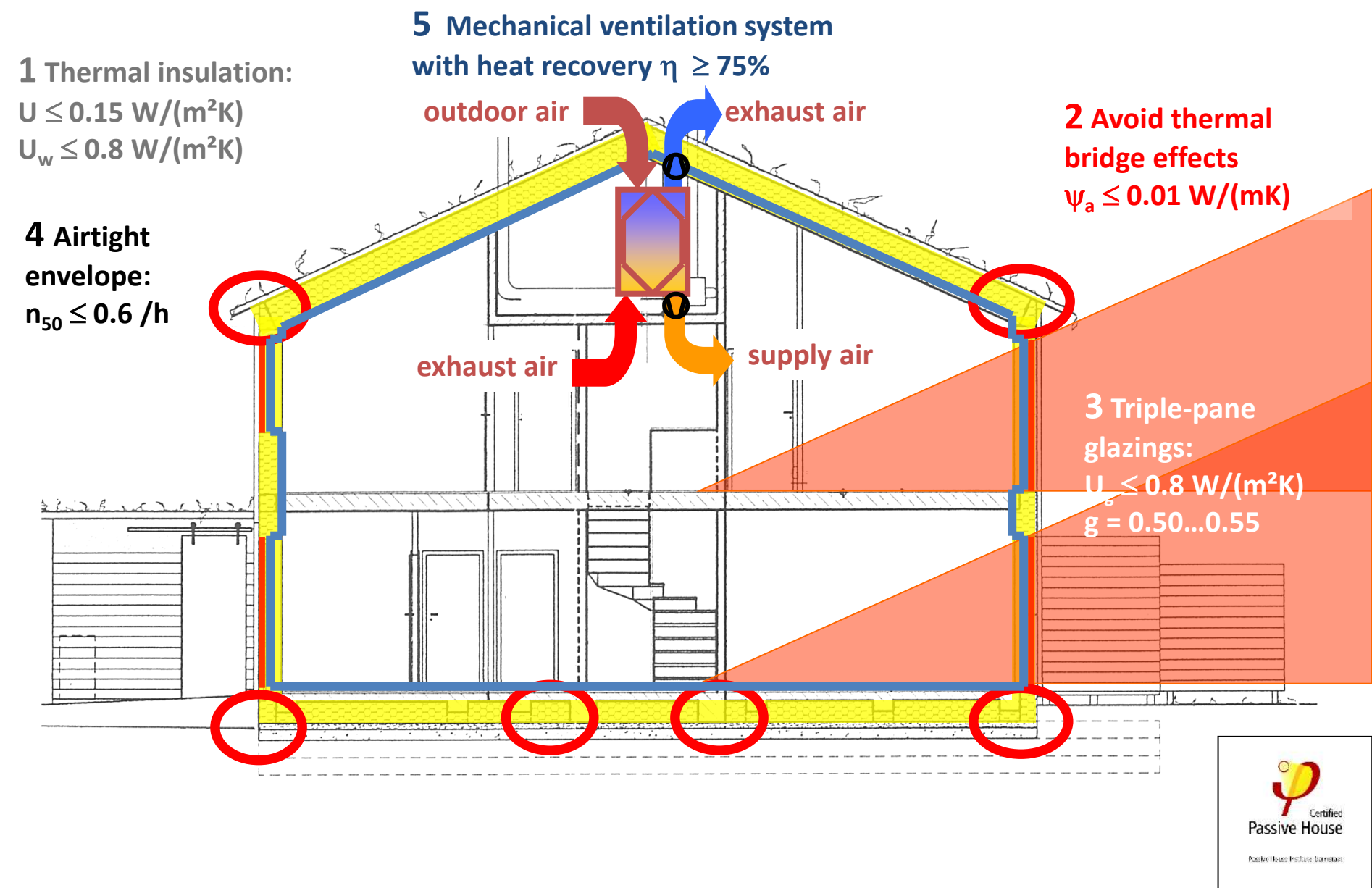
- Stable indoor temps 20–25°C
- ≤10% hours >25°C
- Balanced MVHR with 75%+ recovery

Thermal Comfort & MVHR



- Psi-values ≤ 0.01 W/mK
- All junctions modeled
- Avoids mold, improves comfort

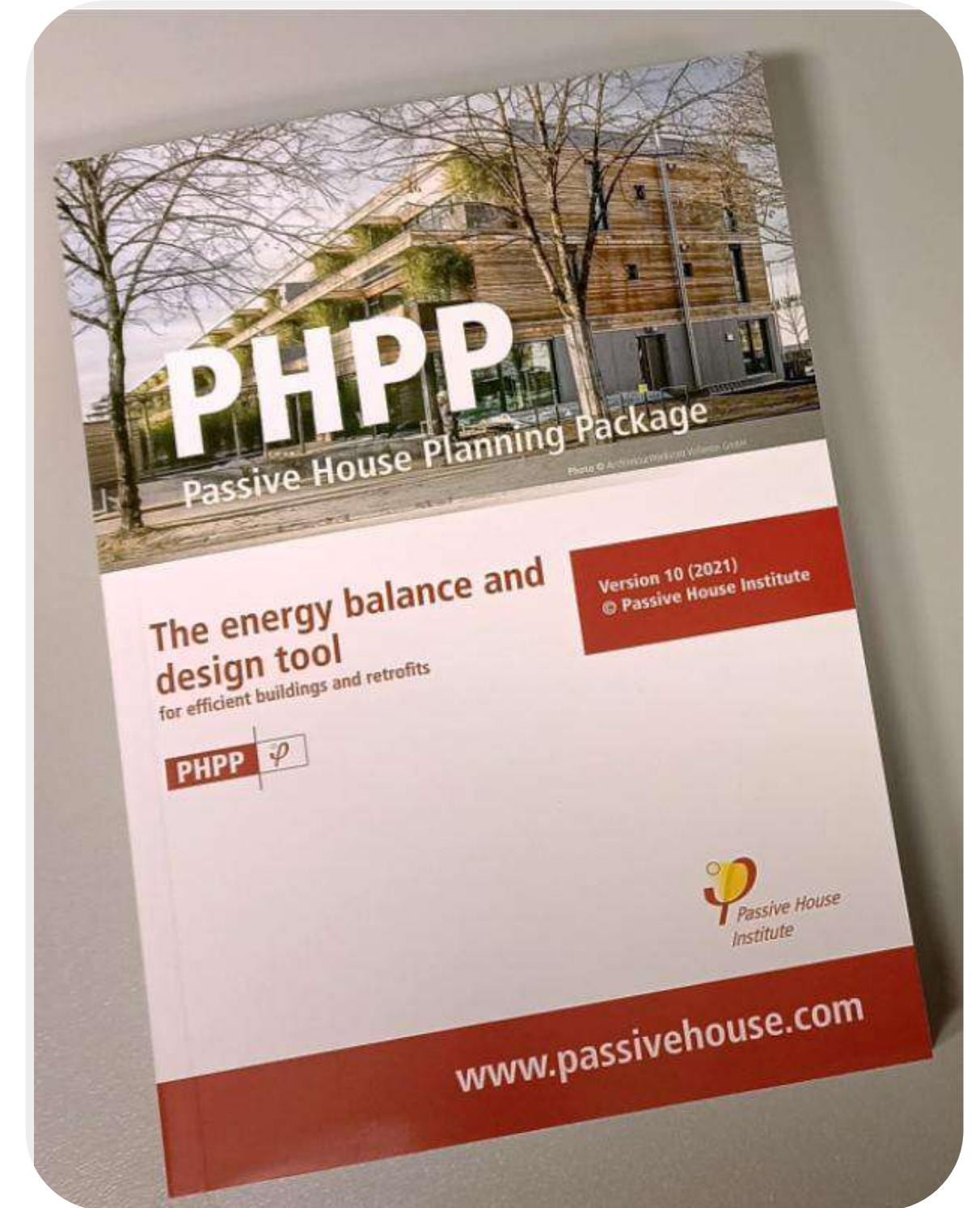
Thermal Bridge-Free Detailing



- Excel-based, monthly balance tool
- Detailed input, traceable results
- Preferred for Passive House

Specific building characteristics with reference to the treated floor area					
	Treated floor area m ²			Criteria	Alternative criteria
Space heating		175.5			
	Heating demand kWh/(m ² a)	11	≤	15	-
	Heating load W/m ²	10	≤	-	10
Space cooling	Cooling & dehum. demand kWh/(m ² a)	-	≤	-	-
	Frequency of overheating (> 25 °C) %	1	≤	10	-
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20	-
Airtightness	Pressurisation test result n ₅₀ 1/h	0.6	≤	0.6	-
Non-renewable Primary Energy (PE)	PE demand kWh/(m ² a)	58	≤	-	-
Primary Energy Renewable (PER)	PER demand kWh/(m ² a)	58	≤	60	60
	Renew. energy generation (in rel. to projected building footprint area) kWh/(m ² a)	13	≥	-	-

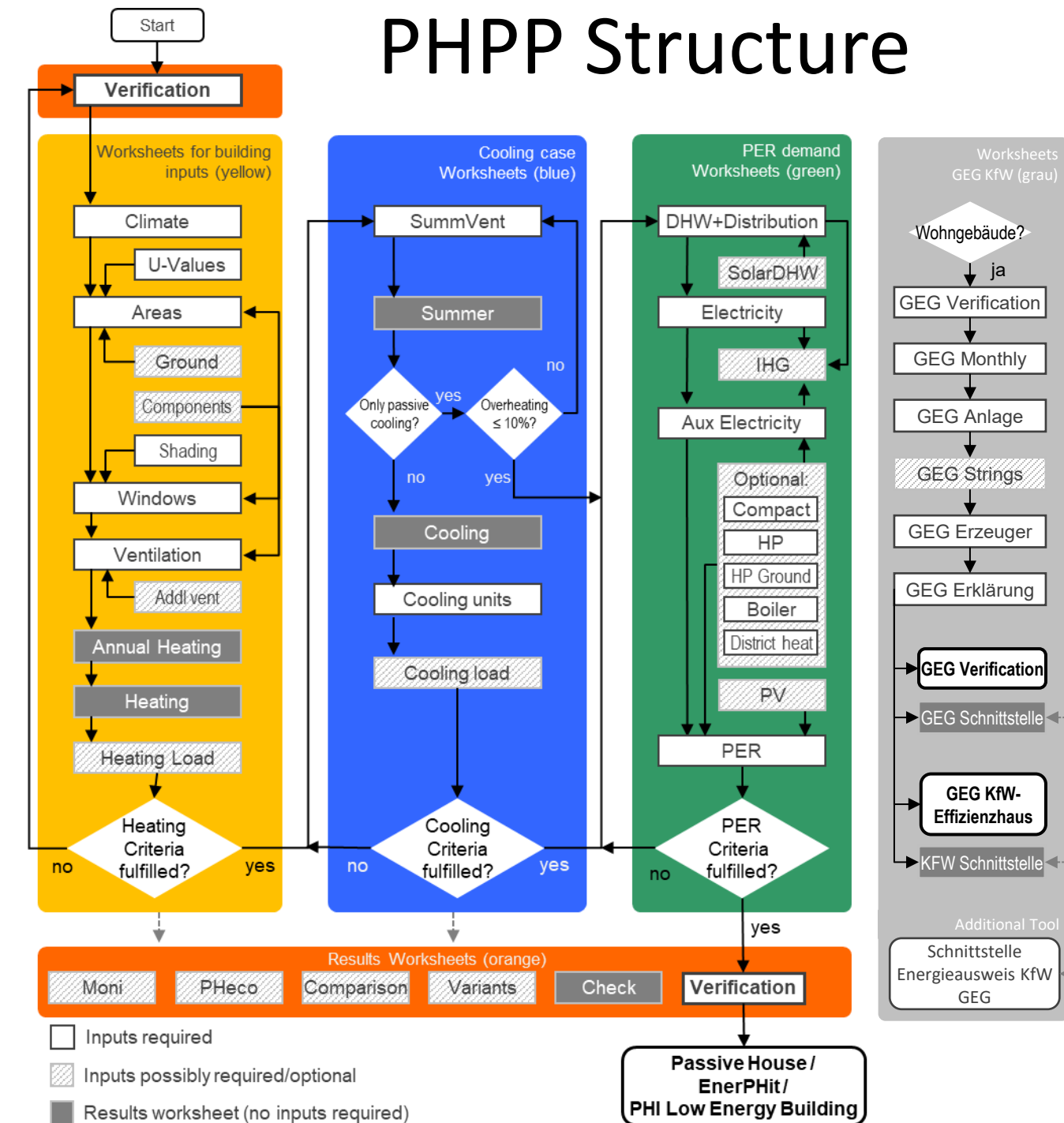
What is PHPP?



- U-values, window specs, MVHR, shading
- Climate file and occupancy
- Ventilation and airtightness data

PHPP Inputs

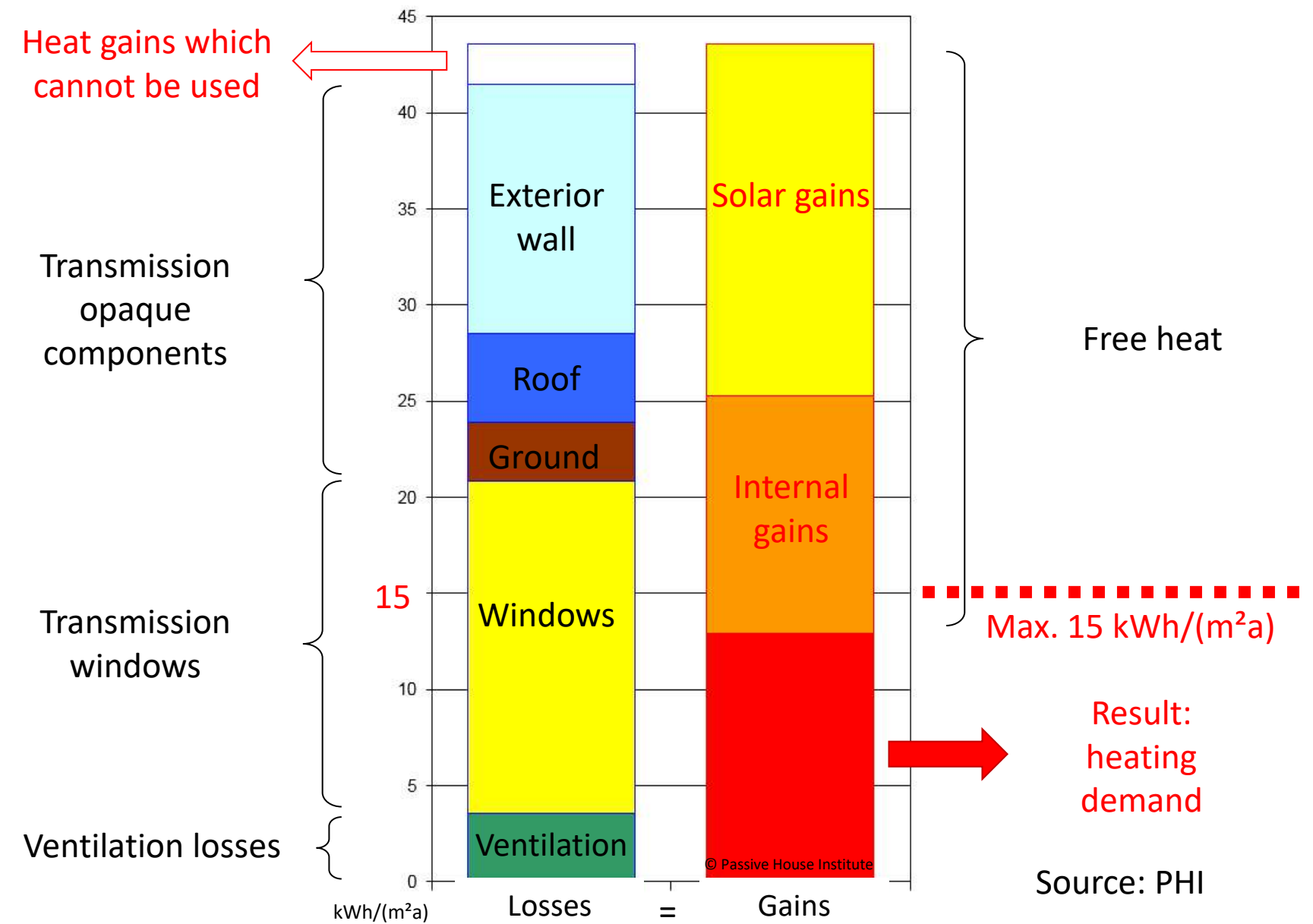
PHPP Structure



© PHI

- Heating/cooling demand
- Overheating % and PER
- Ventilation efficiency

PHPP Outputs



Lodenareal – Innsbruck (PH Classic)

- Build type: apartment house
- 361 units
- Air tightness: $n_{50} = 0.18/\text{h}$ test result
- Annual heating demand:
14 kWh /(m^2a) calculated according to PHPP
- Heating load: 9 W/ m^2
- PE demand: 117 kWh /(m^2a) calculated according to PHPP
on heating installation, domestic hot water, household electricity and auxiliary electricity calculated
- Building structure costs (gross) 1600 €/m² Treated Floor Area according to PHPP



Zaragoza – Spain (PH Classic)



- ClimateWarm, temperate
- Air tightness $n_{50} = 0.3/h$
- Annual heating demand: 12 kWh /(m^2a)
calculated according to PHPP
- Heating load: 10 W/ m^2
- PE demand (non-renewable Primary Energy): 87 kWh /(m^2a) on heating installation, domestic hot water, household electricity and auxiliary electricity calculated according to PHPP
- PER demand (renewable Primary Energy): 53 kWh /(m^2a) on heating installation, domestic hot water, household electricity and auxiliary electricity calculated according to PHPP
- Generation of renewable energy: 0 kWh /(m^2a) based on the projected area
- Cooling load 7 W/ m^2
- Cooling and dehumidification demand: 10 kWh /(m^2a) calculated according to PHPP

Şile, İstanbul – Türkiye (PH Plus)

Heating: 9 kWh/m²a

Cooling: 9 kWh/m²a

RE Generation: 53 kWh/m²a

External Wall U-Value: 0.102 W/m²K

Ground Floor U-Value: 0.110 W/m²K

Roof U-Value: 0.113 W/m²K

Window U-Value: 0.8 W/m²K

Heat Recovery Efficiency: 86%

Air tightness $n_{50} = 0.6/h$



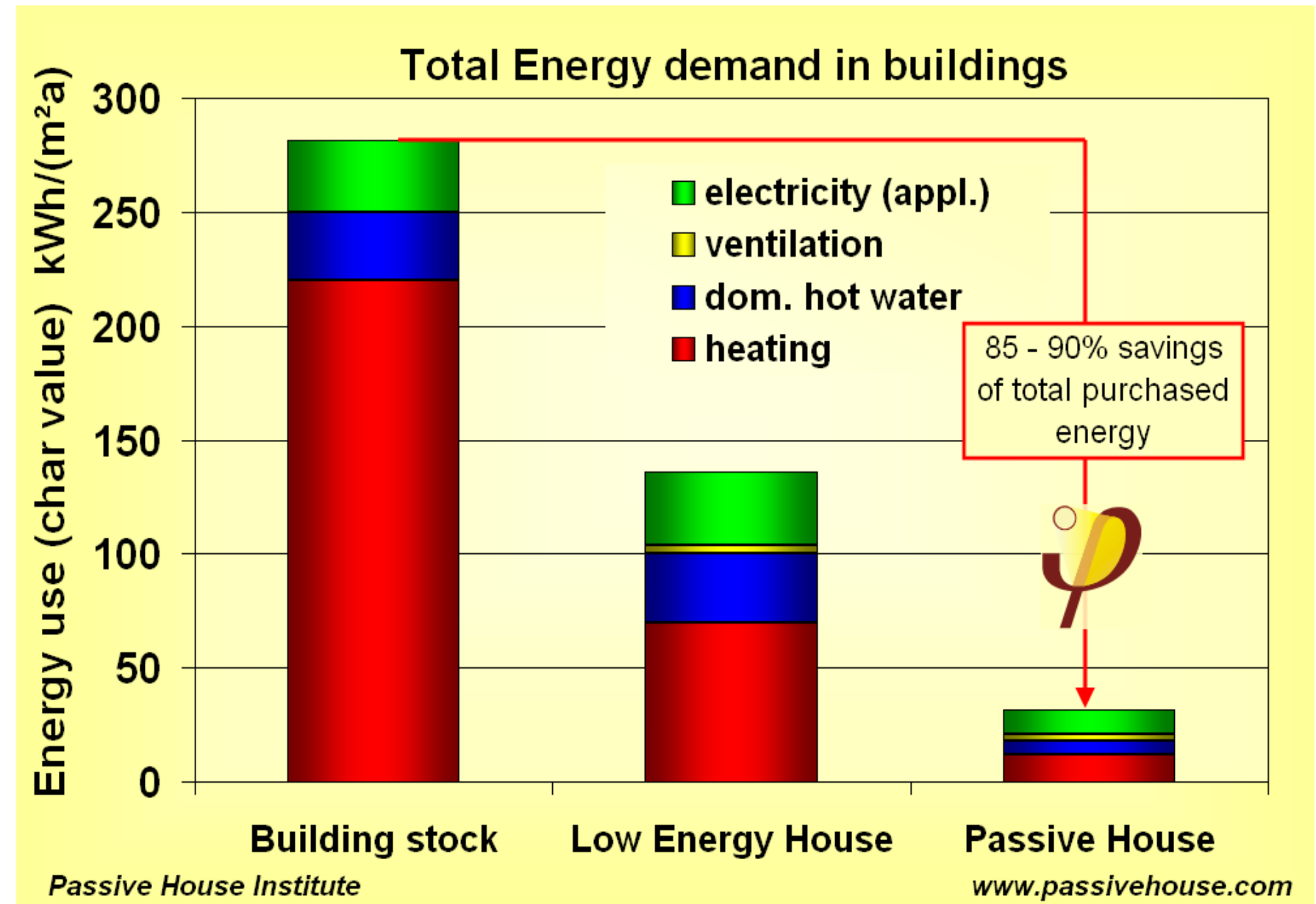
Lessons Across Projects

- Early integration: success
- PHPP supports reliability
- Construction execution matters



- Ultra-low demand meets ZEB targets
- PHPP transparency supports QA
- Measured performance → reliable output

How PH Aligns with EPBD



- No native GHG reporting
- Not accepted as EPC substitute
- No embodied carbon coverage

Where PH Falls Short



- Add emissions calcs to PHPP
- Dual tracking with EPC tools
- Use Level(s) for whole-life indicators

Bridging the Gap

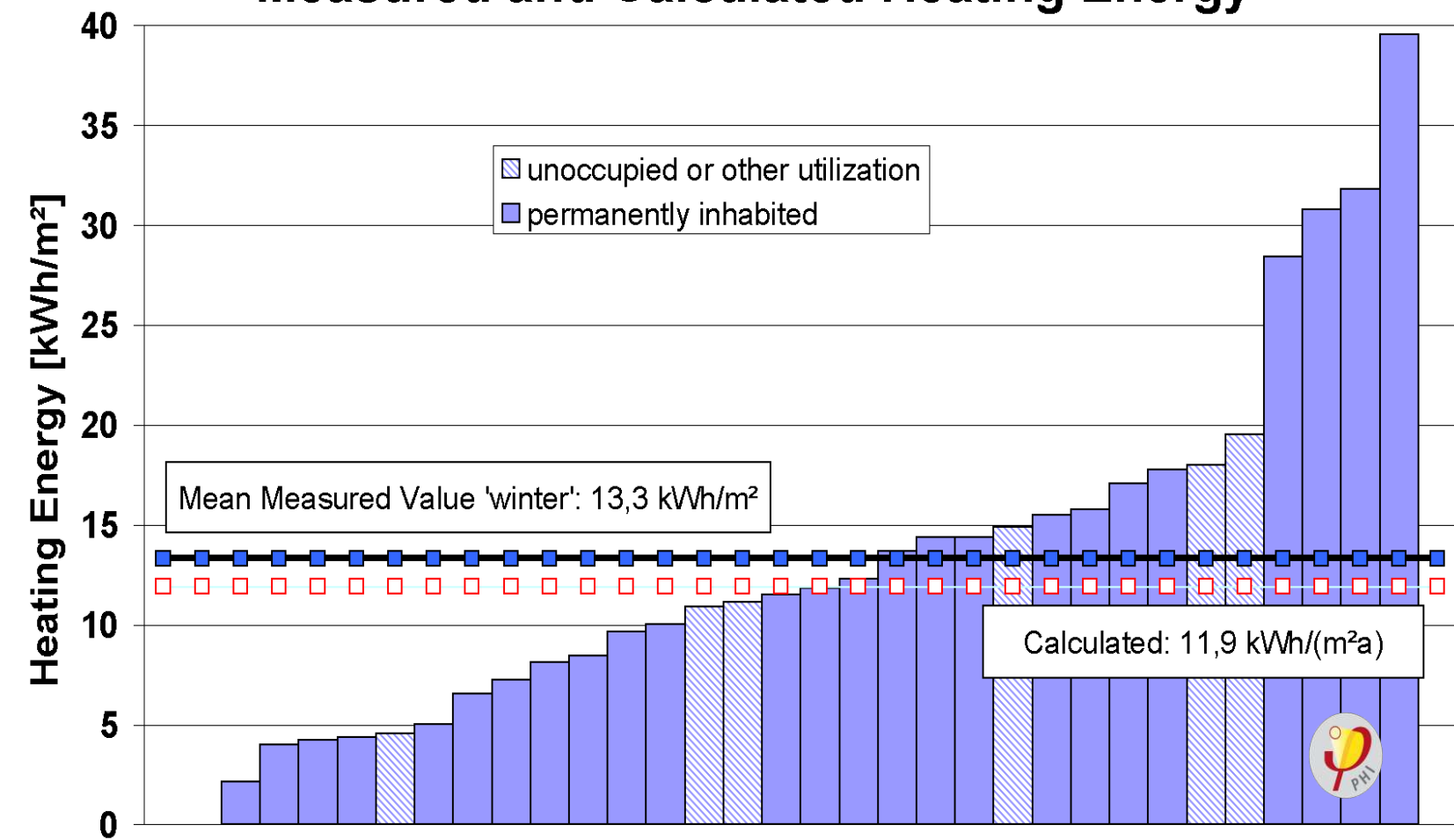


PHPP vs Real Energy Use Example

- PHPP modeled: 11,9 kWh/m²a
- Measured: 13,3 kWh/m²a
- Small deviation shows reliable forecasting



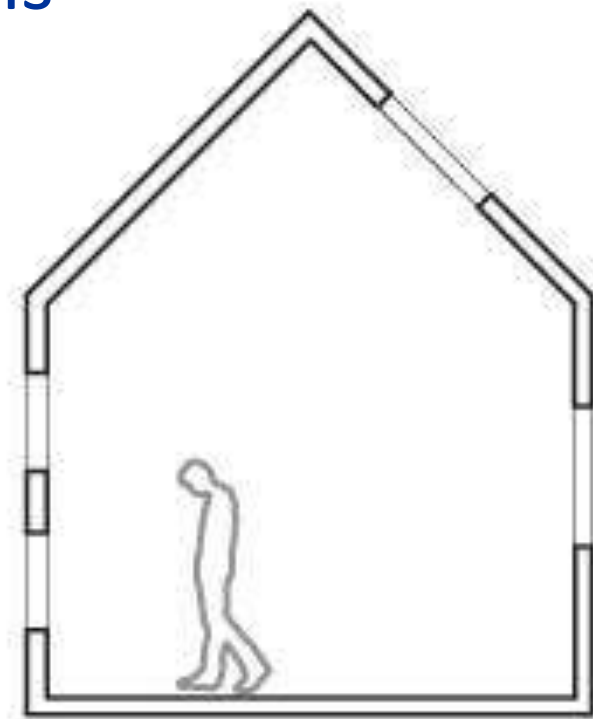
Project 1: Comparison of Measured and Calculated Heating Energy



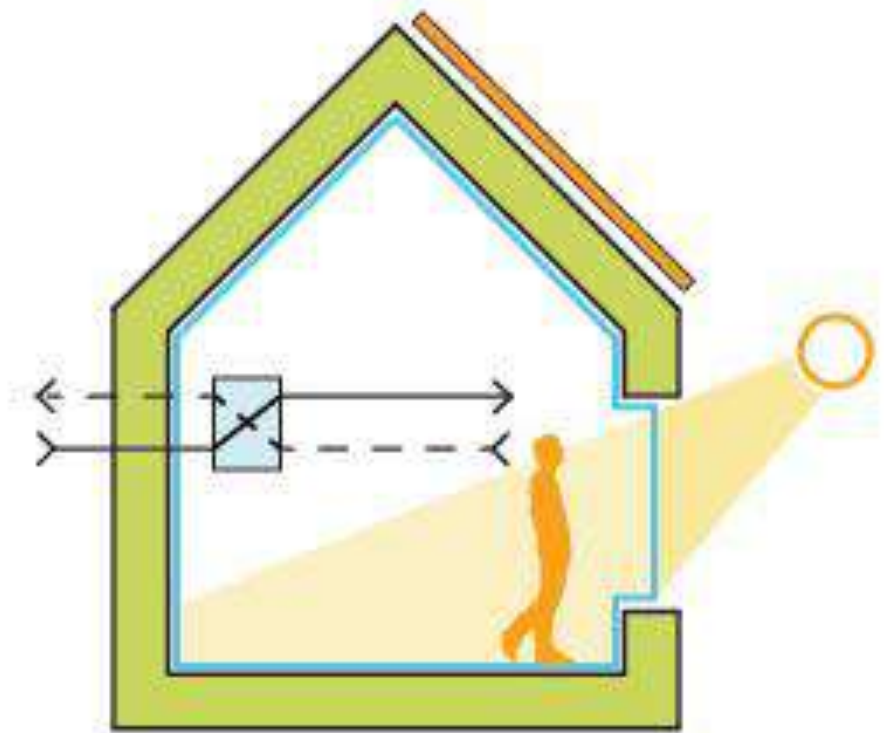
Source: PHI

Passive House vs Local Norm Conflicts

- PH requires low demand, but may conflict with:
 - Local SHGC limits (cooling zones)
 - EPC modeling software assumptions
 - Building form or site restrictions

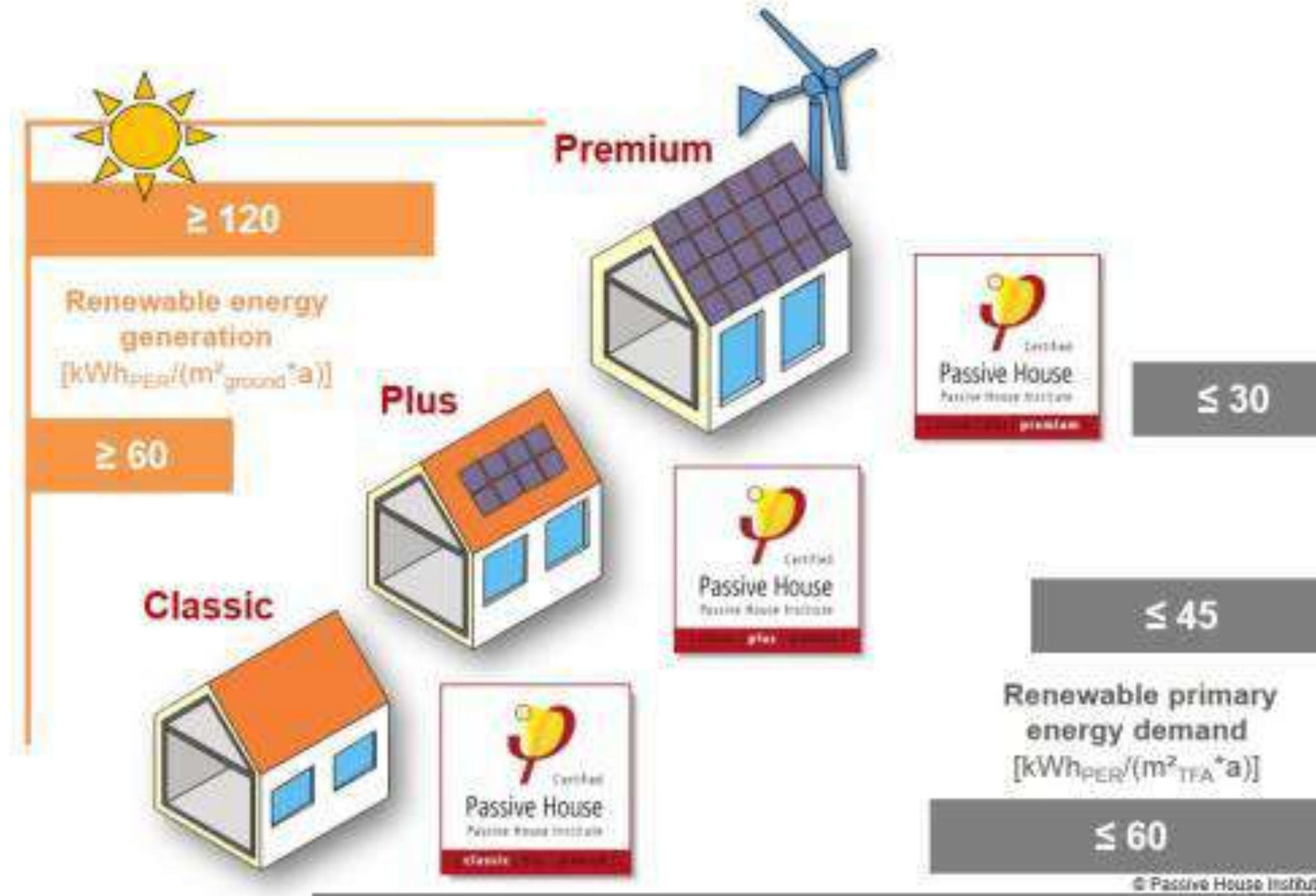


VS



Passive House Classes: Classic, Plus and Premium

STEP2CleanPLAN



Conclusion & Reflection

- PH: consistent high performance
- Not a law, but a method
- What would boost PH adoption in your region?



Thank you!

Q & A

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 202: Energy Efficiency in Urban Infrastructure

202 C: Retrofitting and Construction for Zero Emission Performance

Trainer:

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

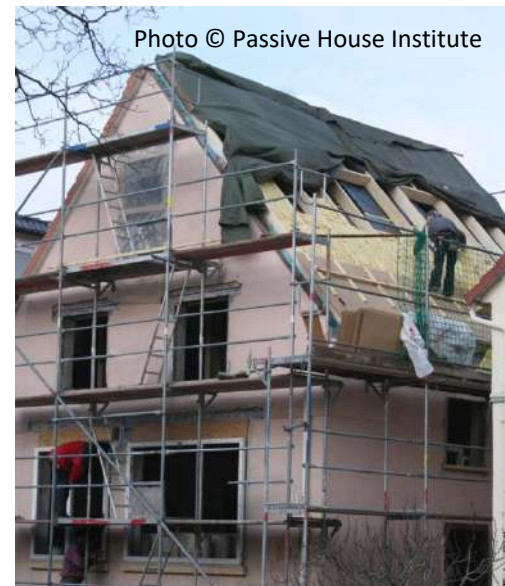


Agenda

- Why Retrofit for Zero Emission Goals?
- Envelope First: Insulation & Airtightness
- Ventilation, Windows, and HVAC Integration
- Retrofit Workflow & Coordination
- EnerPHit and Staged Sequencing
- Case Strategies for Real-World Success
- Conclusion & Reflection

The Retrofit Imperative

- 85% of buildings pre-modern codes
- Still in use by 2050
- Renovation: climate strategy

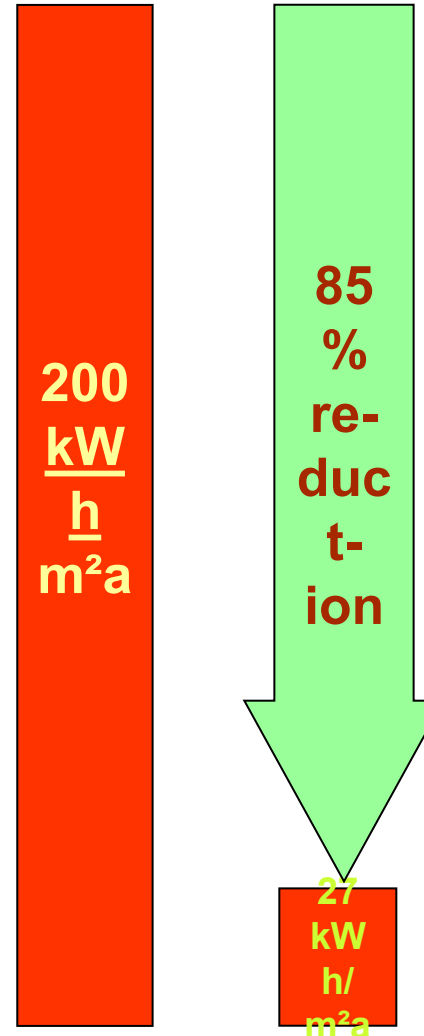


Deep Retrofit Benefits

- Up to 80% GHG reduction / 85% energy consumption reduction
- Improved comfort, durability
- Supports energy poverty relief



before



after retrofit

- basement insulated
- walls insulated
- Passive House windows
- ventilation with highly efficient heat recovery

Photos and diagram: © Schulze-Darup

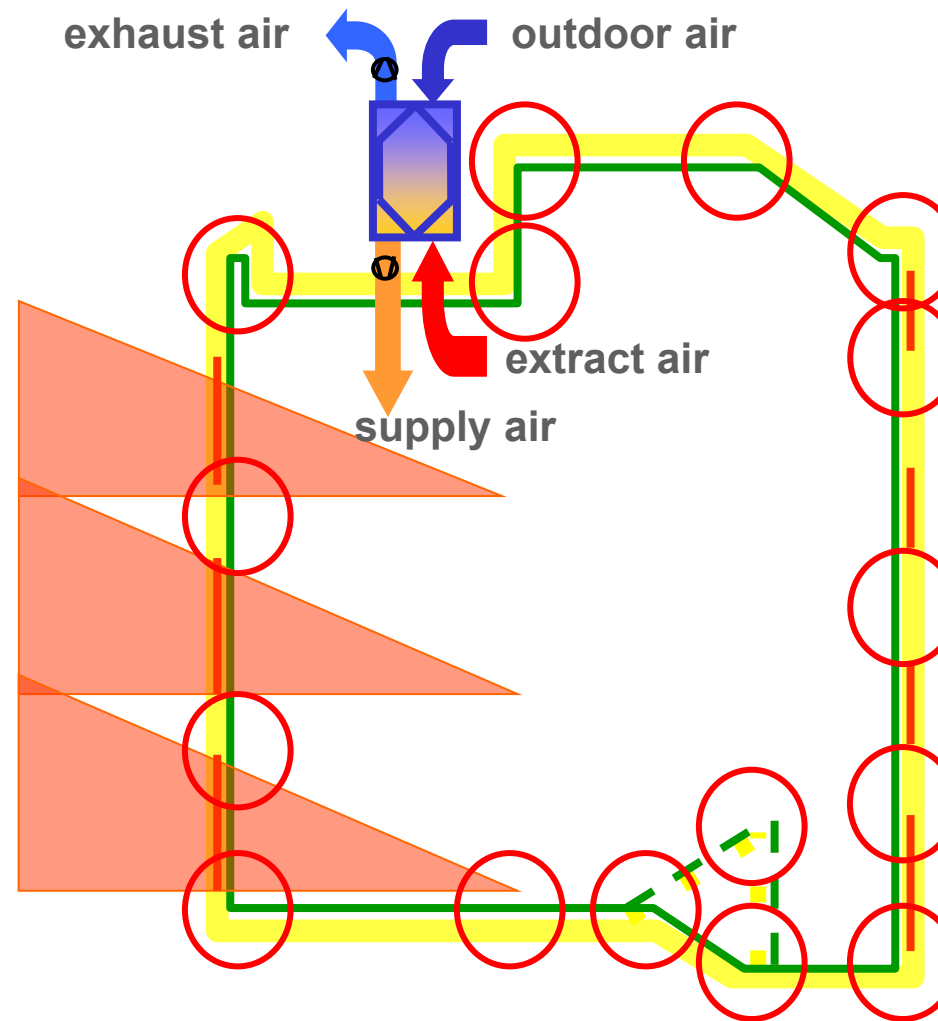
Why Shallow Renovations Fail

- Boiler/window swaps $\neq$ performance
- Miss airtightness, ventilation
- Lack of systems integration



Envelope as Retrofit Foundation

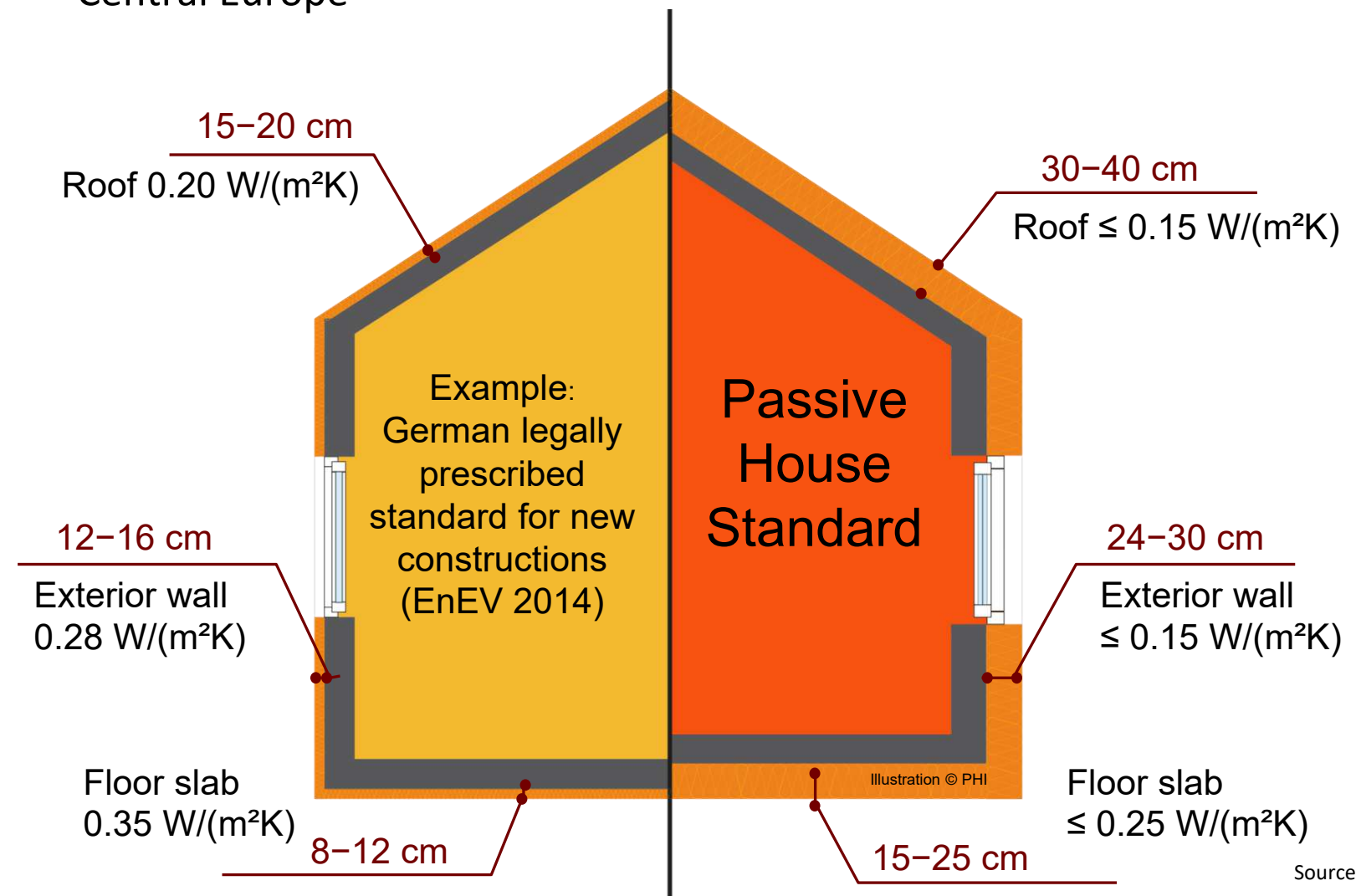
- Thermal enclosure comes first
- Insulation, airtightness, bridge-free
- Enables other systems to perform



Insulation Best Practices

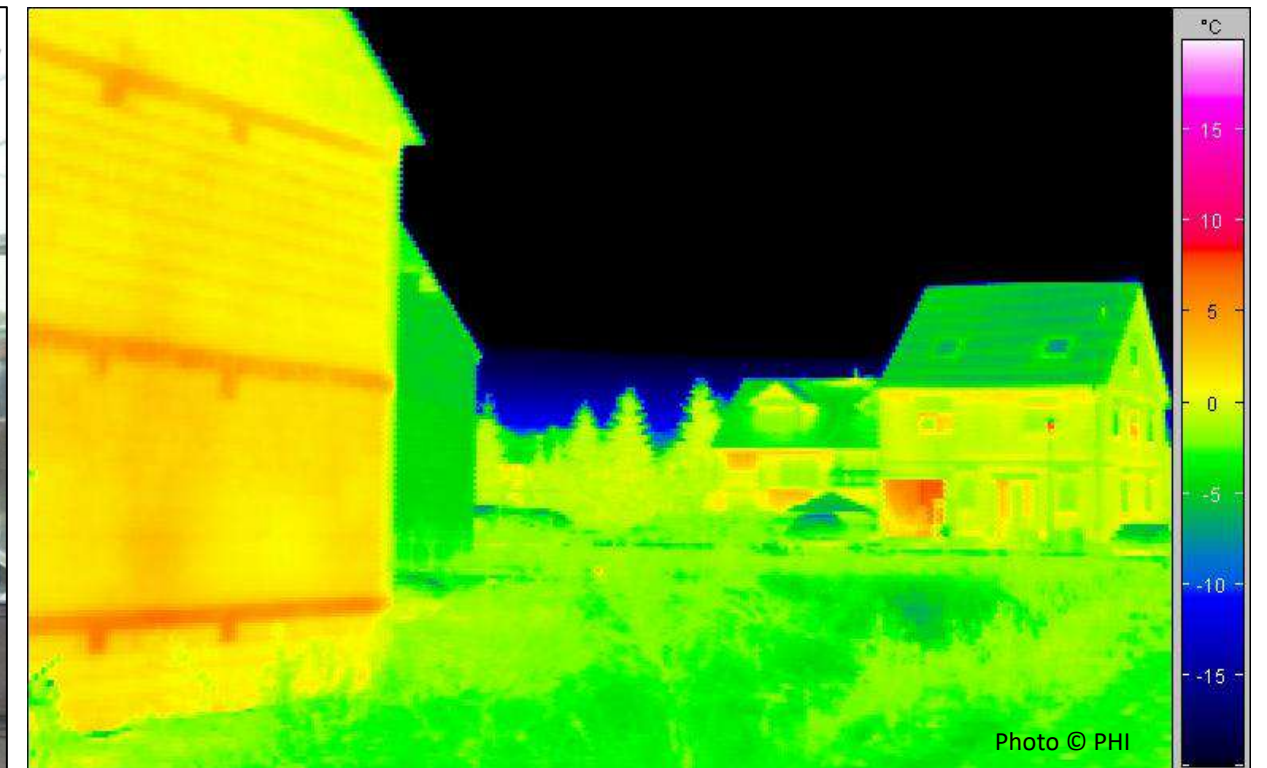
- Continuity > thickness
- External preferred (e.g., ETICS)
- U-values: wall 0.10–0.15, roof 0.08–0.12

Typical U-values and insulation thickness for a Passive House building in Central Europe



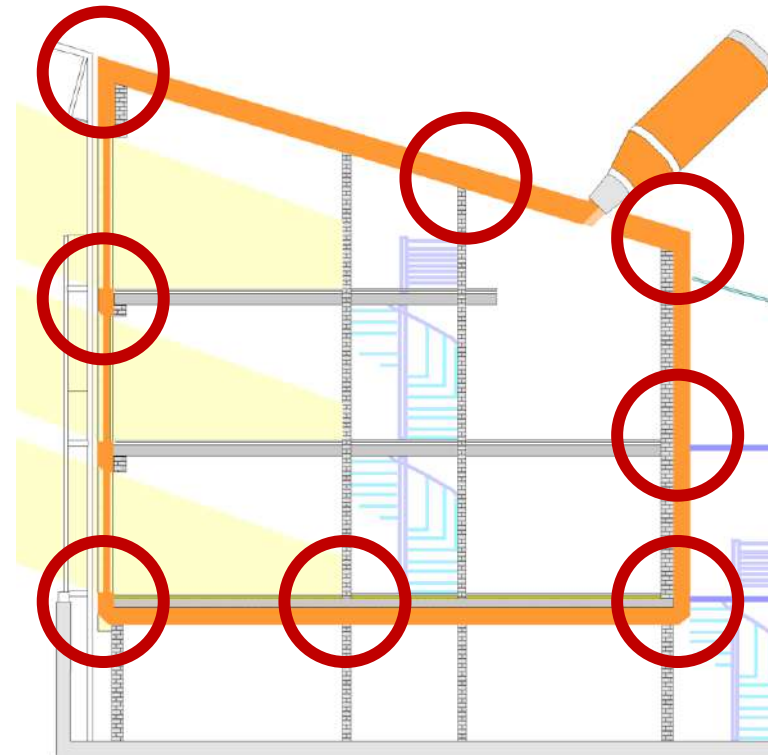
Airtightness Detailing

- EnerPHit: ≤ 1.0 ACH @ 50 Pa
- Defined layer, taped transitions
- Pre/post blower door tests



- Ψ -values $< 0.01 \text{ W/mK}$
- Sill/jamb/foundation wraps
- Modeled with THERM or Flixo

Thermal Bridge Elimination

**Avoidance Rule:**

The insulating envelope should not be interrupted if this can be avoided.

Penetration Rule:

If penetration of the insulating layer is unavoidable, the thermal conductivity of the penetrating material should be as low as possible.

Use porous concrete or even better wood, or PUR or foam glass elements.

The insulating envelope encloses the entire heated volume.

Thermal bridge-free design:

$$\Psi_e \leq 0.01 \text{ W/(mK)}$$

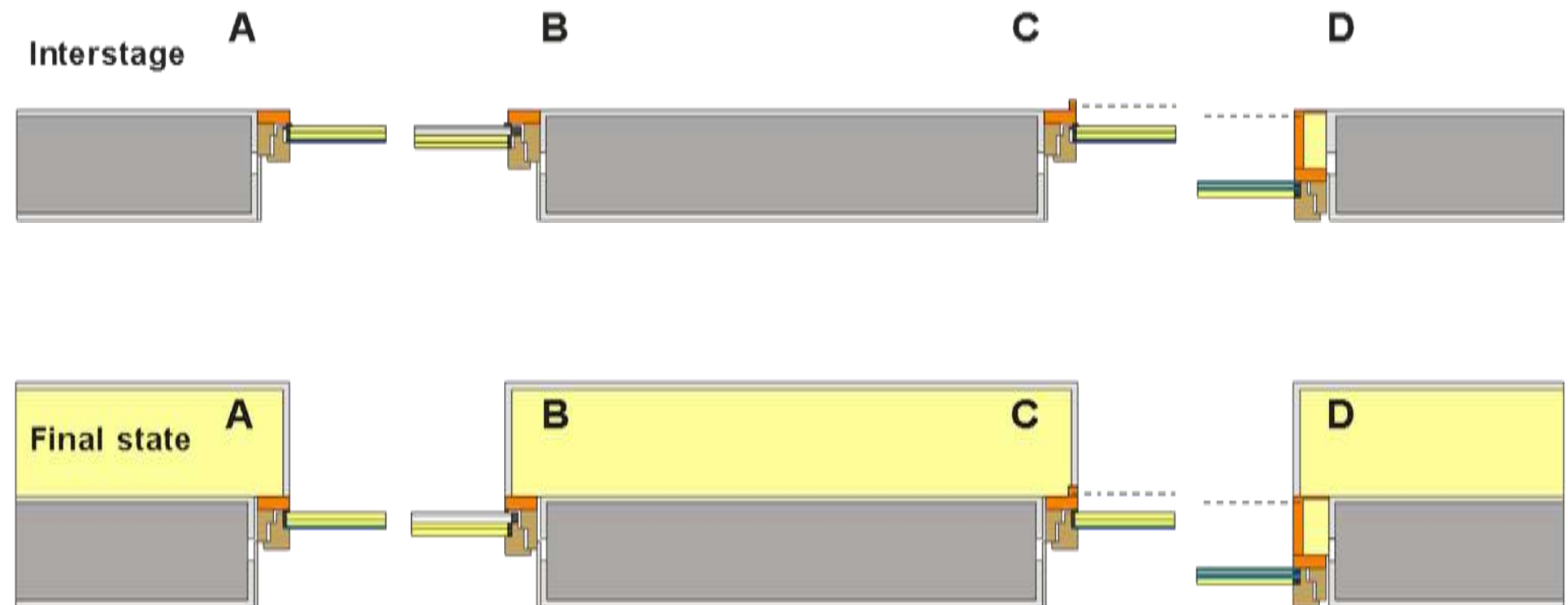
Connection Rule :

Insulation layers at building component connections merge into each other over the entire surface without interruption.

© PHI

- Windows before insulation
- Air barrier before finishes
- Insulation after prep/testing

Sequencing Envelope Work



Figures © Passivhaus Institut

Planning & Verification Tools

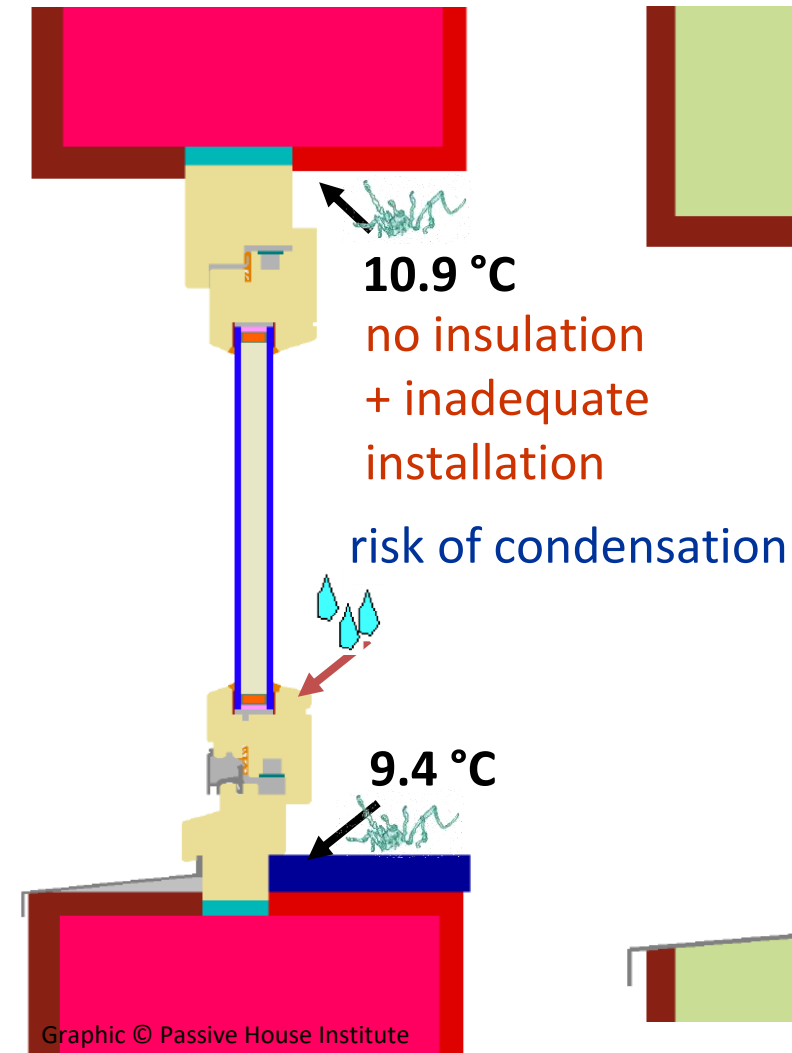
- Airtightness plans, thermal modeling
- Blower door, infrared camera
- U-value calculations



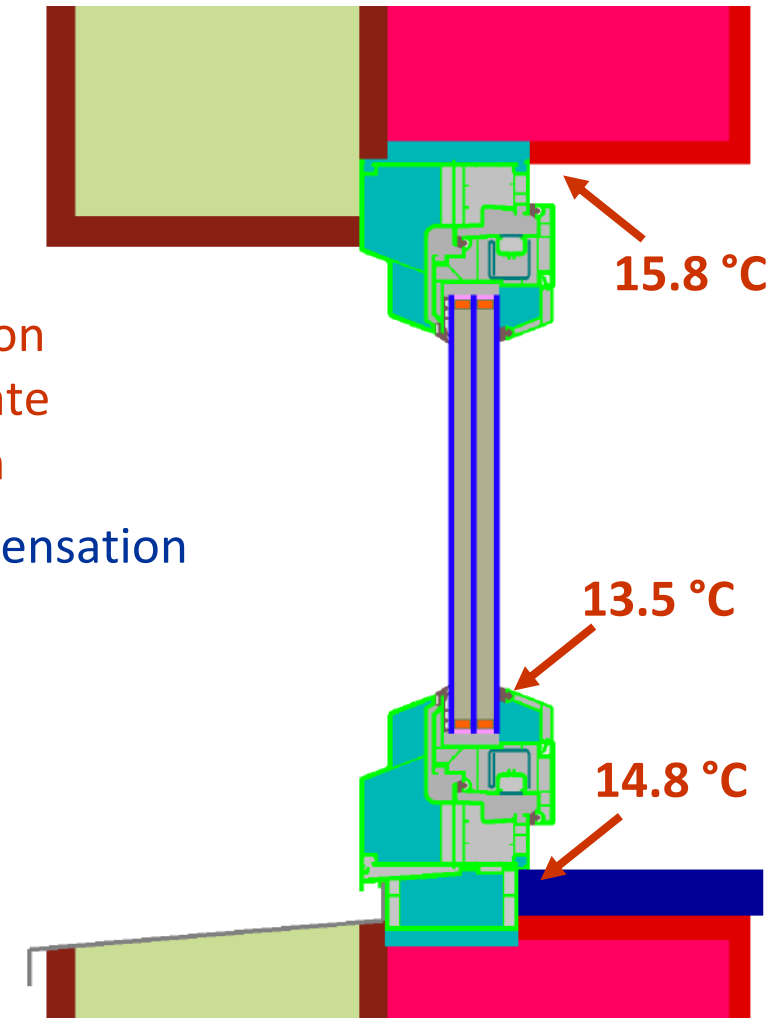
- $U \leq 0.85\text{--}1.0 \text{ W/m}^2\text{K}$, triple-glazed
- Orientation: SHGC strategy varies
- Air/thermal continuity at frame

High-Performance Windows

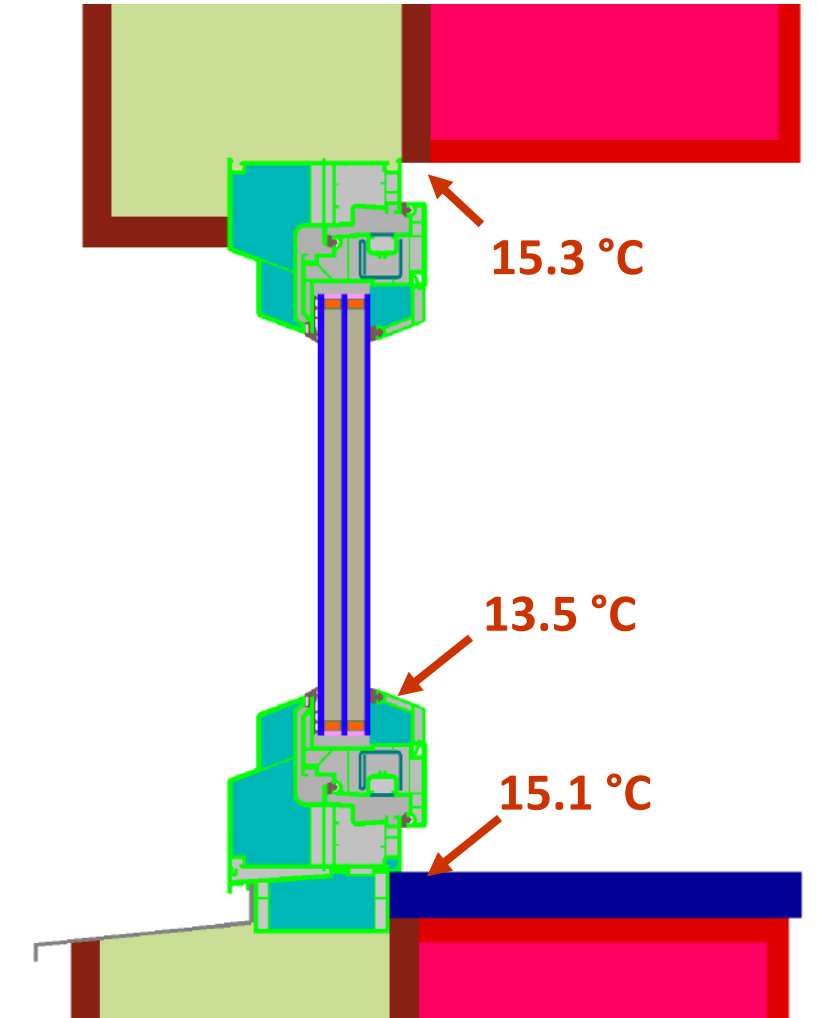
Low temperatures at interior surfaces



... flush with the exterior wall surface



... placed within the insulation layer



- Small systems for small loads
- Prefer heat pumps, low-temp delivery
- Smart zoning, defrost readiness

HVAC for Passive Loads



© Nilan Comfort CT150

HRV unit for
installation in a
wardrobe...

...or in a kitchen wall
cupboard

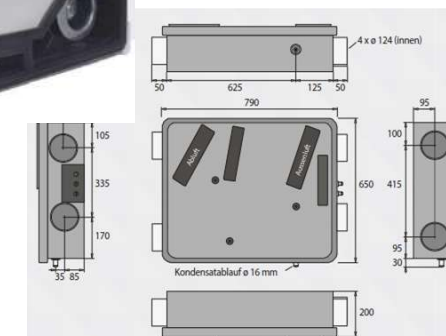


© Vallox Heinemann



© Ventilair Fox Comfort

...or in a **plumbing wall**
(HRV unit only 20 cm deep)



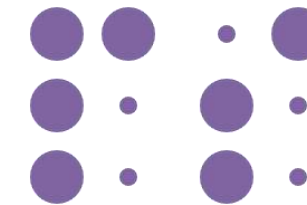
Whole-System Synergy



Envelope enables ventilation



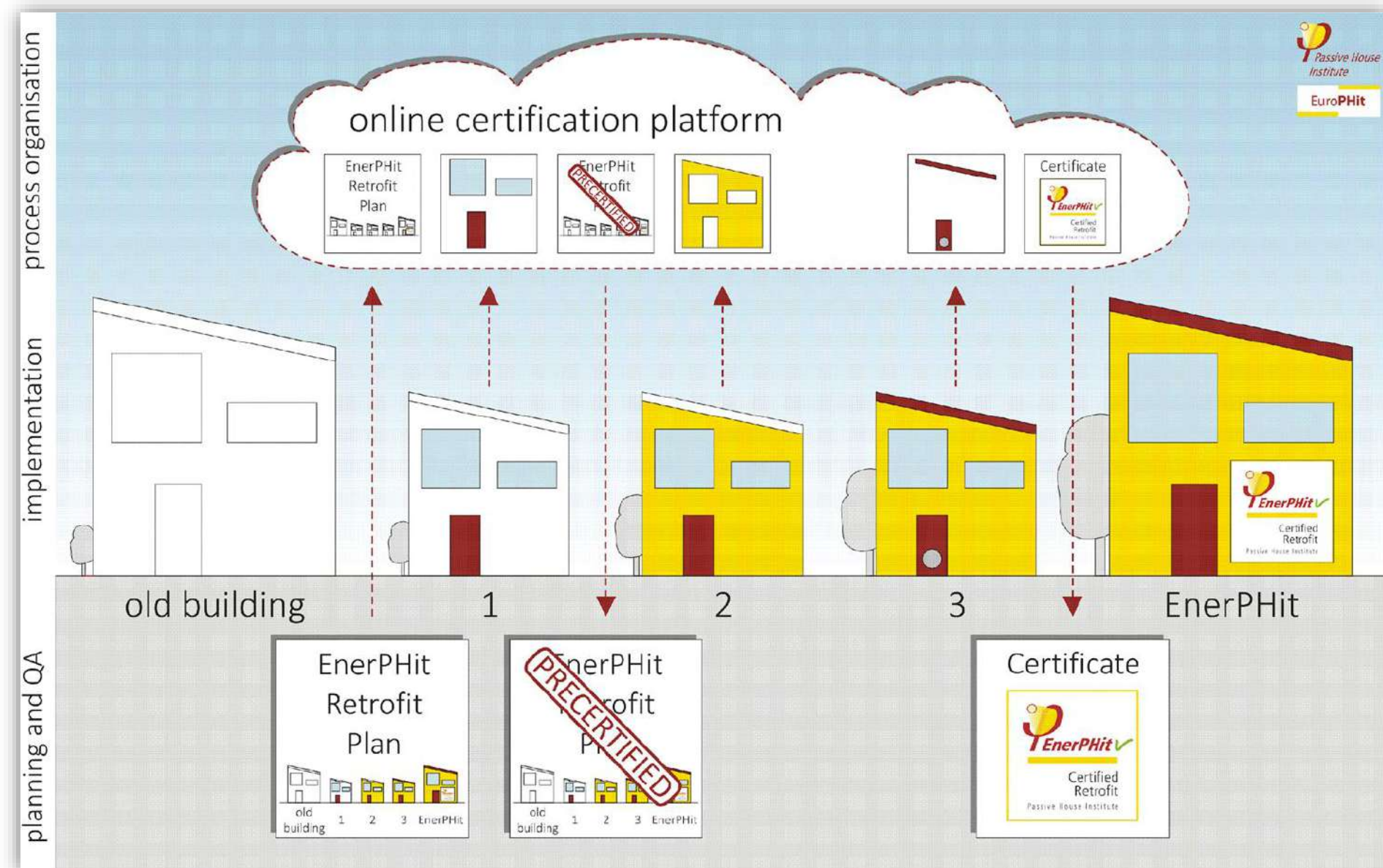
Ventilation stabilizes air quality



Systems right-sized by PHPP

Retrofit Workflow Logic

- Diagnostics → Design → Envelope → MVHR → QA
- Air test before finishes
- PHPP modeling aligns each step



- Pre-start workshops/mockups
- Annotated site drawings
- Passive House trained crews

Contractor Risk Mitigation



Budget & Time Pressures

- Upfront cost + time = higher
- But lifecycle + ROI = strong
- Use energy + comfort gains to sell



- Flexible: phased or full
- 25 kWh/m²/year heating target
- Allows component upgrades

EnerPHit Principles

Source file: 'EnerPHit_SBS_Windows_2_EnerPHit_PHPP.xlsm' (PHPP version: 9.3)

EnerPHit Retrofit Plan

Target standard: EnerPHit Plus

Co-funded by the Intelligent Energy Europe Programme of the European Union

Object:	End-of-terrace Passive House
Example Street 99	
99999	Example City
Example Province	DE-Germany
Row house	
Climate data set:	DE-9999-PHPP-Standard
Climate zone:	3: Cool-temperate
Altitude of location:	
Owner:	Passivhaus Association of Owners
Example Street 99	
99999	Example City
Example Province	DE-Germany

Energy consulting:	Example Energy Consultant	Pre-Certification:	Passive House Institute
Example Street 99		Rheinstr. 44/46	
99999	Example City	64269	Darmstadt
Example Province	DE-Germany		DE-Germany

Year of construction:	2015	Interior temp. winter [°C]:	19,0	Interior temp. summer [°C]:	25,0
No. of dwelling units:	1	Treated floor area:	156,0	No. of occupants:	2,9

Energy demand and generation over the retrofit steps

Retrofit Step	Heating demand [kWh/(m²_TFA.a)]	Cooling + dehumidification demand [kWh/(m²_TFA.a)]	Renewable primary energy generation [kWh/(m²_TFA.a)]
1-Existing	280	-	-
2-Windows + heat recovery vent	247	-	-
3-Basement ceiling + roof + PV	189	-	-
4-External walls + Entrance door	21	-	-
5-Heatpump + solar thermal	21	-	120

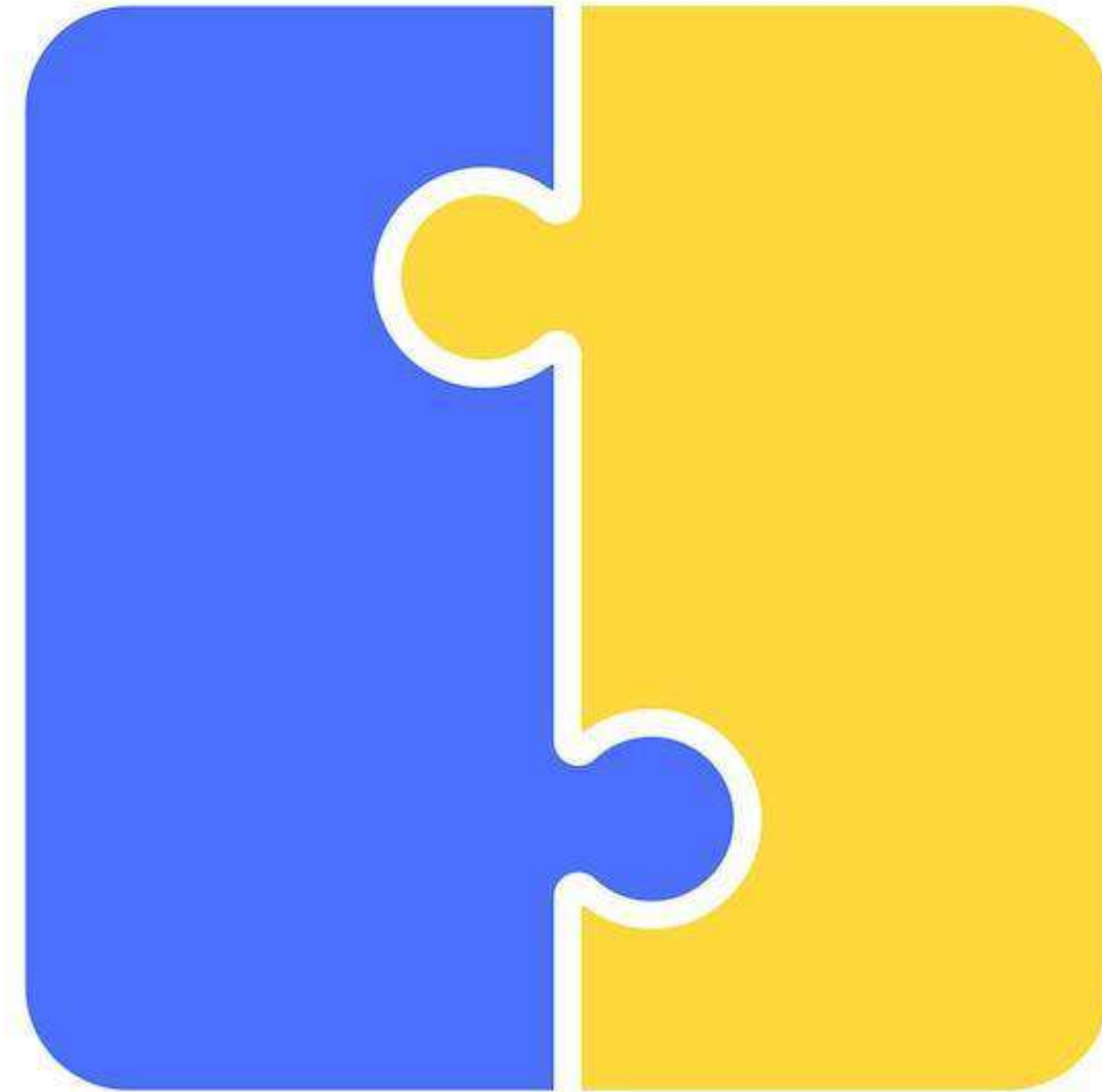
■ Heating demand ■ Cooling + dehumidification demand ● Renewable primary energy generation (reference to projected building footprint)

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

First name	Last name	Signature
Company	Issued (date)	City

- Staged = budget/practicality
- PHPP supports step-by-step
- Requires airtightness foresight

Phased vs Whole-Building Approach



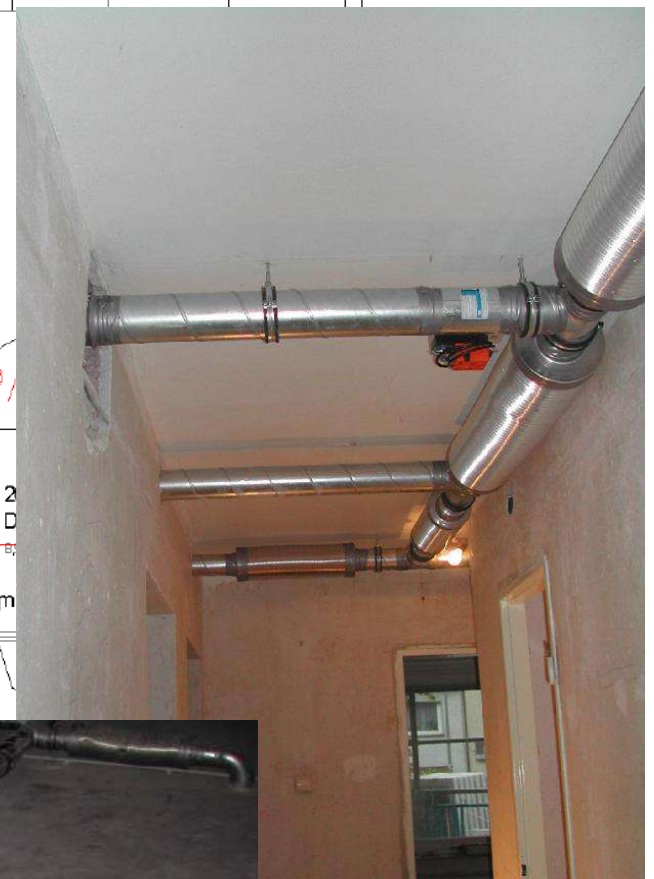
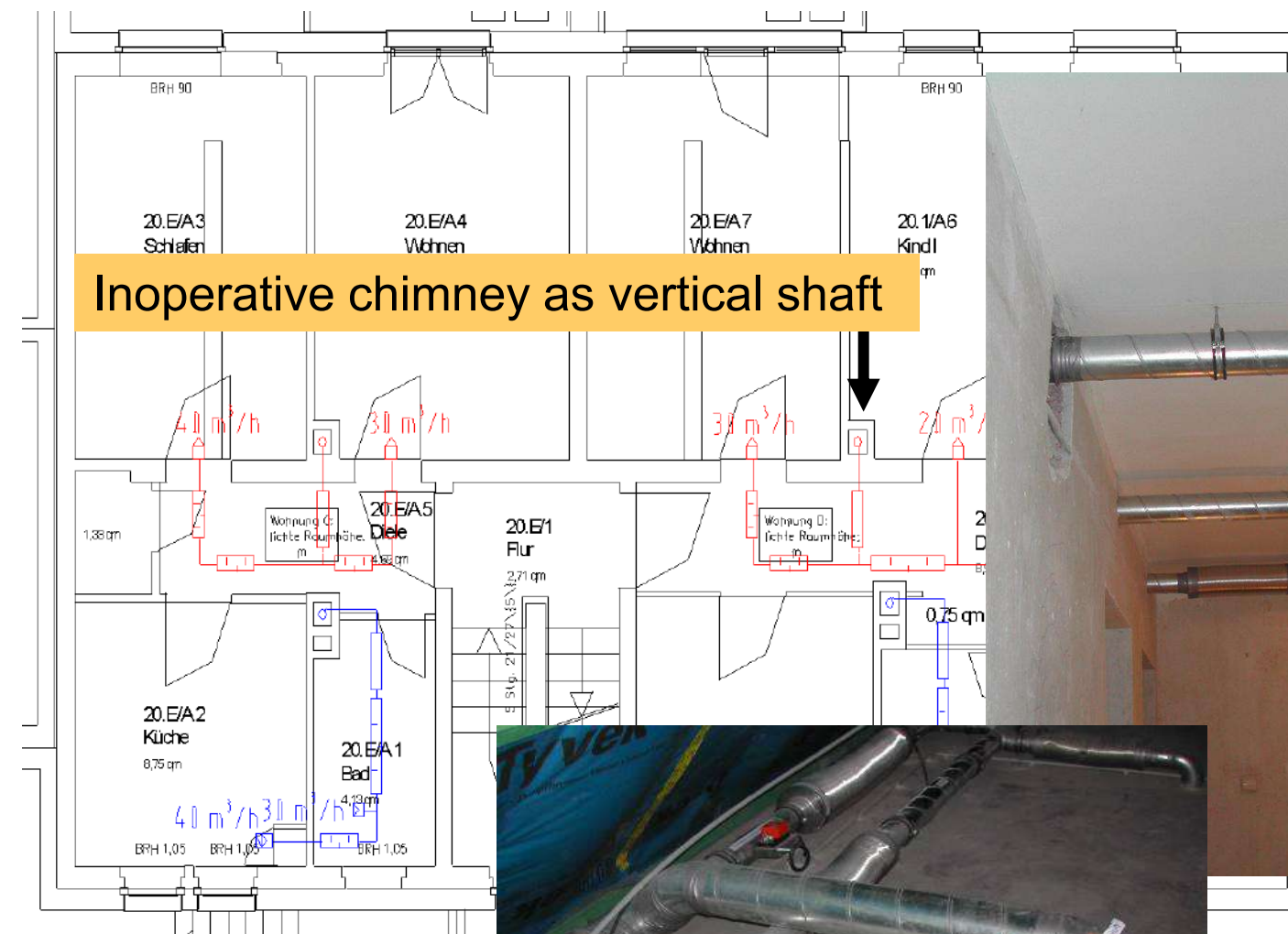
Apartment Building Hofheim, Taunus



constant
volume
flow
regulator



Photos © Planungsgruppe DREI



supply air

Retrofit Project, Tevesstrasse, Frankfurt, Germany

STEP2CleanPLAN

Retrofit Project, Tevesstrasse, Frankfurt

Photo © Passive House Institute



Photo © Passive House Institute

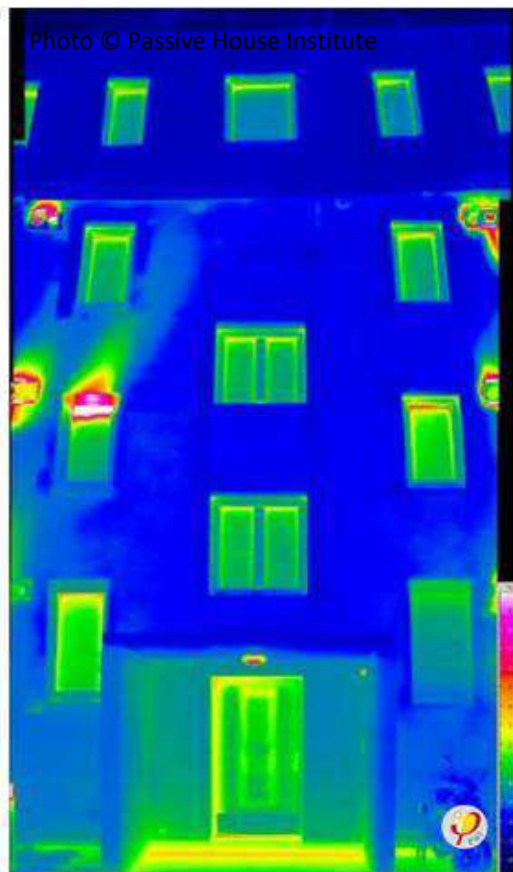
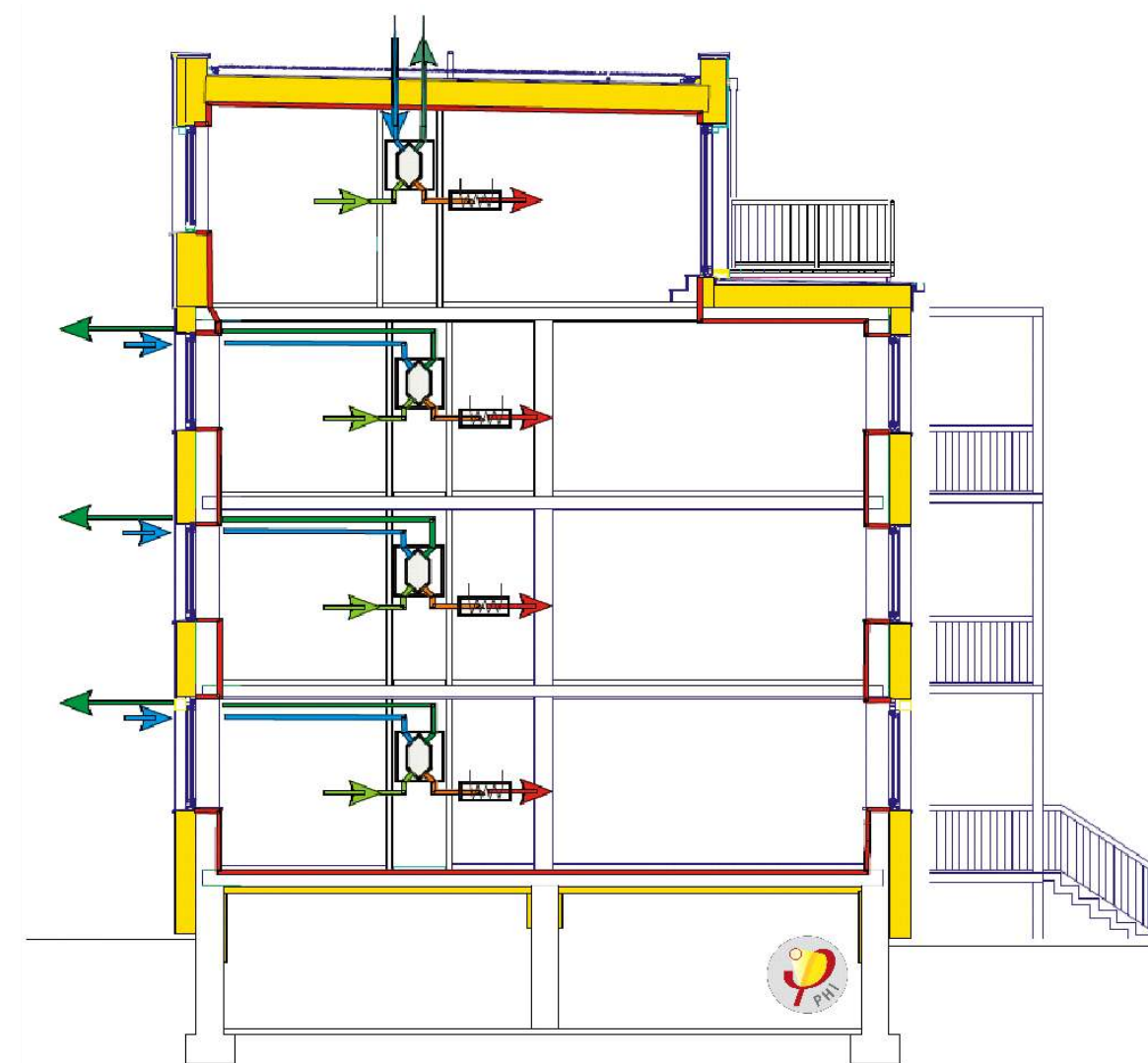


Photo © Passive House Institute



Reflection Prompt

- Where do YOU hold leverage?
- Detailing? QA? Coordination? Client framing?



Contractor Training & Construction Mockups

STEP2CleanPLAN

- Passive House–aligned training improves quality
- Mockups for complex joints (e.g. floor-wall-air barrier)
- Toolbox talks: align sequences, reduce clashes



Thank you!

Q & A

COOPERATION FOR SUSTAINABLE ENERGY AND CLIMATE ACTIONS PLANNING AND MONITORING IN BSB

STEP2CleanPlan BSB00004

Module 2: Sustainable Urban Mobility and Energy Efficiency

Sub Module 202: Energy Efficiency in Urban Infrastructure

202 E: Sensors, IoT Devices & Control Strategies

Trainer:

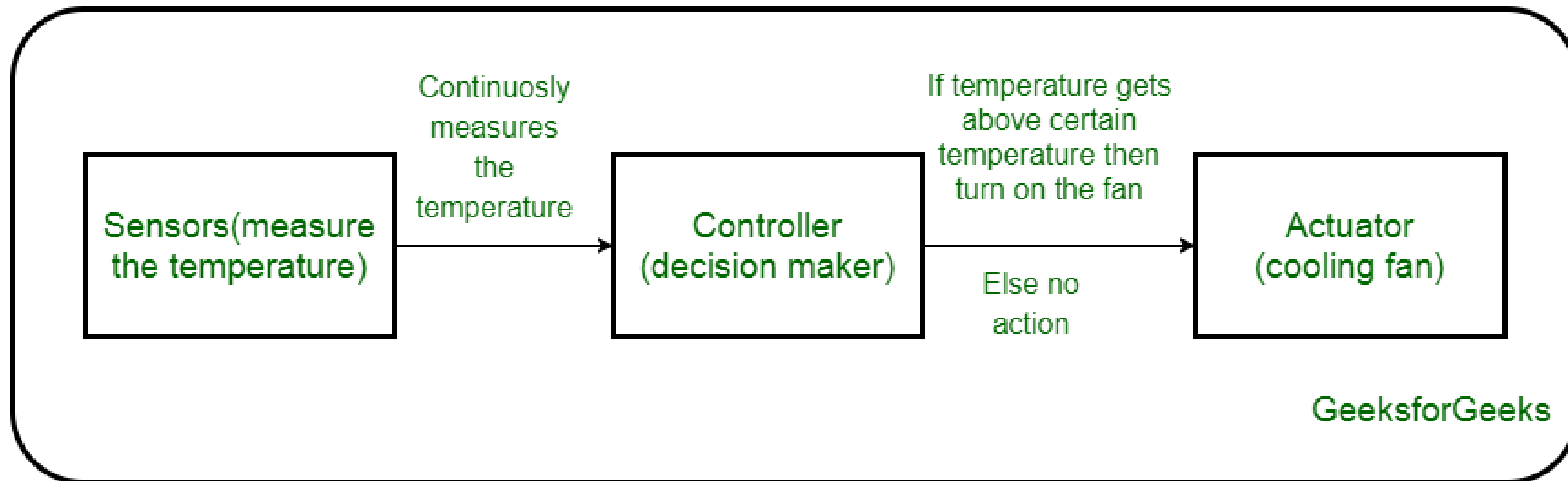


Agenda

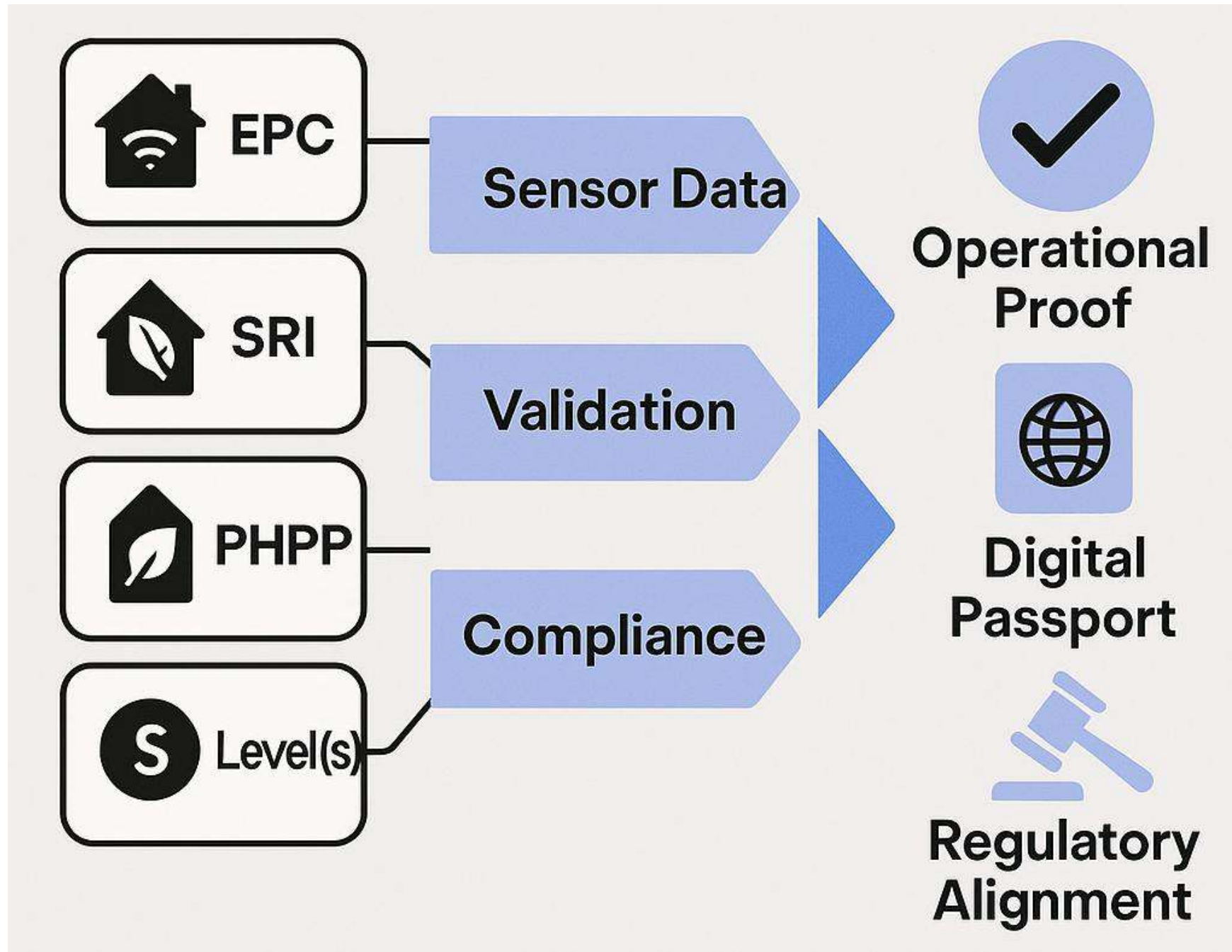
- Sensor Fundamentals
- Types and Applications
- IoT Devices & Network Logic
- Control Strategies & QA
- Override Failures & Fusion Logic
- Security, Calibration & Reflection
- Conclusion & Reflection

Why Sensors Are Foundational

- Enable automation and efficiency
- Connect user comfort to system logic
- Basis for BAS and smart operation

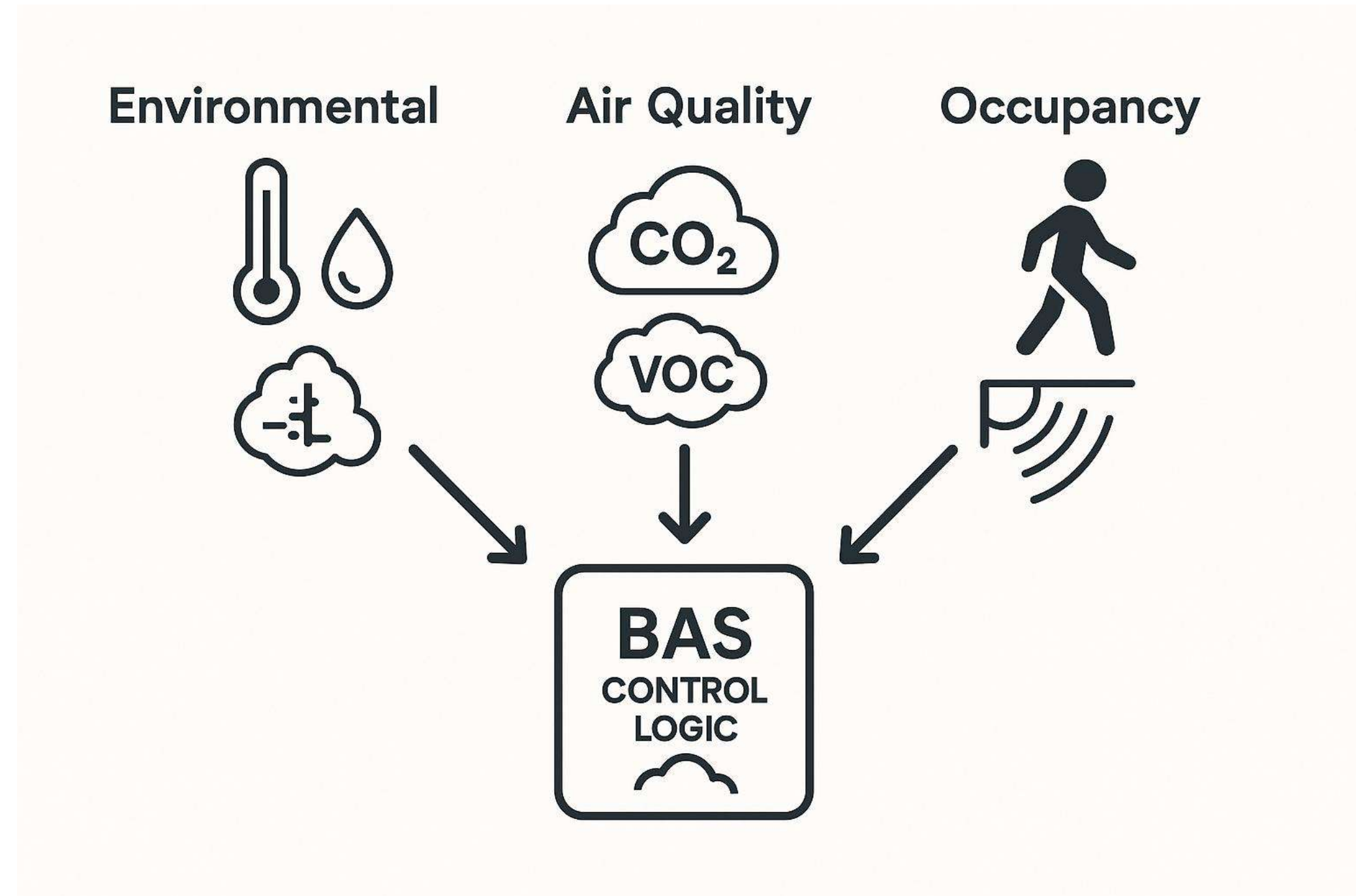


Sensors in EU Policy Frameworks



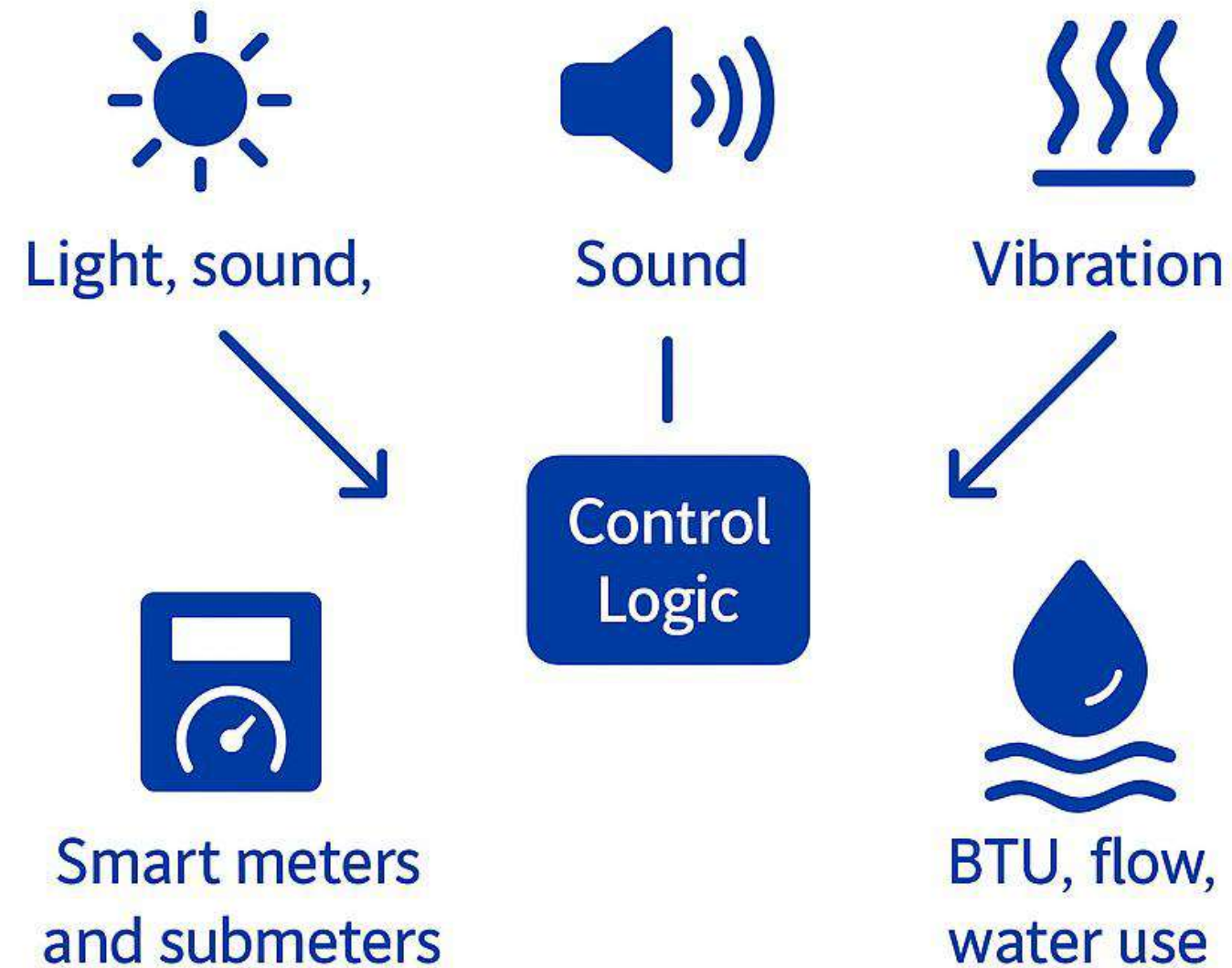
Common Sensor Types in Smart Buildings

- Temperature / Humidity
- CO₂ / VOC / IAQ
- Occupancy / Motion / Presence



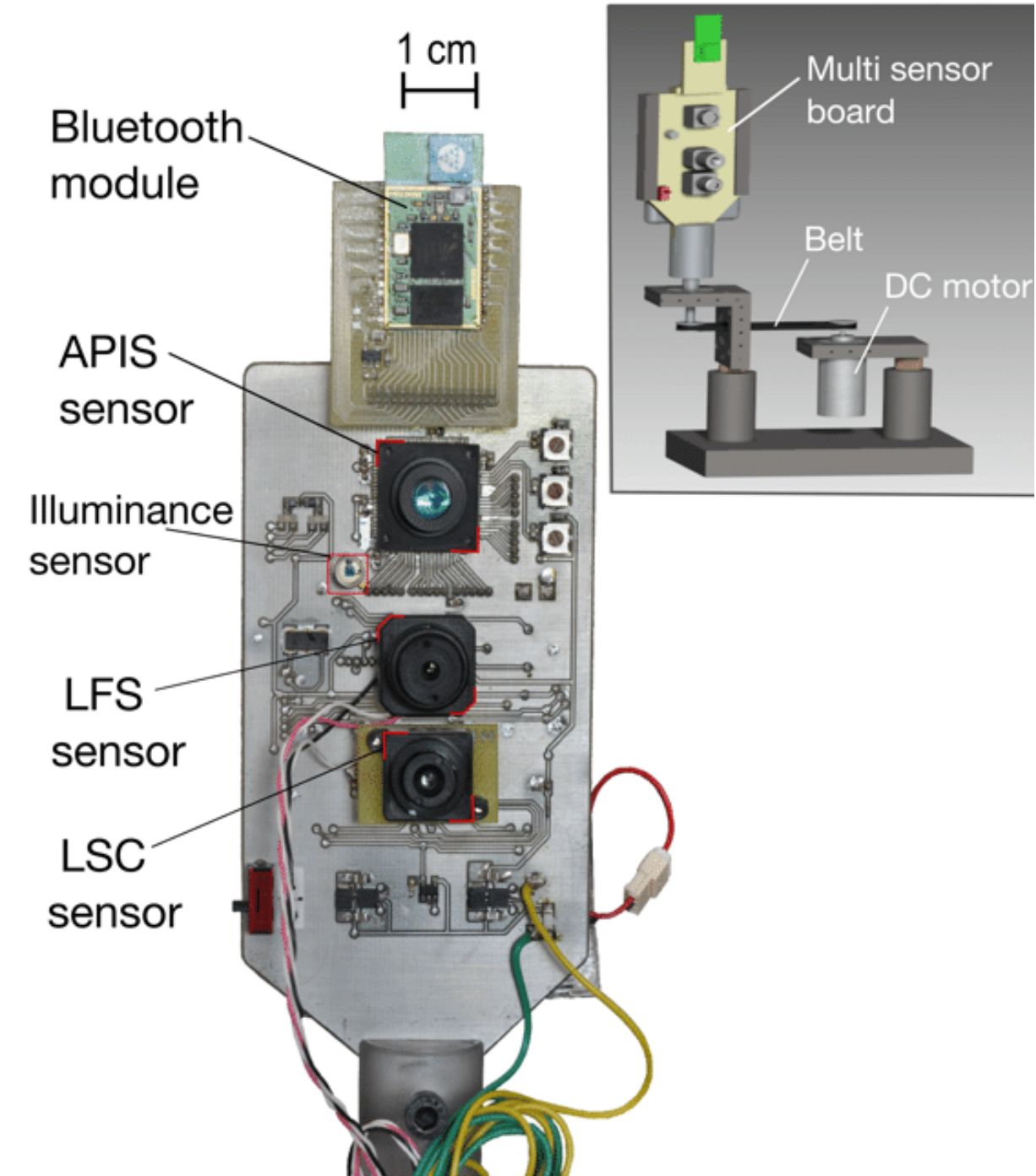
- Light, sound, vibration
- Smart meters and submeters
- BTU, flow, water use

Specialized & Energy Sensors



- Combined: CO₂, temp, motion
- Enable predictive logic
- Reduce installation points

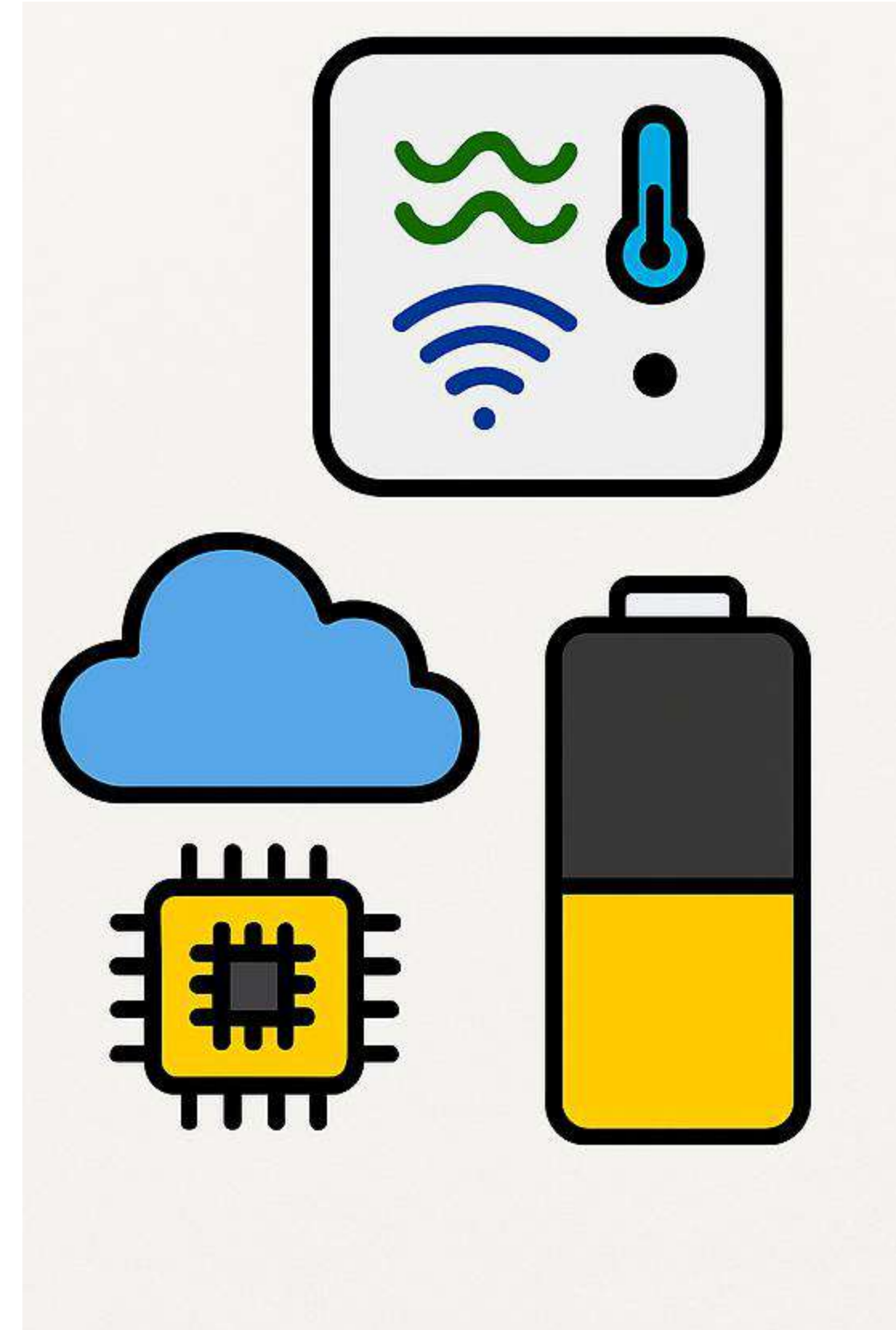
Multi-Sensor Devices



https://www.researchgate.net/figure/The-multi-sensor-PCB-board-includes-three-OF-sensors-an-illuminance-sensor-based-on-a_fig4_232656243

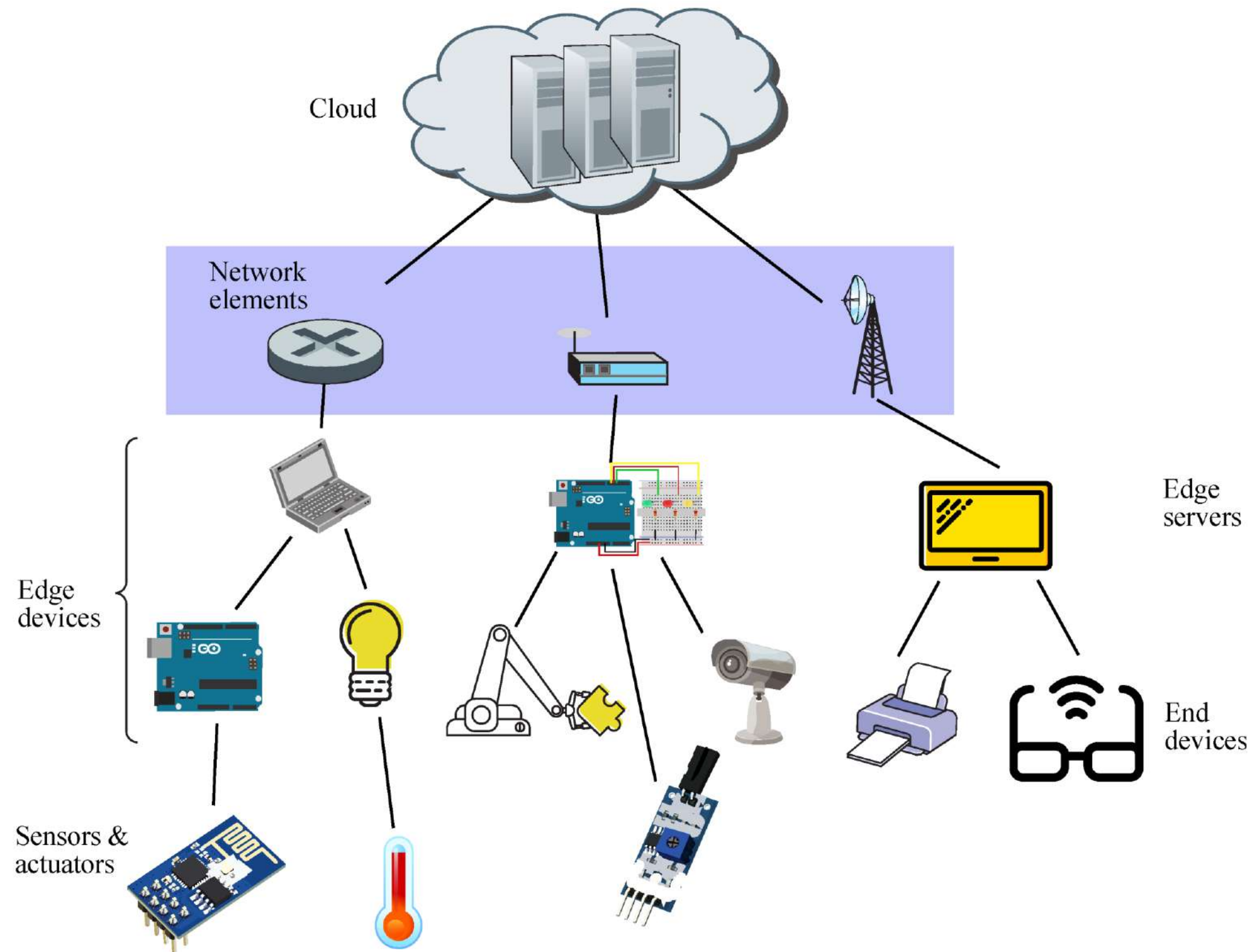
What Makes a Device 'IoT' in Smart Buildings?

- Sensing + communication
- Cloud-ready, edge-aware
- Often wire-free and self-powered



Smart Building IoT Topologies

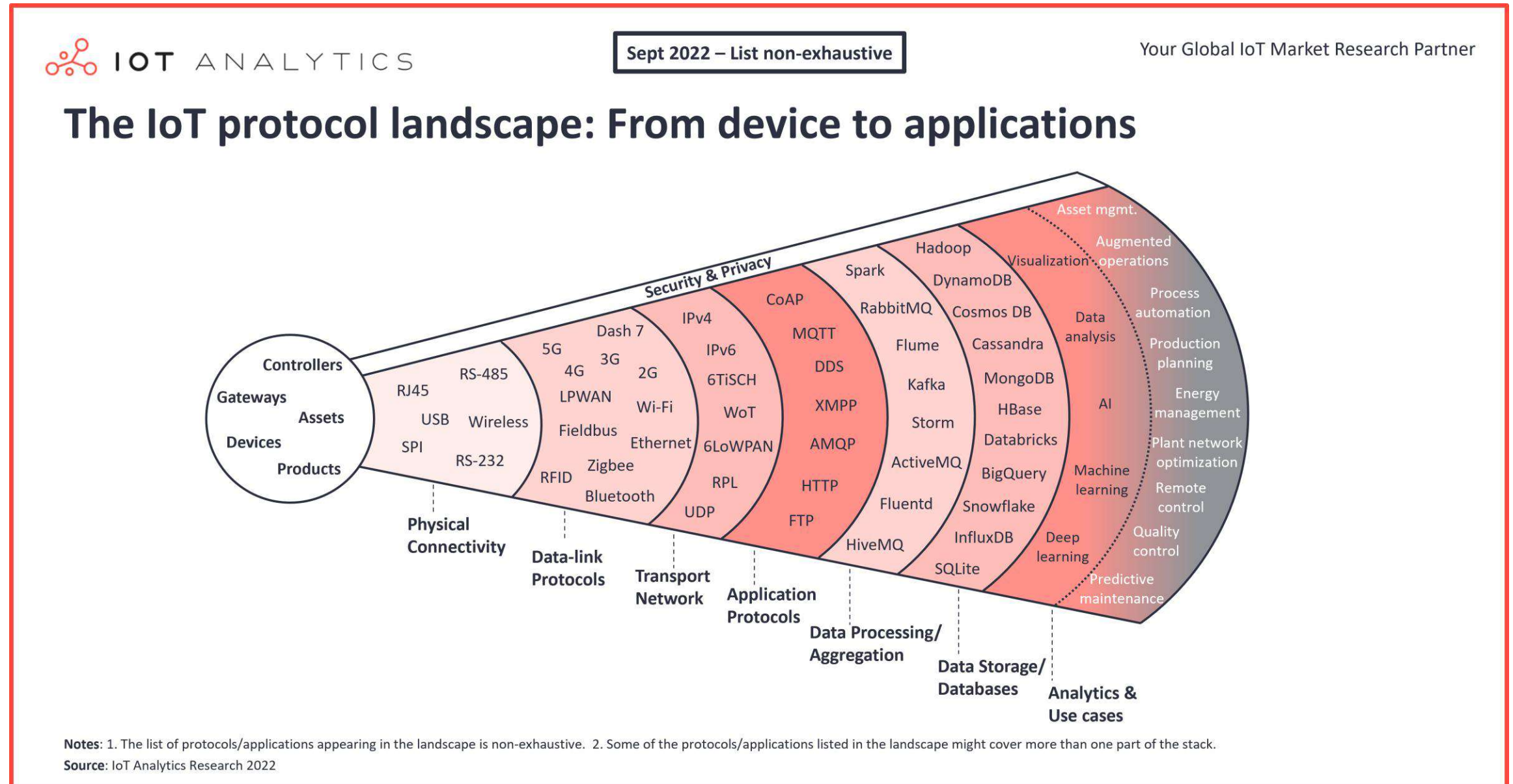
- Edge > Gateway > Server
- Distributed data and control
- Supports zoning and local override



<https://www.mdpi.com/1424-8220/21/21/7276>

- Zigbee: short-range, mesh
- LoRaWAN: long-range, slow data
- BLE / WiFi / Thread trade-offs

IoT Protocol Comparison



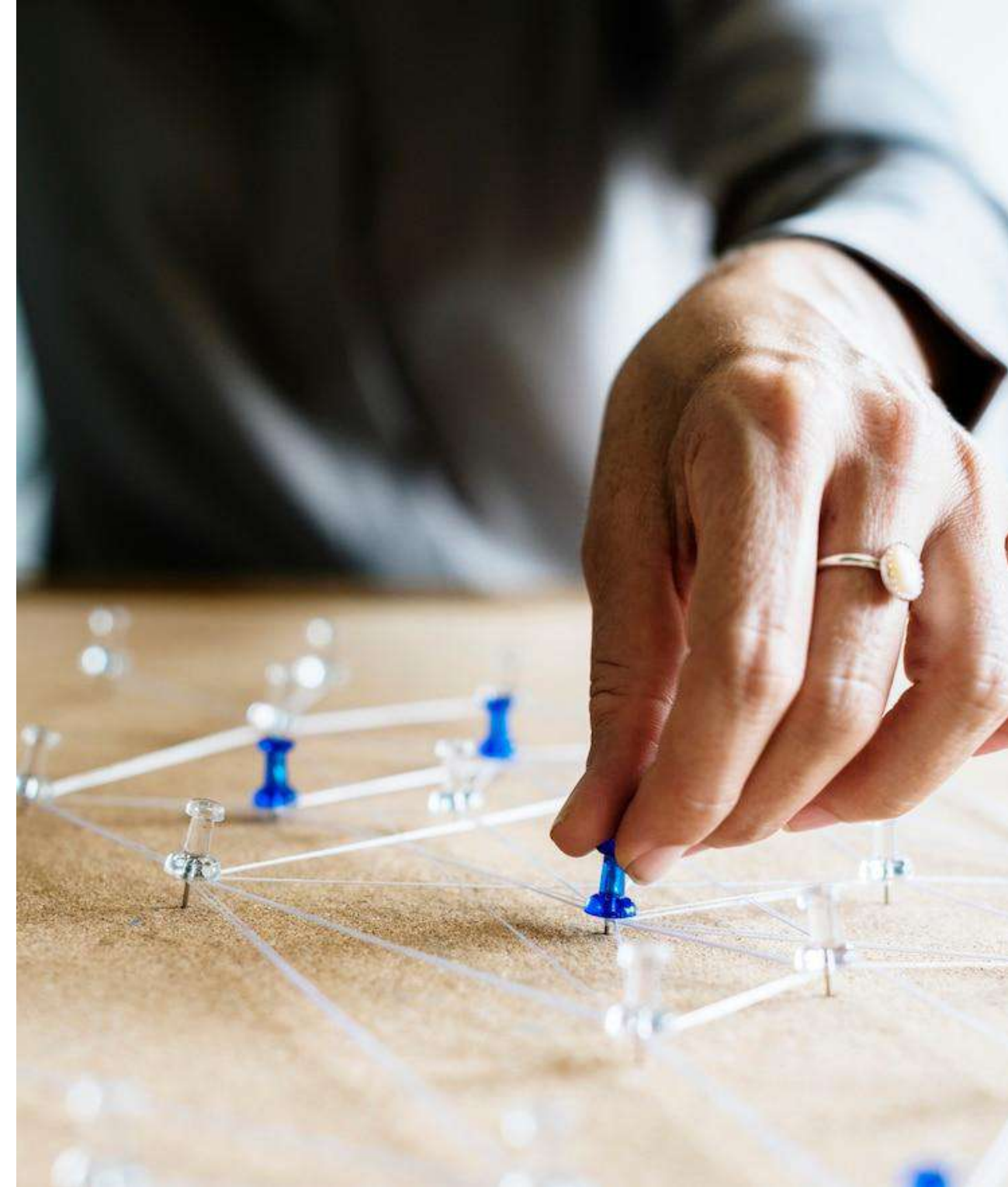
- Authentication, encryption
- Firmware update cycles
- Risk from default credentials

Security in IoT Devices



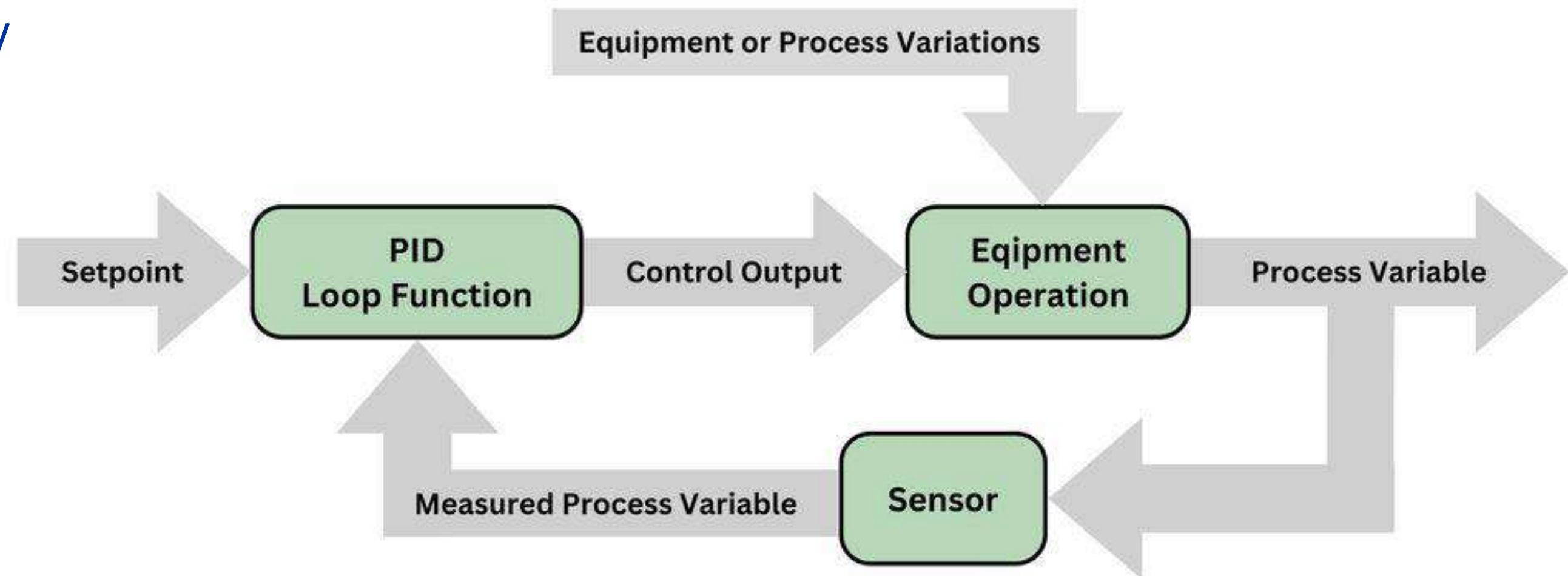
- Rule or logic-based response
- Sensors feed decisions
- Key to ZEB-ready operation

What is a Control Strategy?



Types of Control Logic

- On/Off (bang-bang)
- Schedule / Occupancy
- PID loop tuning



<https://www.wevolver.com/article/pid-loops-a-comprehensive-guide-to-understanding-and-implementation>

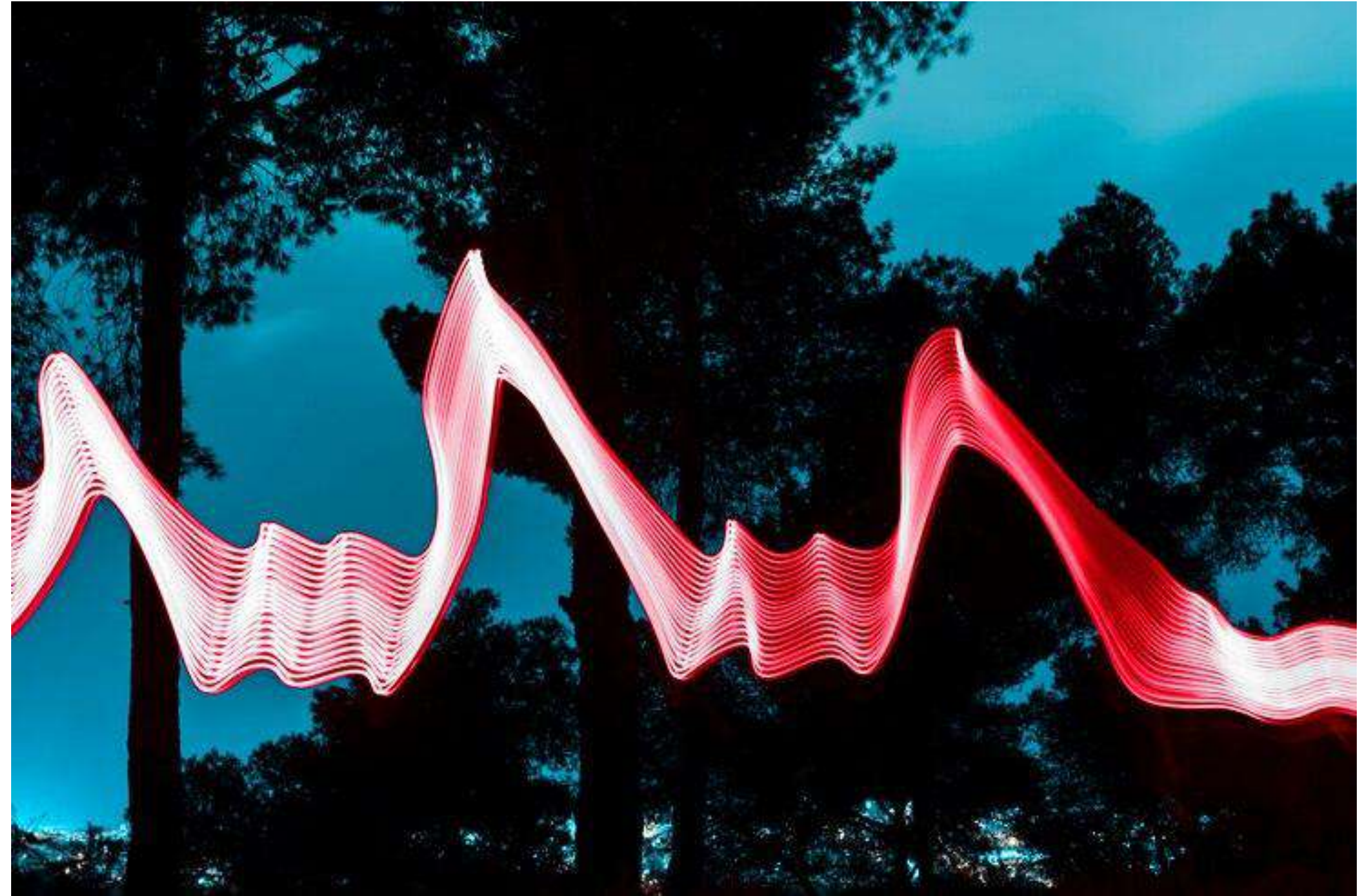
- Each sensor/control link calibrated
- QA pre-checks, field override testing
- Logging and data integration

Tuning and Commissioning



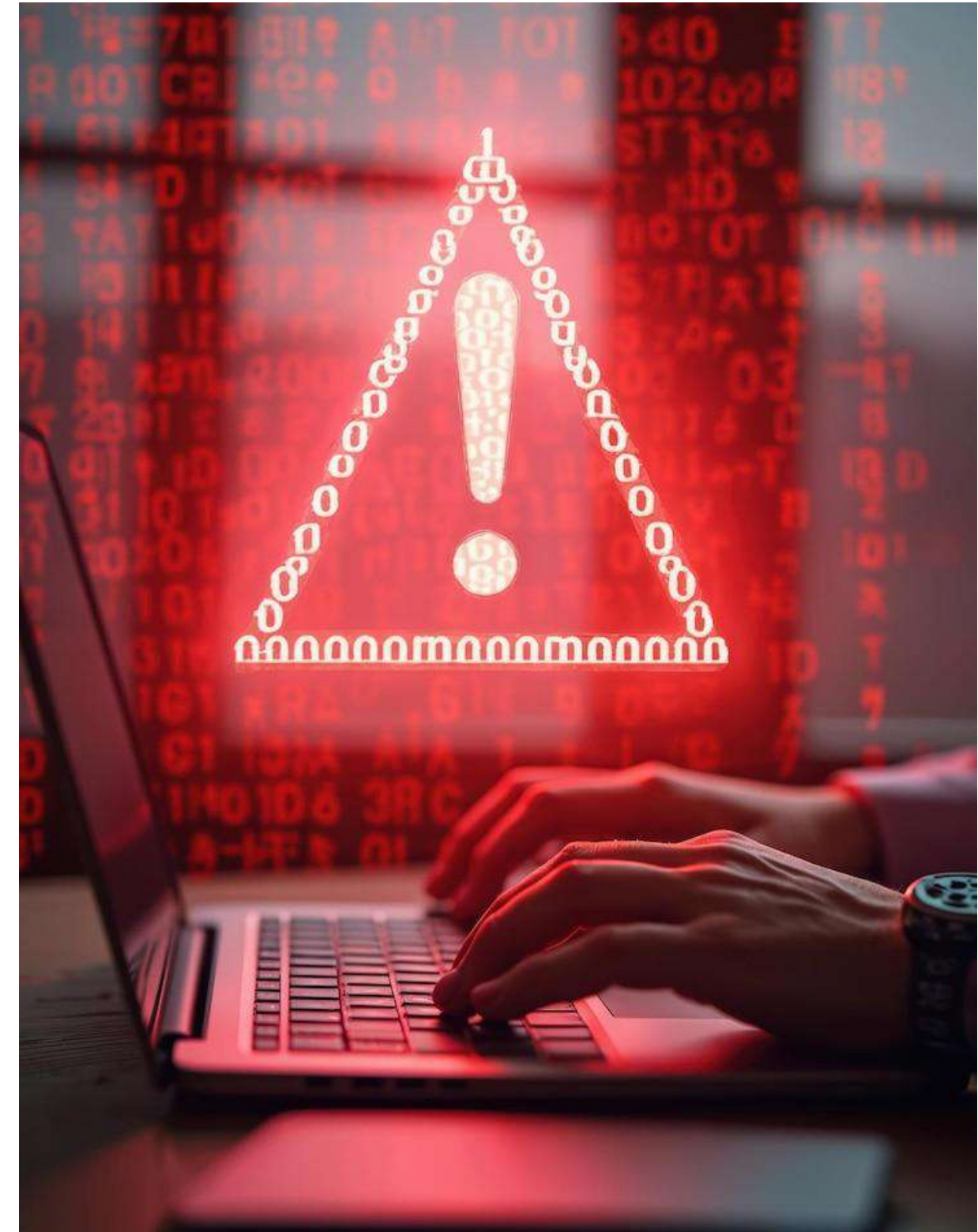
- Manual setpoint changes
- Occupant override loops
- Disconnected logic → inefficiency

Override & Drift Scenarios



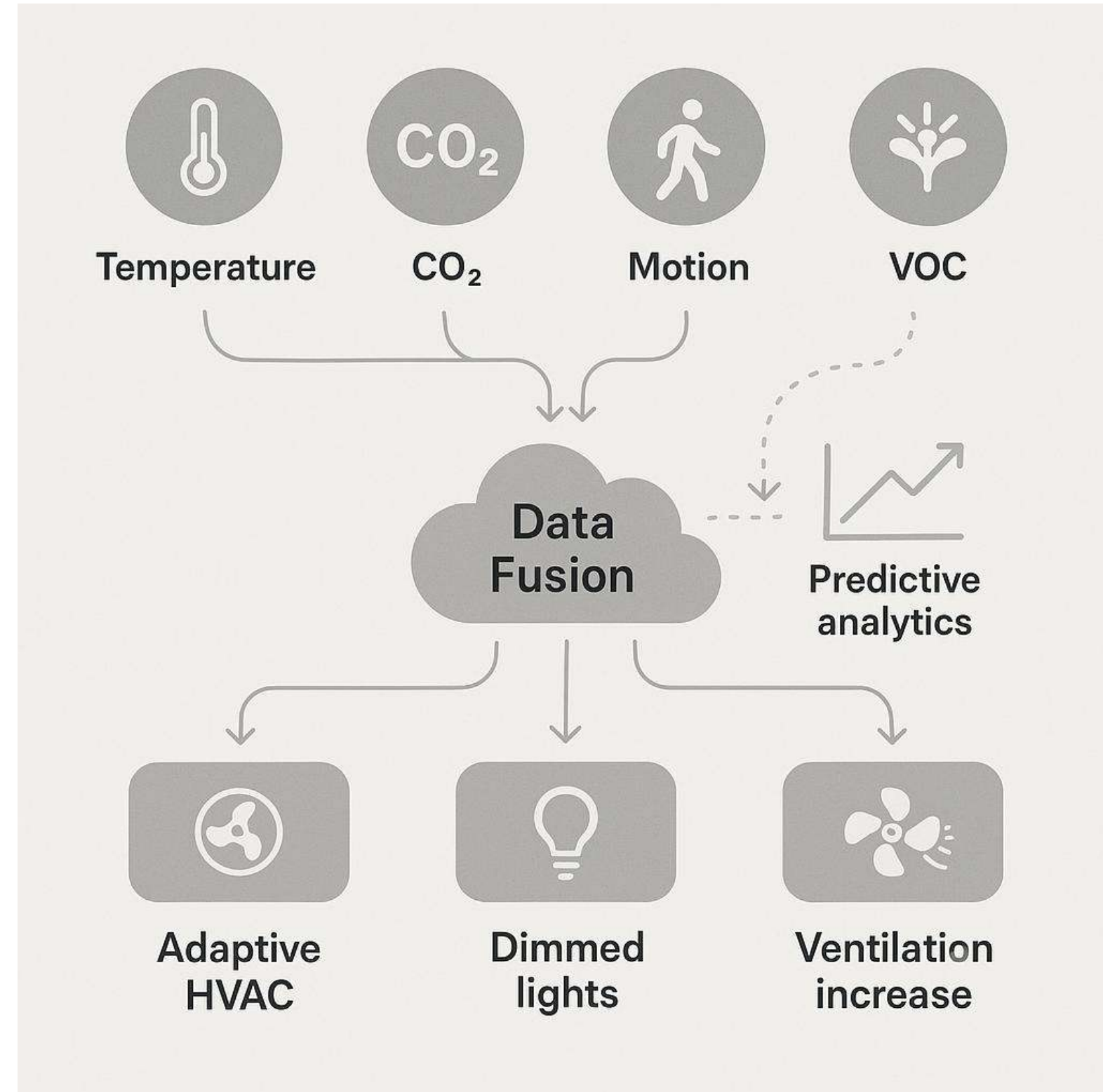
- Sensor drift / misplacement
- Network dropout / stale data
- Firmware bug in actuator response

System Failure Risks



- Combines temp + CO₂ + motion
- Used for adaptive HVAC, lighting
- Basis for predictive analytics

Sensor Fusion → Multivariable Logic



Examples of Fusion in Control

- CO₂ + occupancy → ventilation trigger
- Lux + motion → lighting dimming
- IAQ + thermal → window opening



Conclusion: Reliable Sensing → Reliable Buildings

STEP2CleanPLAN

- Sensors → performance gatekeepers
- Control → balancing comfort + policy
- QA, tuning, security → success



- Where is your biggest sensor risk?
- Which controls fail silently in your region?
- Where can IoT or fusion logic add value?

Reflection Prompts



Long-Term Sensor Drift

- CO₂ sensor baseline rises after 18–24 months
- Humidity sensors drift due to particulate buildup
- Requires scheduled recalibration (1–2 years typical)



Example: Manual Override Causing Energy Waste

STEP2CleanPLAN

- Office user overrides setpoint to 23°C all summer
- BAS fails to revert logic due to access settings
- Energy spike + discomfort in adjacent zones



Sensor Commissioning QA Checklist

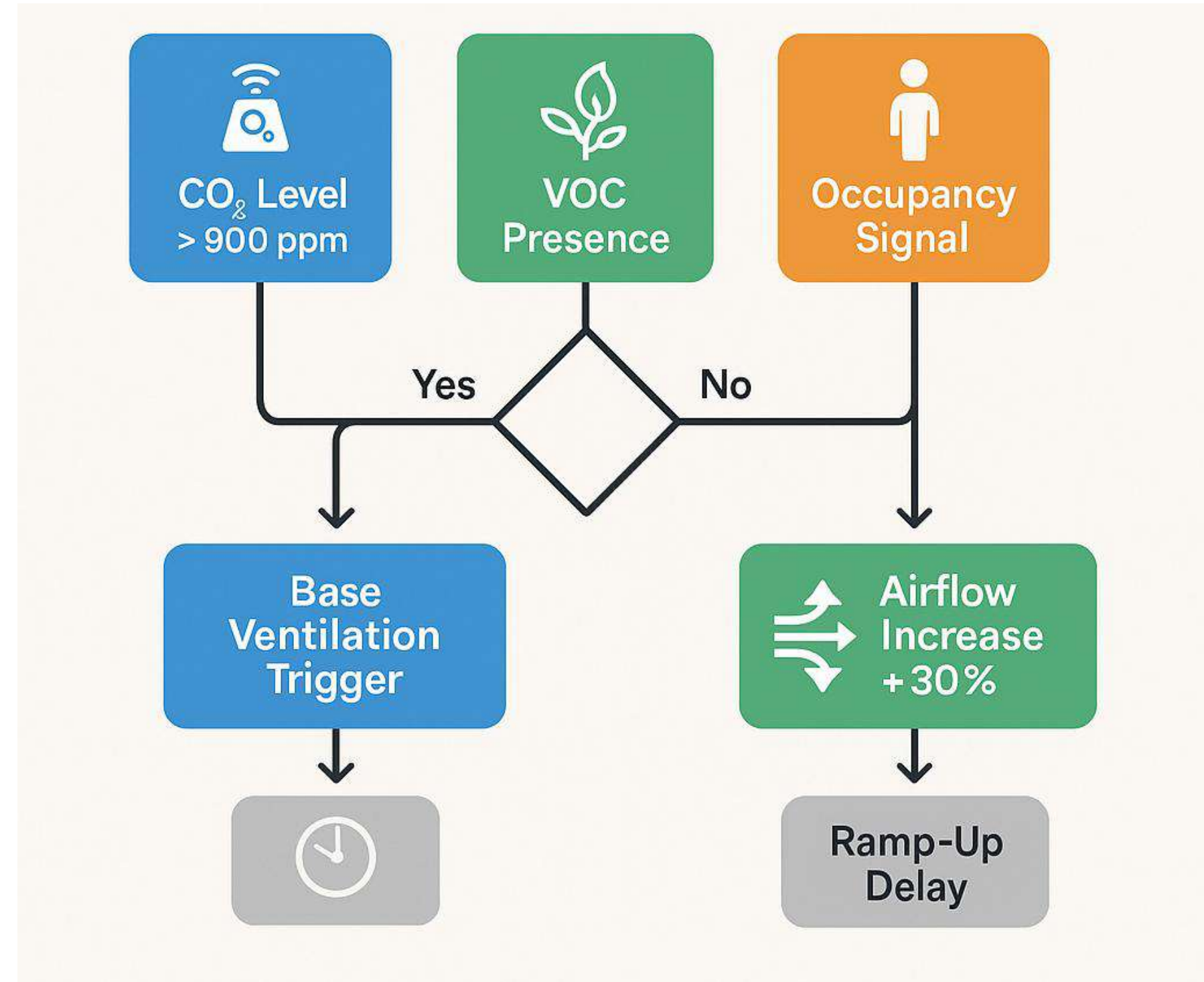
- Checklist: location, label, response time, paired device
- Cross-reference with control input and visual tag
- Trend chart shows baseline test data



Multivariable Fusion: Adaptive Ventilation Logic

STEP2CleanPLAN

- $\text{CO}_2 > 900 \text{ ppm}$ → base ventilation trigger
- VOC detected → add 30% airflow
- Occupancy signal absent → delay ramp-up



Thank you!

Q & A