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Sustainable Energy Connectivity in Central Asia

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The European Union – Turkmenistan Sustainable Energy Days

Lectures for faculty members and students of the State Energy Institute of Turkmenistan

State Energy Institute of Turkmenistan, Mary, 15 December 2023

What goes beyond the energy efficiency in the building sector?

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Expert in energy efficiency
SECCA

Stantec | intec MEMBER OF GOPA CONSULTING GROUP | ACTED | European University Institute | Robert Schuman Centre for Advanced Studies | FSR ENERGY Florence School of Regulation

WHY WE SHOULD CARE ABOUT THE ENERGY IN BUILDINGS?

90% of our lives we spend inside of the buildings

The Indoor comfort of the building influences **occupants' productivity and health.**

30% of global energy consumption is due to the need of buildings

26% of global energy-related emissions are related to buildings

20-50% of energy consumption could be reduced if best practices would be adopted

Investment in energy-efficient buildings can **stimulate economic growth and create jobs.** The construction and renovation of buildings create new employment opportunities.

Energy in buildings is a **research topic** as it merges innovation, sustainability, and efficiency to create healthier, cost-effective, and environmentally responsible living and working spaces.

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THE OUTLINE OF PRESENTATION

① ENERGY EFFICIENCY IN BUILDINGS

② ENERGY PERFORMANCE OF BUILDINGS

③ NEAR ZERO ENERGY BUILDINGS

④ BUILDING LIFE CYCLE ANALYSIS

⑤ BUILDING DECARBONISATION AND ZERO-EMISSION BUILDING

⑥ SUSTAINABLE BUILDINGS

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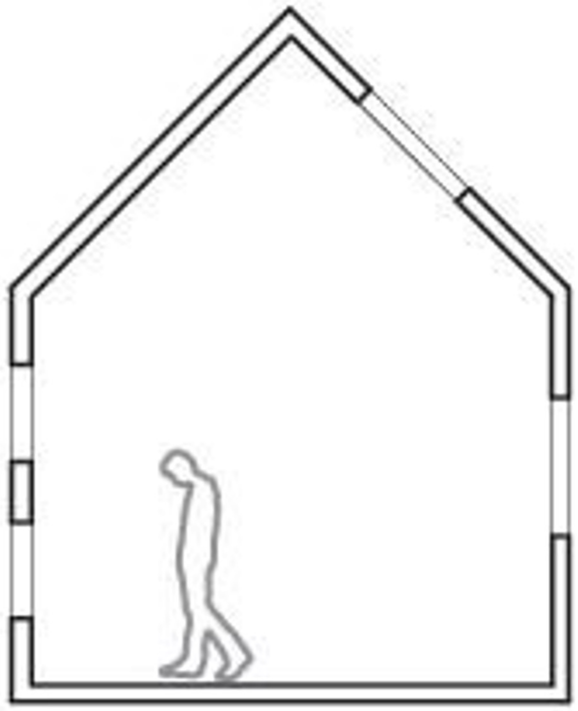

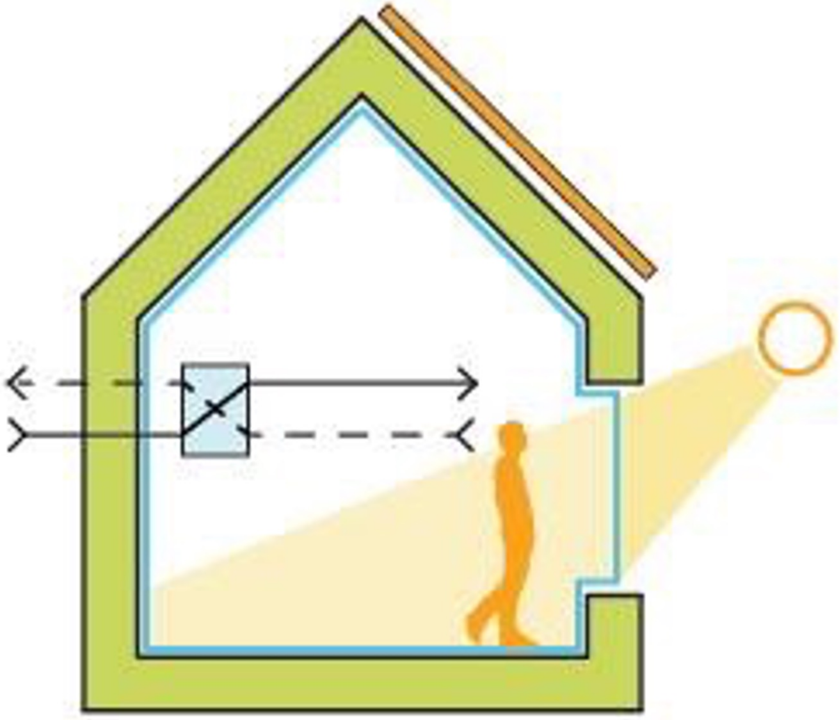

ENERGY EFFICIENCY IN BUILDINGS

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ENERGY EFFICIENCY IS UNDERSTOOD AS A METRIC WHICH IS USED TO TRACK THE IMPROVEMENT

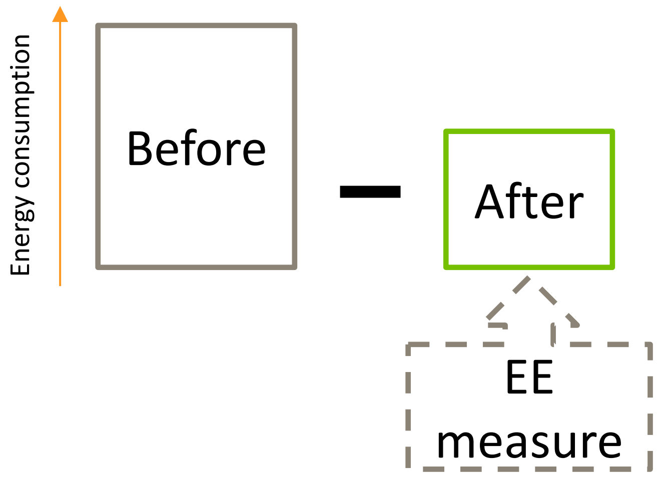
ENERGY EFFICIENCY =

$$\frac{\textit{performance, service, goods or energy}}{\textit{energy}}$$

ENERGY EFFICIENCY IMPROVEMENT an increase in ***energy efficiency*** as a result of measures in:

- *Technological;*
- *Behavioural;*
- *Economic aspects.*

ENERGY SAVINGS =



energy efficiency first principle means prioritizing the use of less energy before considering how to increase energy supply, by improving how energy is used and delivered, in a cost-effective way that still meets energy goals.

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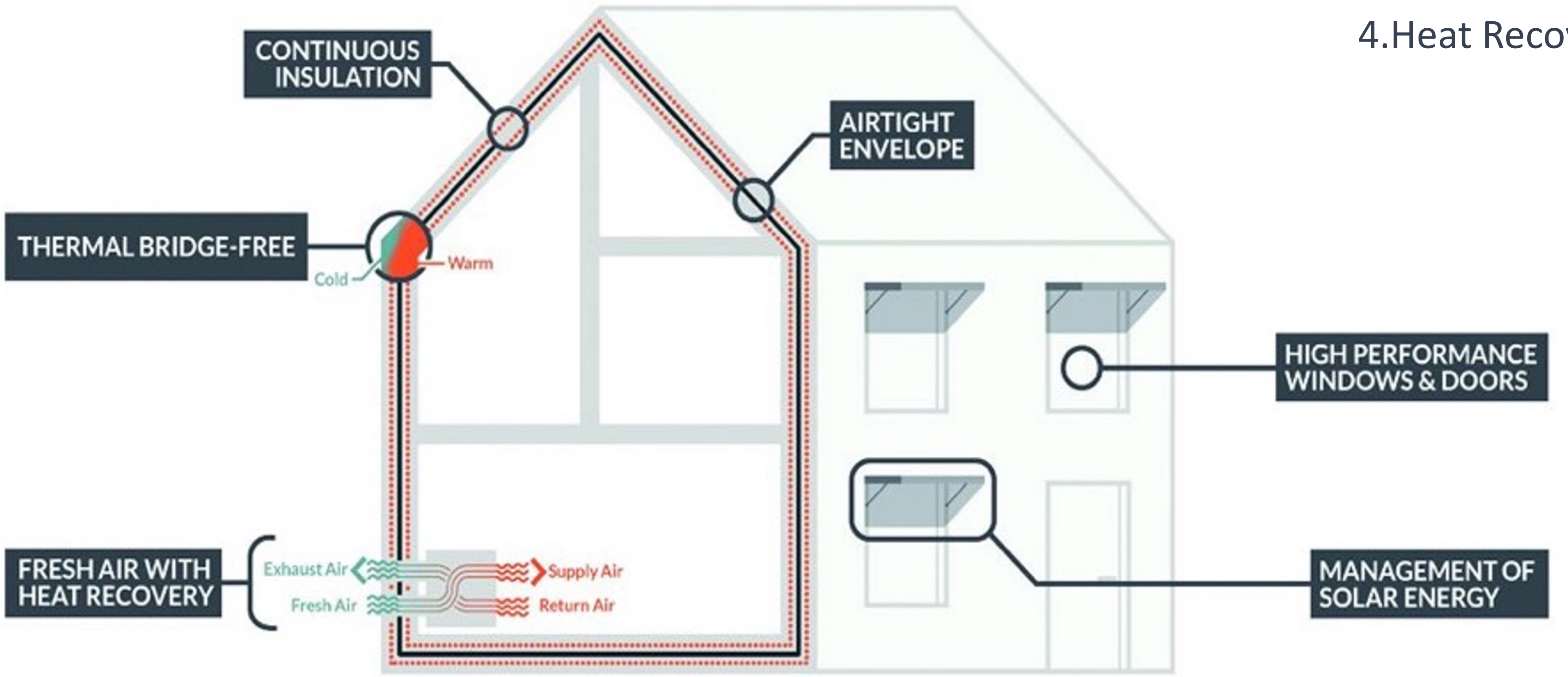
THE MAIN PRINCIPLES – HOW ENERGY CONSUMPTION COULD BE REDUCED FOR ENSURING INDOOR COMFORT

As building consumes energy due to the need to cover heat losses or remove surplus of heat – if the heat exchange with environment is reduced, that leads to EE improvement.



For Cold ❄️ Climate:

1. Superior Insulation
2. Triple-Glazed Windows
3. Thermal Bridge-Free Construction
4. Heat Recovery Ventilation

For Hot 🌡️ Climate:

1. Shading and Glazing
2. Thermal Mass
3. Natural Ventilation
4. Reflective Exterior Surfaces

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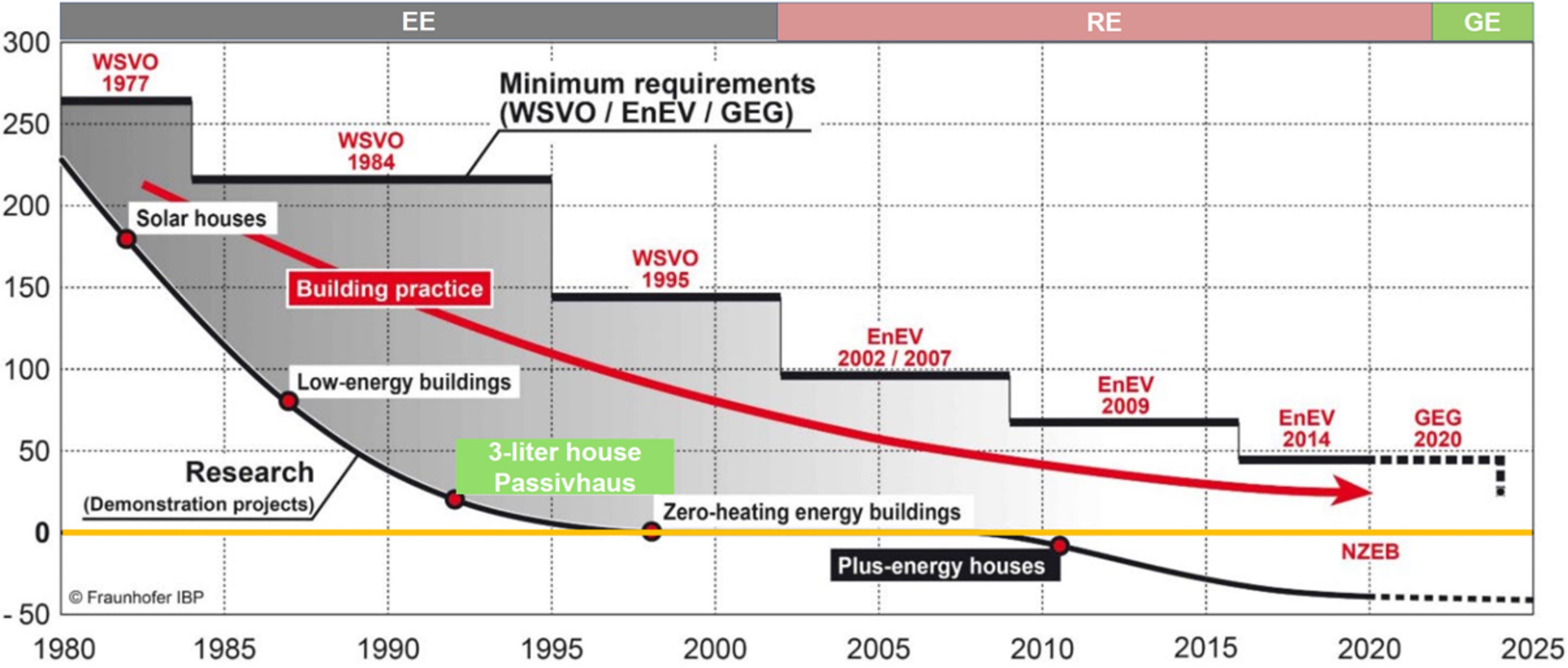
THE DEVELOPMENT IN GERMANY – ENERGY EFFICIENCY WAS SEEN AS PRE-REQUISITE FOR INTRODUCING ANOTHER CONCEPTS



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EE: CHALLENGES OF APPLICATION

1.Regulatory Complexity: Ineffective policies and diverse priorities among EU member states hinder uniform energy efficiency strategies (Fotiou et al., 2022; von Malmborg, 2022).
2.Data Accessibility: Legal and technical challenges in accessing building-related energy data impede informed decision-making for energy efficiency (Geissler et al., 2019).
3.Market Barriers: Limited market development for energy efficiency technologies and services, coupled with consumer distrust or lack of understanding (Camarasa, 2019; Labanca et al., 2015).
4.Quality Assurance: Need for improved quality management in energy performance contracting projects (Kamenders et al., 2018).
5.Public Building Constraints: Unique challenges in enhancing energy efficiency in public buildings, such as bureaucratic hurdles and specific infrastructure needs (Fogheri, 2015).
6. Operation Management Efficiency: Gaps in the effective management and operation of building systems, as highlighted by long-term monitoring data (Motuziene, 2022).
7.Consumer Behavior: Overcoming market dynamics and consumer behavior to unlock energy savings potential in buildings (Tuominen et al., 2012).

EE: WHERE THE RESEARCH IS GOING

1. **Energy-Efficient Retrofitting**: Exploring sustainable retrofitting methods for existing buildings to enhance energy efficiency (Sümer Coşkun & Arslan Selçuk, 2022).
2. **Optimizing Building Energy Performance**: Evaluating and improving energy performance in both new and existing buildings (Yudin et al., 2022).
3. **Advanced Systems for Buildings**: Investigating innovative technologies and systems for enhancing energy efficiency in new constructions and rehabilitations (Gómez Melgar & Andújar Márquez, 2022).
4. **Energy Modeling in HVAC Systems**: Developing predictive models and controls for HVAC systems to optimize energy use (Kim et al., 2022).
5. **Remote Sensing for Energy Efficiency**: Using imagery and temperature data for estimating building energy efficiency on a large scale (Benelli, 2023).
6. **Energy-Smart Building Construction**: Designing and constructing buildings with integrated energy-efficient solutions (Lamb & Pollet, 2020).
7. **Semantic Interoperability in Building Systems**: Focusing on advanced control systems and data integration for energy performance optimization (Benndorf et al., 2018).

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ENERGY PERFORMANCE OF BUILDINGS

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ENERGY PERFORMANCE

'**energy efficiency**' means the ratio of output of performance, service, goods or energy, to input of energy

$$\text{energy efficiency} = \frac{\text{Final energy}}{\text{Function}}$$

+ Origin of energy

+ Renewable energy integration

+ **Inform the users**

+ fixed conditions for comparison

'**energy performance of a building**' means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, among other things, energy used for heating, cooling, ventilation, hot water and lighting

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ENERGY PERFORMANCE CERTIFICATION SHOULD BE UNDERSTOOD AS RATING SYSTEM GIVING MARK FOR A BUILDING FOR THE PERFORMANCE

ENERGY PERFORMANCE CERTIFICATION is a rating* scheme to summarize and express the performance of the building in a simplified way.

ENERGY PERFORMANCE CERTIFICATE (EPC) is a document that shows the energy performance of a building. It provides information on the building's energy consumption (calculated or measured), and additional information like carbon dioxide emissions, and gives indicative recommendations on how to improve its energy performance

*__Rating__ could be understood as a marking system used in school:

10 (A) – the best

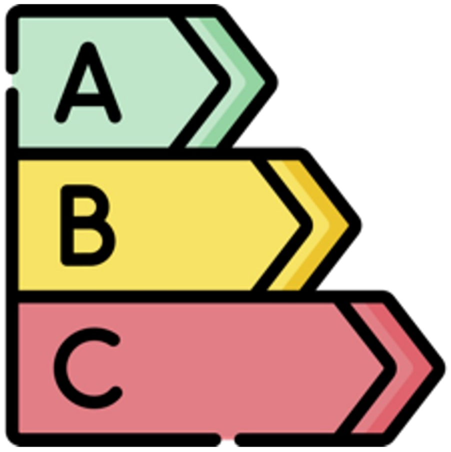
….

….

1/10 (G) – the worst

To have a rating for building performance, we should define:

- **What criteria or values the best performer should satisfy**
- **What are the minimum requirements to be acceptable?**
- **When is the lowest rating assigned?**



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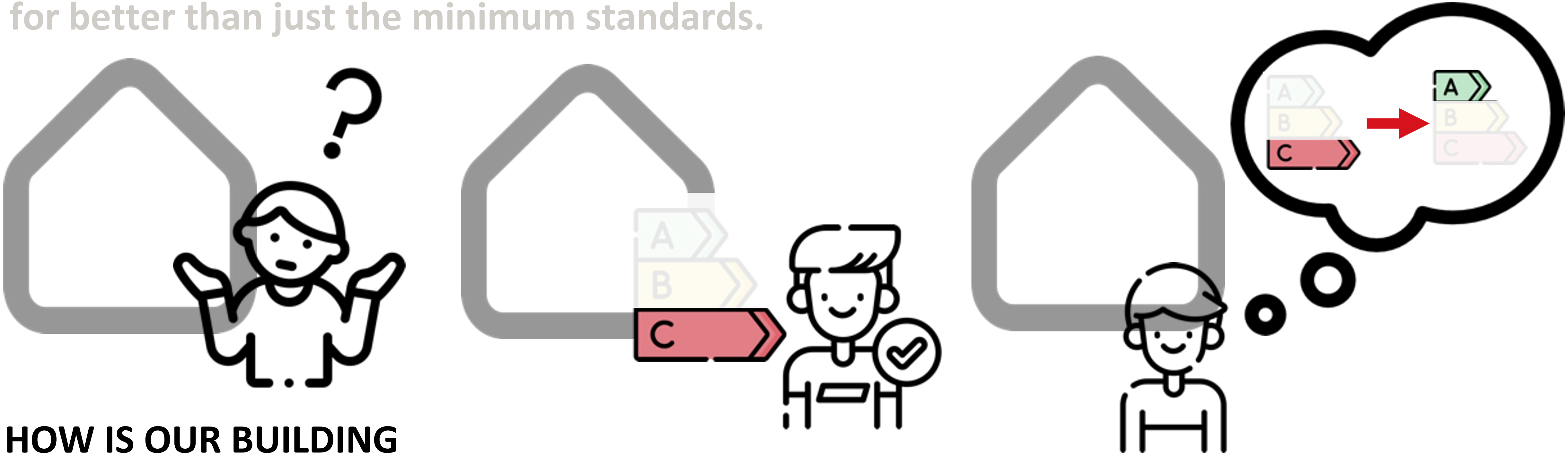
ENERGY PERFORMANCE CERTIFICATES MAKE BUYERS AND OWNERS LIVES EASIER BY INFORMING THEM ABOUT THE STATE OF THE BUILDING

Energy Performance Certificates (EPCs) make it easier to understand how good in terms of energy consumption the building is. They help customers know more and aim for better than just the minimum standards.



HOW IS OUR BUILDING PERFORMING?

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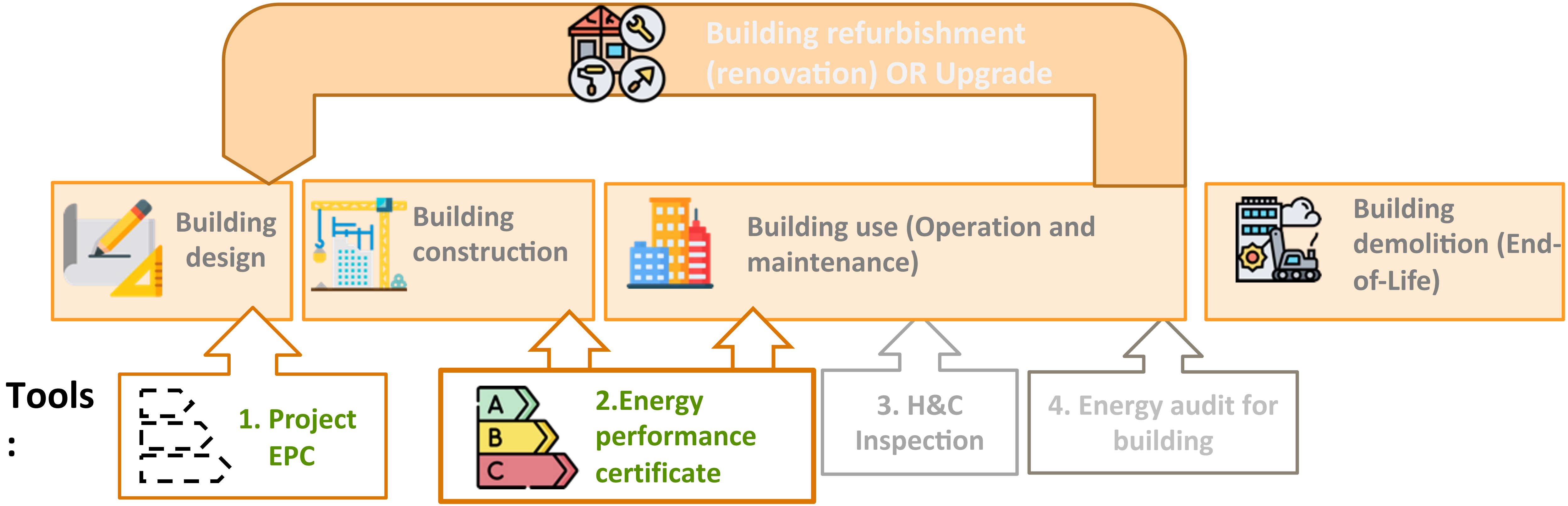
ENERGY PERFORMANCE CERTIFICATION HELPS TO SET AND CORRECT THE COURSE OF BUILDING PERFORMANCE IN ITS LIFE CYCLE



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EPC HELPS TO UNDERSTAND THE NATIONAL BUILDING STOCK AND ITS PERFORMANCE

ESTABLISH THE BRIGHTER PICTURE OF THE SITUATION IN THE BUILDING STOCK

Identifying Renovation Priorities: Pinpoint less energy-efficient buildings/areas for prioritized renovations.

Tailoring Regional Strategies: Address specific energy efficiency needs and challenges of different regions..

Protect Vulnerable Consumers: Identify regions at risk of energy poverty and develop support measures.

Develop Renovation Strategies: Forecast future energy demands and prioritize renovation areas.

Evaluate Policy Impact: Monitor changes in EPC ratings to assess policy effectiveness

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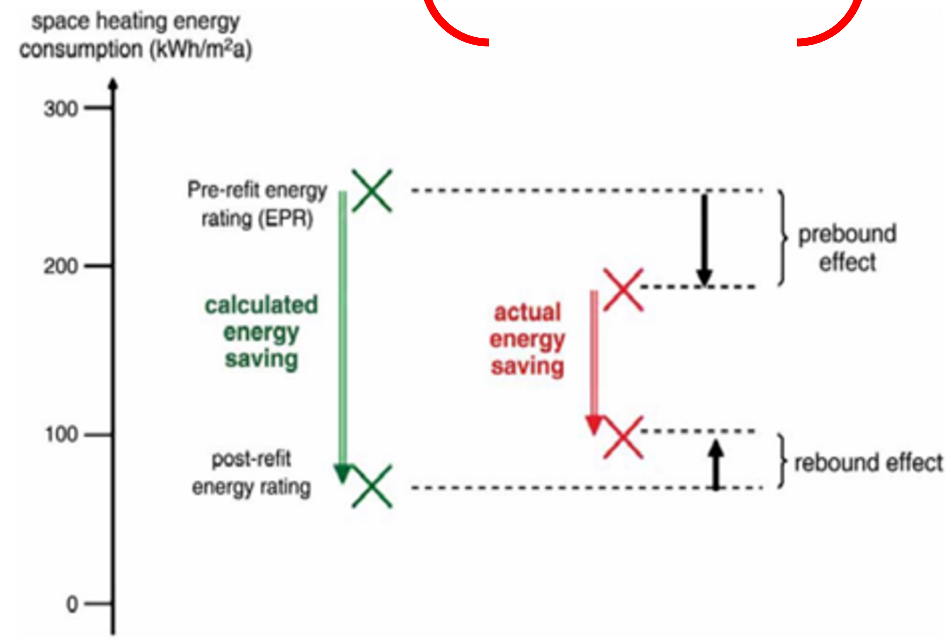
SAMPLE PROBLEM: ENERGY PERFORMANCE GAP

ENERGY PERFORMANCE GAP = Design and Prediction + Deviation during the construction + Deviations in operation and maintainance



Design and Prediction
- Limitations of the prediction method
- Uncertainties in the data and method
- Incomplete information

Deviation during the construction
- Changes during the construction
- Deviation between declared and actual performance
- Defects and quality issues

Deviations in operation and maintainance
- Different operation than predicted
- Inappropriate maintenance

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EPB: CHALLENGES OF APPLICATION

1. **Integration Issues**: Difficulties in integrating smart energy performance platforms, as discussed by Polychroni et al. (2023)
2. **Labeling vs. Efficiency Paradox**: Inconsistencies between energy labels and actual efficiency, highlighted by Macarulla and Casals (2021)
3. **Inadequate Assessment Frameworks**: The need for advanced frameworks to assess building energy performance, as emphasized by Koltsios et al. (2022)
4. **Label Design Impact**: The influence of energy label design on effectiveness, demonstrated by Fujisawa et al. (2020).
5. **Transparency and Optimization Issues**: Challenges in achieving transparency and optimizing energy ratings, discussed by Nadkarni (2012)

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EPB: WHERE THE RESEARCH IS GOING

1. **Future Directions in Building Energy Performance**: Hazem Rashed-Ali (2021) explores evolving methods and future trends in building energy performance.
2. **Advanced Energy Performance Certificates**: Koltsios et al. (2022) discuss the development of next-generation frameworks for building energy performance certification.
3. **Regional Energy Performance Certification Trends**: Samira Akbarova (2018) examines energy performance certification trends in Azerbaijan, offering regional insights.
4. **Smart Energy Performance Assessment Platforms**: Polychroni et al. (2023) focus on smart platforms for more efficient energy performance assessment in buildings.
5. **Energy Labeling in Commercial Buildings**: Kelli Soll and John F. Gardner delve into energy performance labeling challenges specific to the commercial sector.
6. **Semantic Interoperability in Energy Performance**: Gesa A. Benndorf et al. (2018) review the impact of semantic interoperability on building energy performance optimization.
7. **Energy Benchmarking Policies**: Luming Shang et al. (2023) assess how energy benchmarking and disclosure policies affect the marketability of office buildings.

NET ZERO ENERGY BUILDINGS

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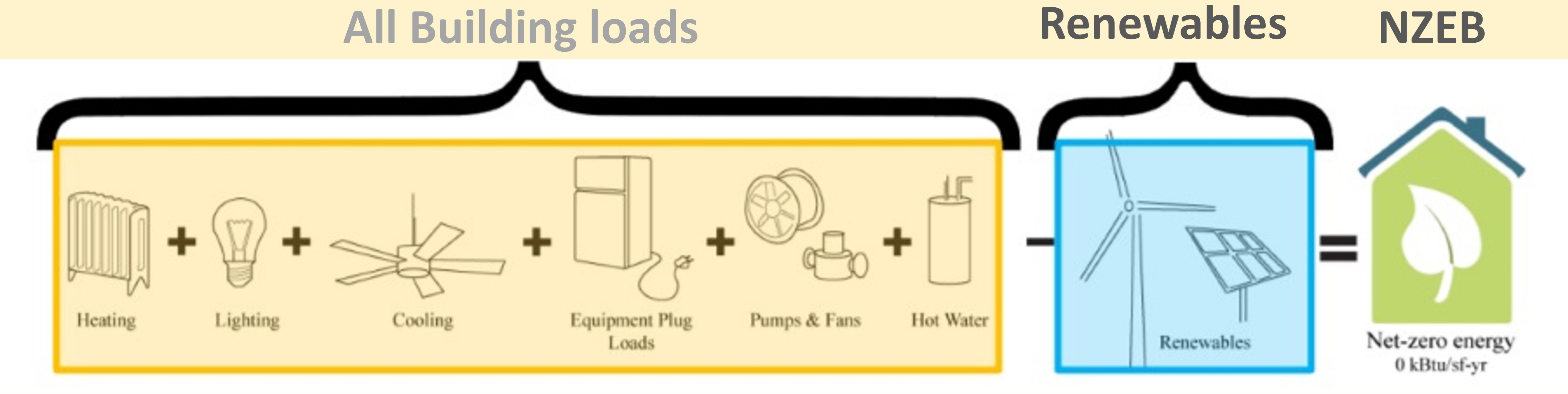
NEAR ZERO ENERGY BUILDINGS

② **ENERGY PERFORMANCE OF BUILDINGS**

‘**nearly zero-energy building**’ means a very high-energy performance building. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;



③ **NEAR ZERO ENERGY BUILDINGS**

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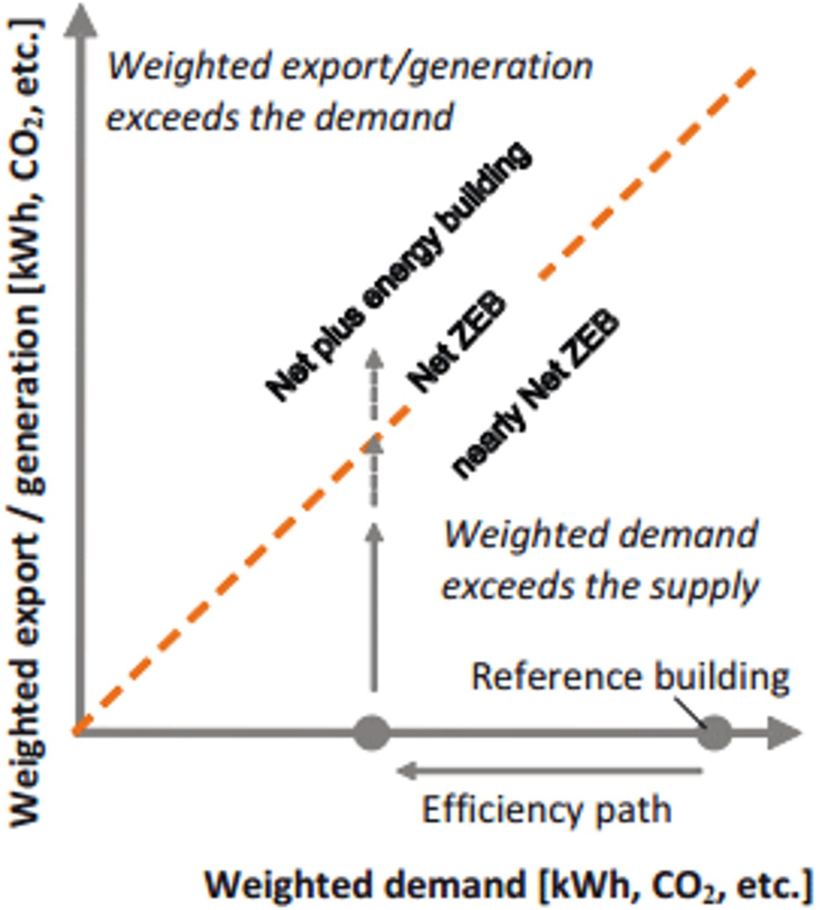
THE PRINCIPLE OF DEMAND COMPENSATION WITH RENEWABLE ENERGY SOURCES



When Energy efficiency plays its part and energy demand is reduced, the generation from renewable sources can be added.

Depending on the demand side, renewable energy sources could cover it partially or fully

If the demand is minimized and renewable energy generation fully covers it and produces a surplus – it can be used for other demands or sold

The challenge is to optimize the overall solution to ensure that the final result is cost-effective and cost-optimal

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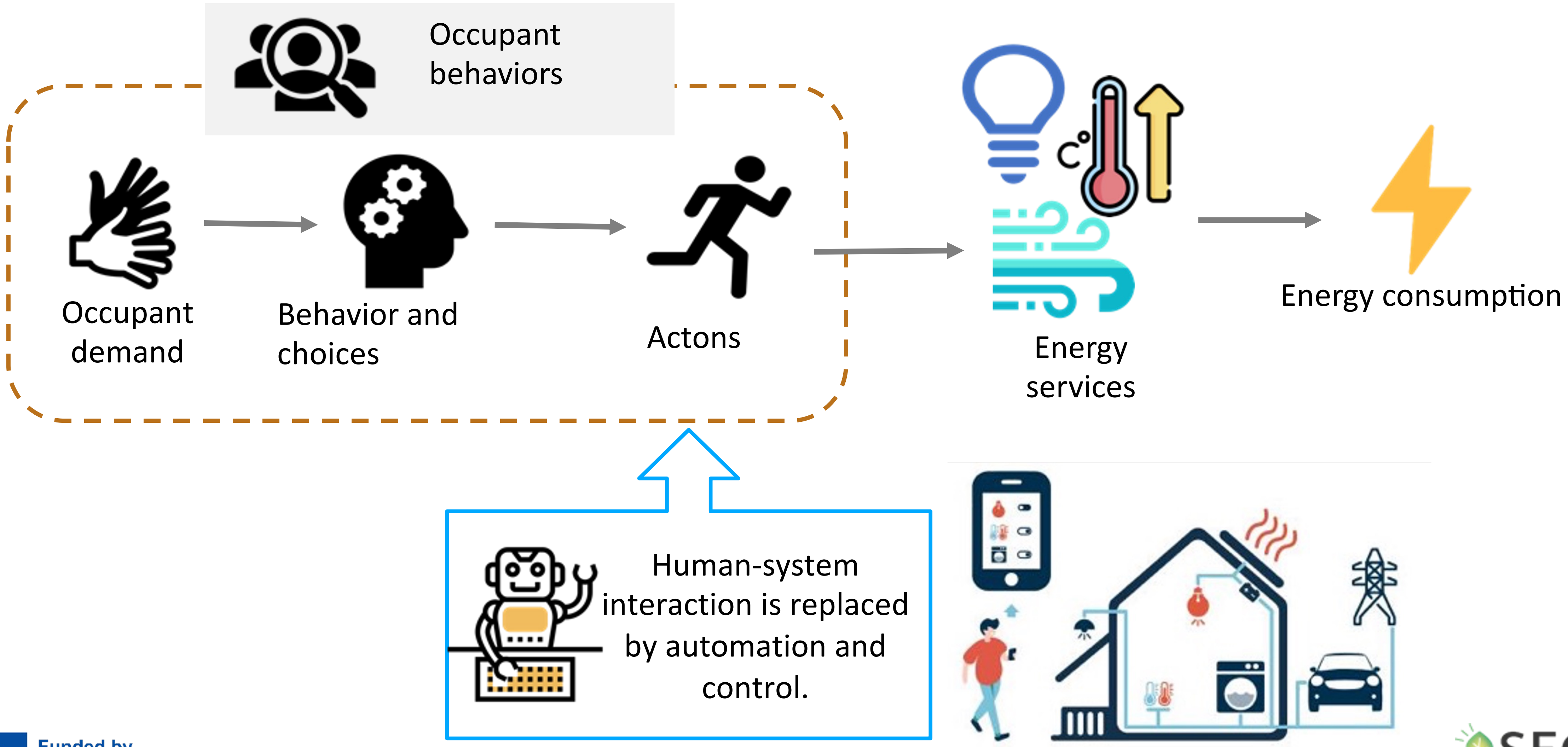
SAMPLE PROBLEM: OCCUPANT BEHAVIOR & BUILDING AUTOMATION AND CONTROL IMPACT



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NZEB: CHALLENGES OF APPLICATION

1. **Renovation Complexity**: Upgrading existing buildings to zero-energy standards involves significant challenges in coordination and communication, especially in diverse European residential contexts (Prieto & Konstantinou, 2023).
2. **Technological and Skill Gaps**: Transitioning from traditional to net-zero energy buildings requires overcoming technological hurdles, high costs, and a shortage of skilled professionals (Salem & Elwakil, 2023).
3. **Solar Energy Integration**: The feasibility of incorporating solar energy into nearly zero-energy buildings is challenged by local climate conditions, design limitations, and integration issues (Ho, 2023).
4. **Aesthetic Considerations**: Balancing the efficiency of photovoltaic systems with aesthetic appeal in building designs remains a significant challenge (Basher et al., 2023).
5. **Energy Management with IoT**: Efficient energy management in connected buildings through IoT systems faces hurdles in technology, scalability, and reliability (Gao et al., 2022).

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NZEB: WHERE THE RESEARCH IS GOING

1. **Indoor Air Quality**: Studies focus on the risk of fungal growth in nZEBs, emphasizing the importance of maintaining healthy indoor environments (Carpino et al., 2023).
2. **Climate-Responsive Design**: Research addresses the challenge of optimizing nZEBs in extreme climates, like hot summers and cold winters (Wang Suqi et al., 2023).
3. **Emerging Technologies and Methods**: A bibliometric analysis identifies evolving technologies and methodologies in ZEB research (Jia Wei et al., 2023).
4. **Life-Cycle Analysis**: The focus is on the long-term performance and sustainability of nZEBs, considering life-cycle impacts (Di Sun, 2023).
5. **Renewable Energy Integration**: Research emphasizes the integration of solar energy systems as a key strategy for achieving zero energy in buildings (Kasaeian & Sarrafha, 2021).
6. **Real-World Impact**: Studies assess the actual energy and carbon costs of net-zero energy buildings to evaluate their environmental impact (Miranda L. Vinay, 2022).

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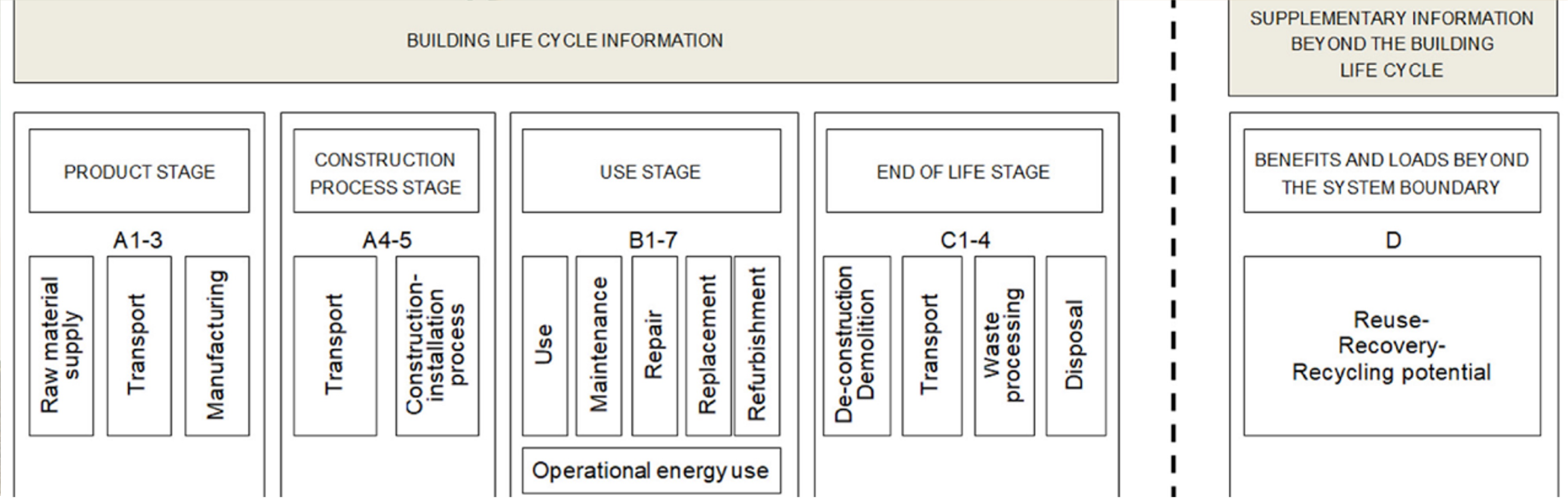

BUILDING LIFE CYCLE ANALYSIS

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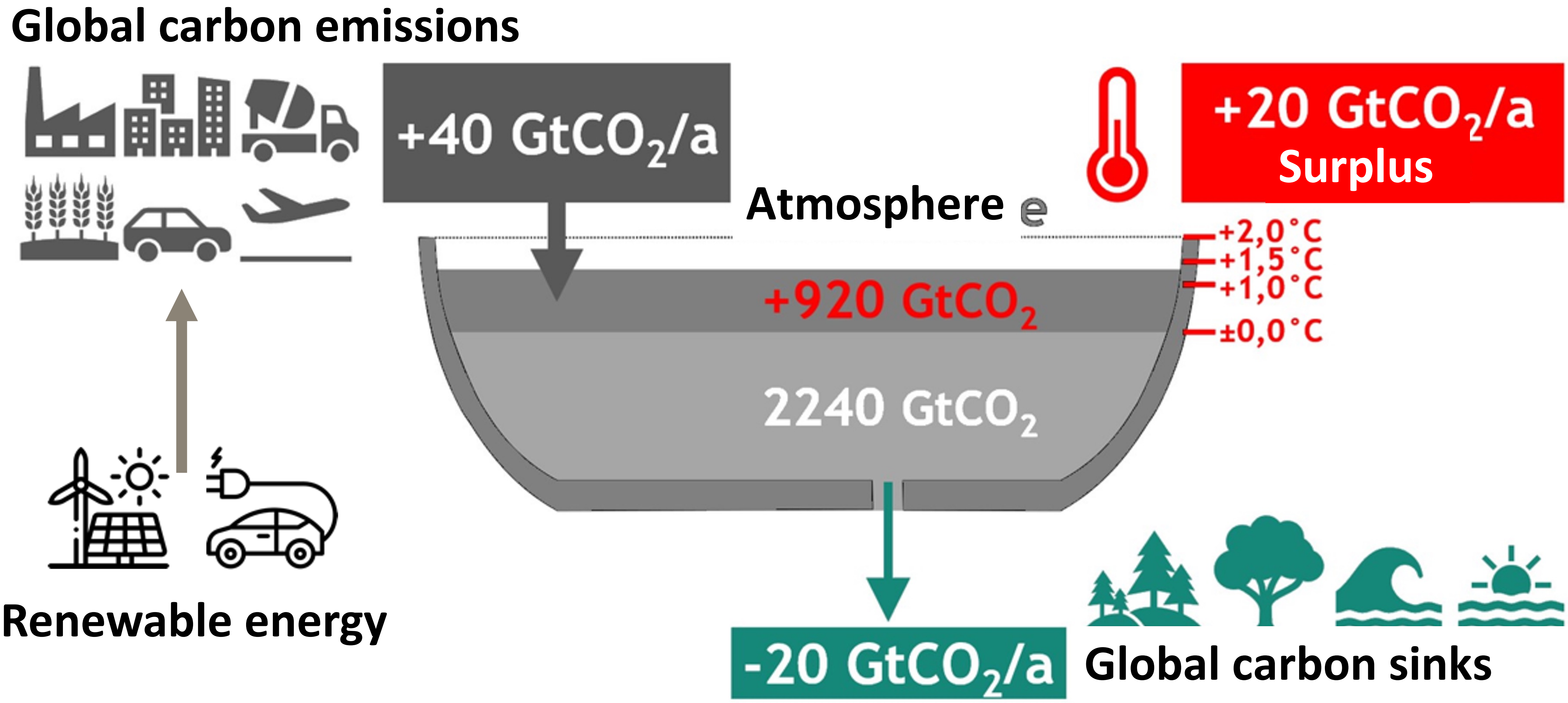
GLOBAL CARBON BUDGET ? BATHUB MODEL



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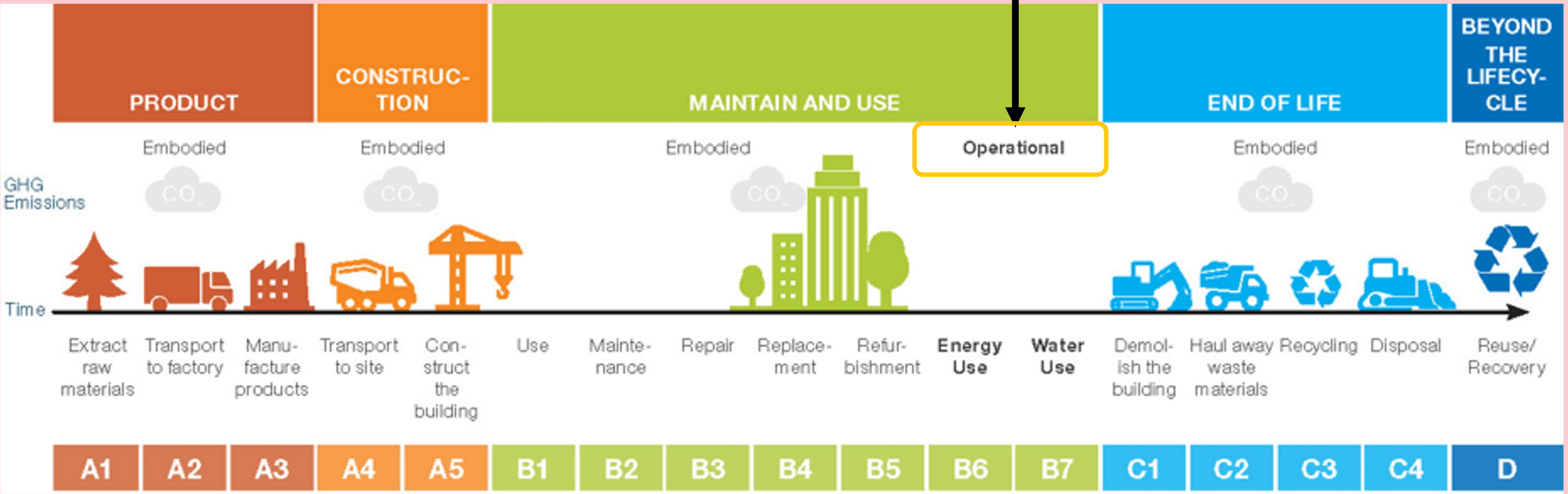
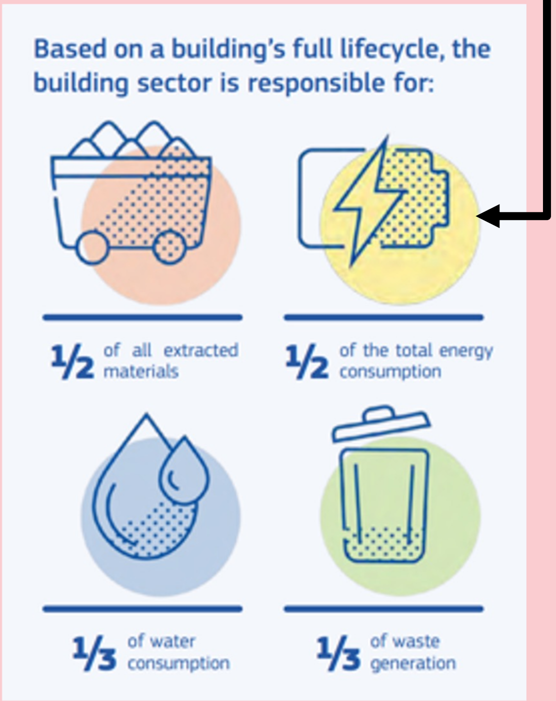
BUILDING LIFE CYCLE ANALYSIS

③ **NEAR ZERO ENERGY BUILDINGS**





④ **BUILDING LIFE CYCLE ANALYSIS**

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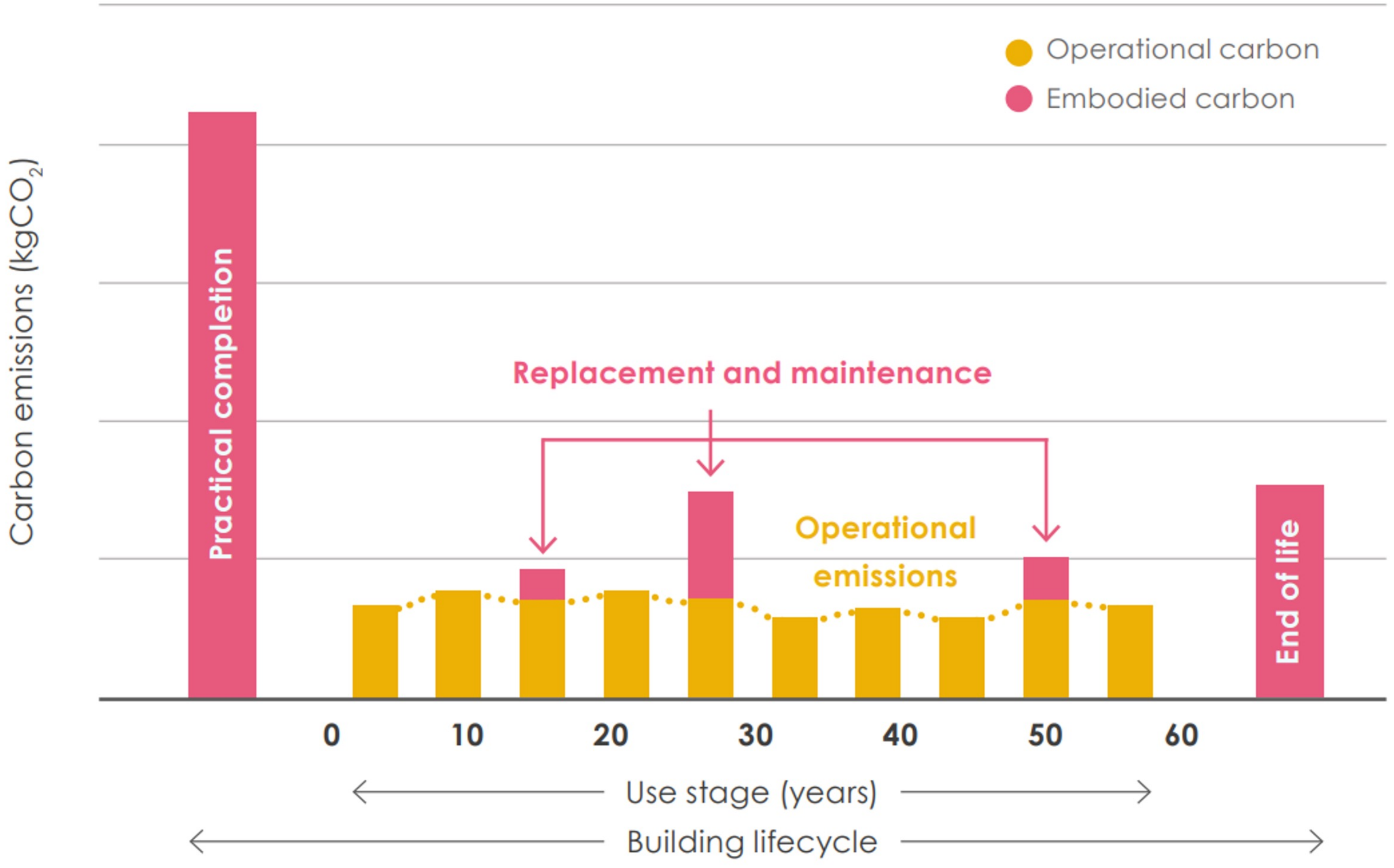
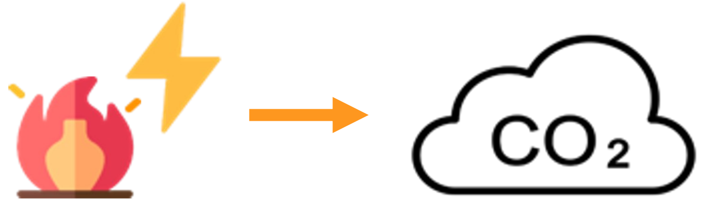
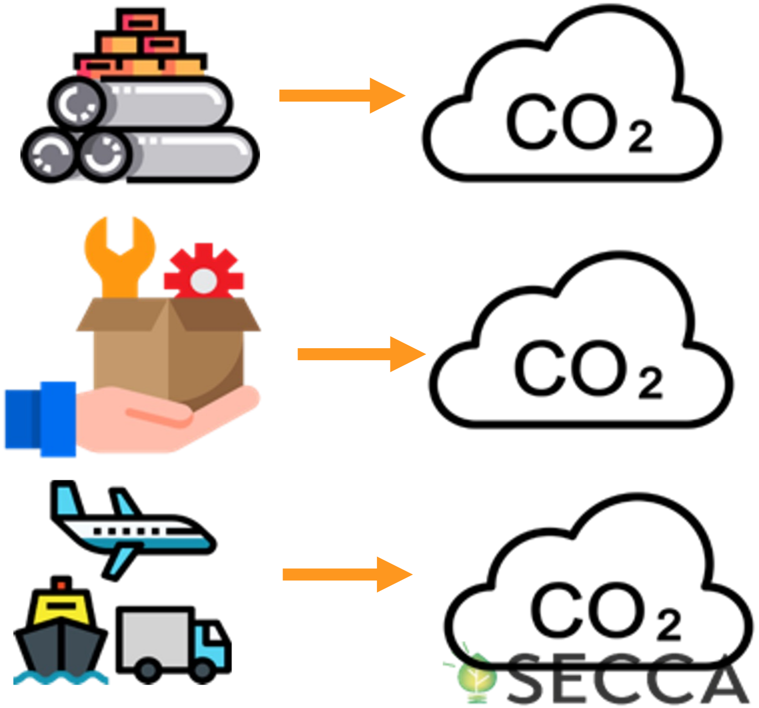
THE EMISSIONS ARE CREATED OVER THE WHOLE BUILDING LIFE CYCLE



Operational emissions:



Embodied emissions:



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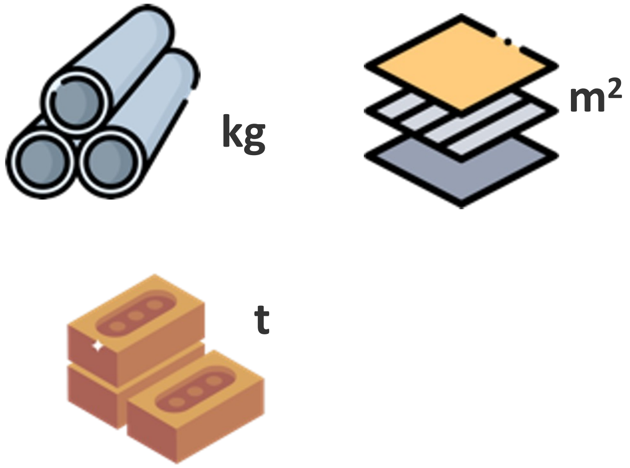
THE EVALUATION OF OVERALL IMPACT THROUGH LIFE CYCLE IS STANDARDIZED TO 4 MAIN STEPS:

① GOAL AND SCOPE DEFINITION

② INVENTORY ANALYSIS



③ IMPACT EVALUATION

[Inventory] x [Impacts] = [Total]

[Inventory]	[Impacts]	[Total]
Estimate of **quantities** of materials and processes	Estimate of the **impact** on environment of each material or process	Estimate of **total impact** on the environment

④ INTERPRETATION

XXX kg CO_2e / m^2

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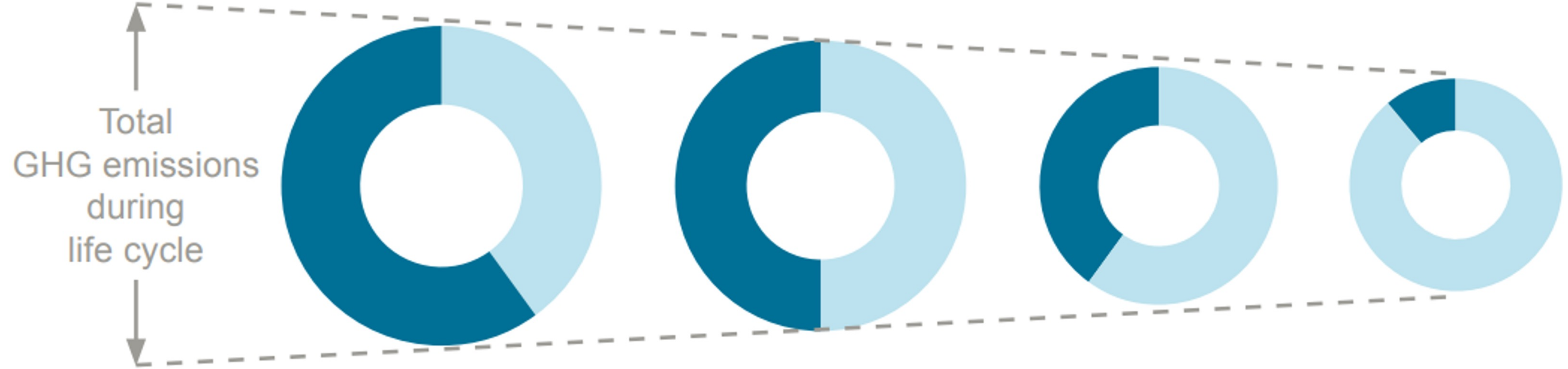
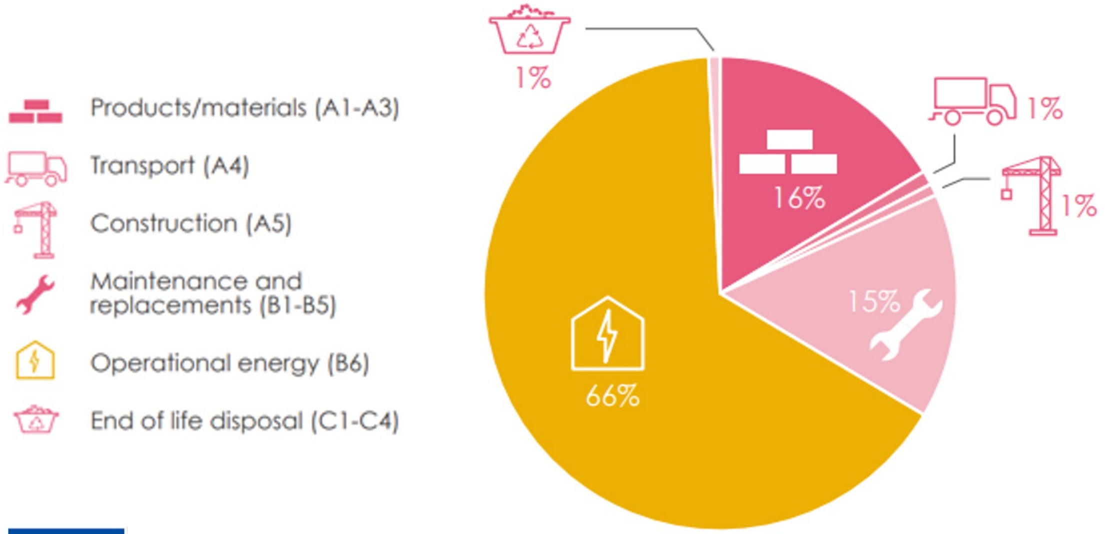
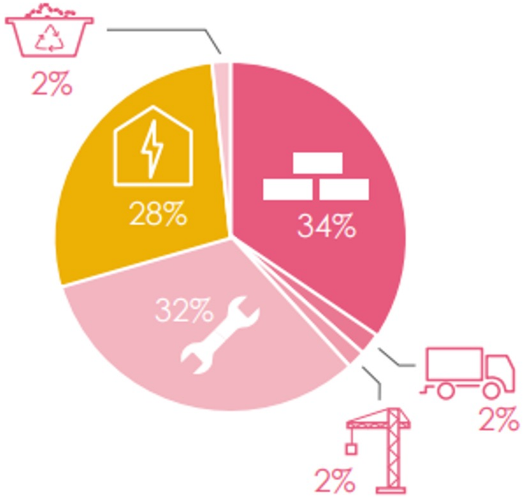
BUILDING EMBODIED EMISSIONS BECOMES IMPORTANT WHEN ENERGY PERFORMANCE IS IMPROVED





Improving energy efficiency reduces impact due to operational energy consumption but increases the material-related emissions



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LCA: CHALLENGES OF APPLICATION

1. **Complexity in Integration**: The complexities of integrating LCA into building rating systems are discussed by Borja Izaola et al. (2022) in "Sustainability", highlighting the challenges in standard assessments.
2. **Need for Innovative Approaches**: The limitations of current methodologies in whole building LCA and the need for new tools are addressed in Canadian Journal of Civil Engineering (2022).
3. **Economic-Environmental Balance**: The difficulty in balancing economic viability with environmental sustainability in LCA, especially in steel building projects, is analyzed by Silvia Vela et al. (2022) in "Sustainability".
4. **Methodological Issues**: Methodological challenges, including data quality and standardization, affecting LCA's reliability are reviewed by Martin N. Nwodo and Chimay J. Anumba (2019) in "Building and Environment".
5. **Retrofitting Costs and Impacts**: The complexity of assessing environmental impacts and costs in building retrofits, influencing retrofit decisions, is examined by Carla Rodrigues and Fausto Freire (2021) in "Sustainable Cities and Society".

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LCA: WHERE THE RESEARCH IS GOING

1. **Life Cycle Energy of Buildings**: Clyde Zhengdao Li et al. (2020) conducted a holistic review on life cycle energy of buildings, emphasizing the increasing importance of energy efficiency and sustainability in building design and operation.
2. **Non-Domestic Building Stocks**: Julian Bischof and Aidan Duffy (2022) focused on the life-cycle assessment of non-domestic building stocks, analyzing current modeling methods to understand the environmental impact of these buildings.
3. **Dynamic Life Cycle Assessment**: The study by Shu Su et al. (2021) highlights the evolution of assessment models and dynamic variables for dynamic LCA of buildings, signifying a shift towards more adaptive and responsive assessment techniques.
4. **Research on Life Cycle Energy**: A review by Xulu Lai et al. (2020) maps out the research on life cycle energy of buildings, indicating a growing interest in understanding and reducing the energy footprint of building projects.
5. **Benchmarking of LCA in Buildings**: Yahong Dong et al. (2021) offer a comprehensive analysis towards benchmarking life cycle assessment in buildings, suggesting a need for standardization and comparability in LCA studies.

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BUILDING DECARBONISATION AND ZERO EMISSION BUILDINGS

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DECARBONISATION OF BUILDINGS

④ BUILDING LIFE CYCLE ANALYSIS

+

Target: Minimize the building's impact on climate change

(over the whole life cycle)

?

⑤ BUILDING DECARBONISATION AND ZERO-EMISSION BUILDING

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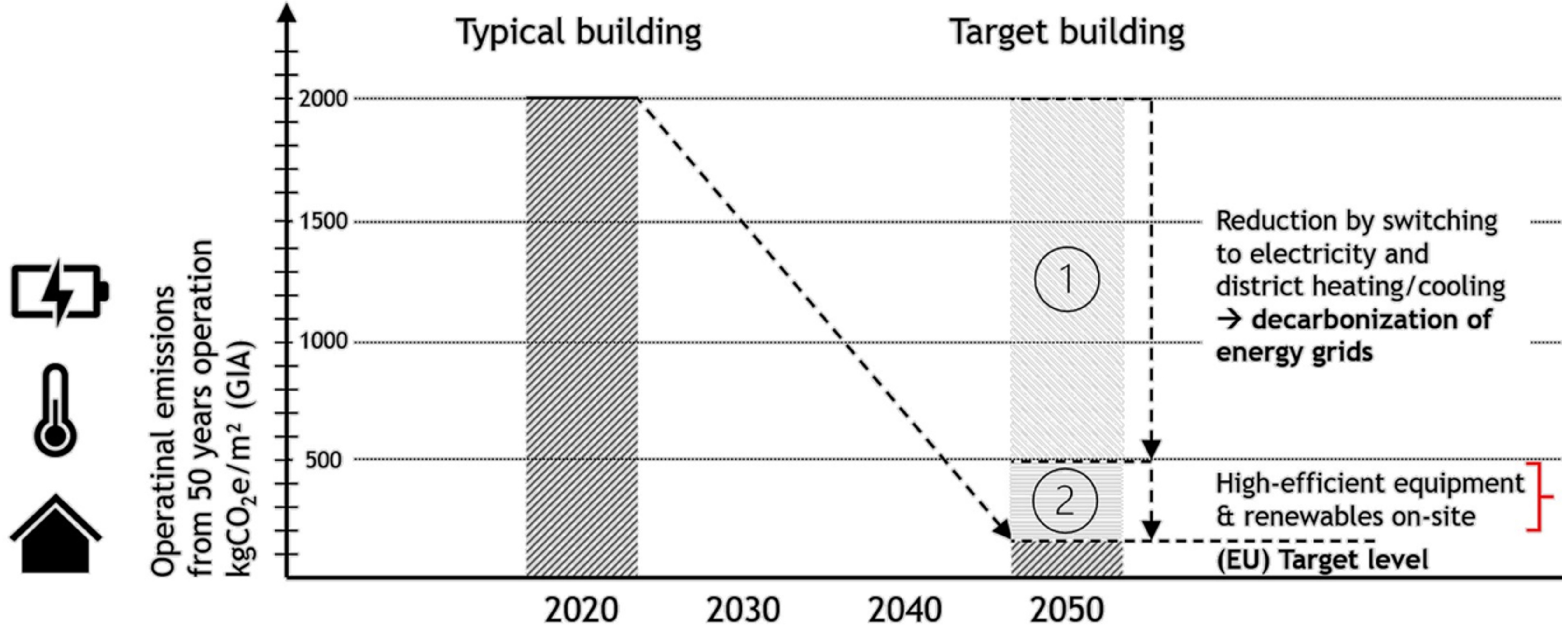
OPERATIONAL EMISSIONS COULD BE REDUCED BY GRID DECARBONISATION AND ENERGY EFFICIENCY + INTEGRATION OF RENEWABLE SOURCES



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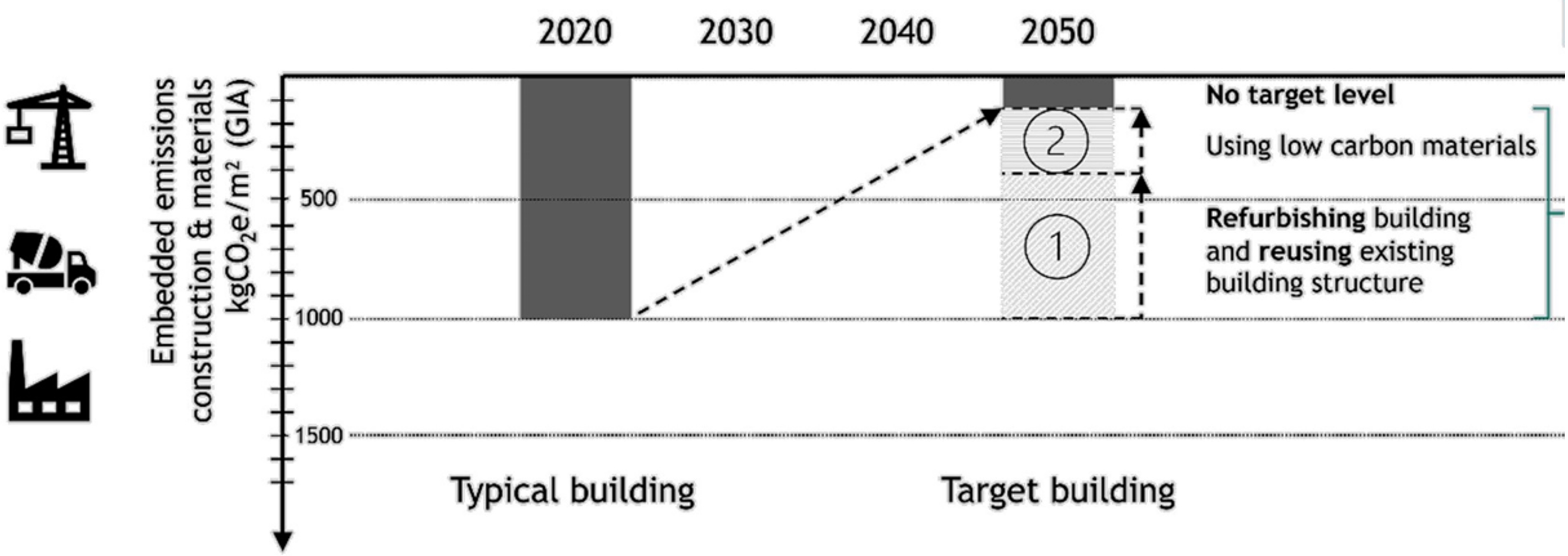
EMBODIED EMISSIONS COULD BE REDUCED BY USING LOW CARBON MATERIALS TOGETHER WITH REUSING & REFURBISHMENT



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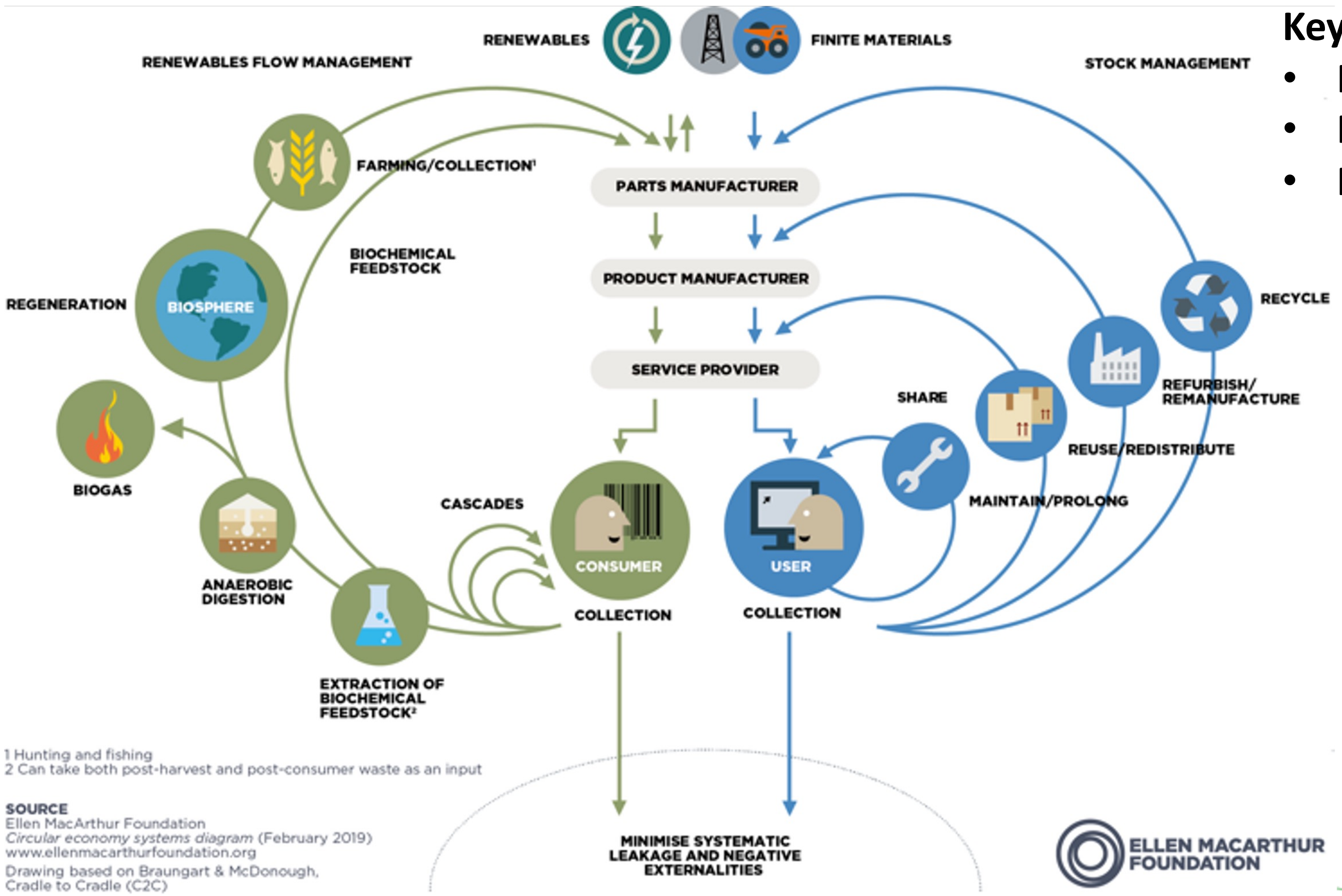
THE MANAGEMENT OF THE BUILDING LIFE CYCLE BECOMES MORE IMPORTANT AS IT GOES BEYOND ENERGY MANAGMENT

Applied strategies:

- **Build nothing**
    - Refuse unnecessary new construction
- **Build for long-term use**
    - Increase utilisation
    - Longevity
    - Adaptability
    - Disassembly
- **Build efficiently**
    - Refuse unnecessary components
    - Material efficiency
- **Build with right materials**

Application of circular economy principles:



Key principles:

- REPAIR
- REUSE
- RECYCLE

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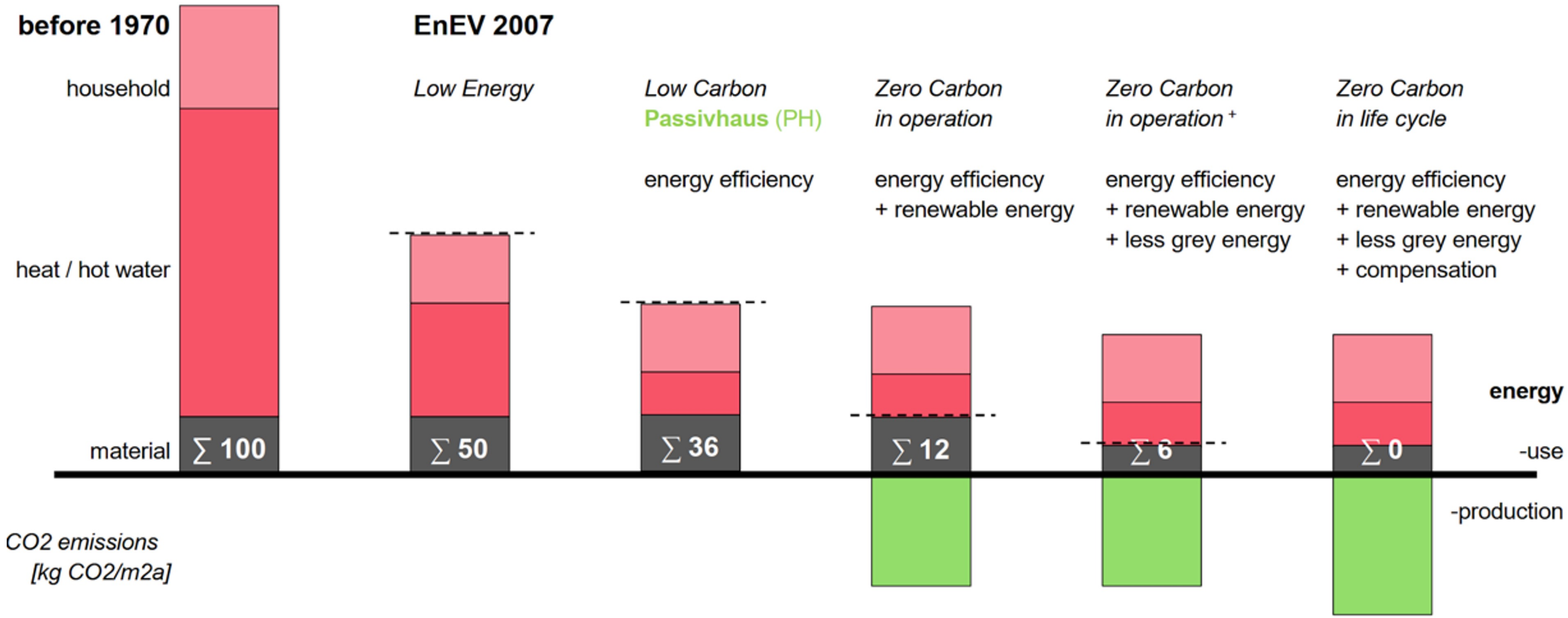
THE DEVELOPMENT OF BUILDING CARBON EMISSIONS IN GERMAN MARKET



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ZE(m)B: CHALLENGES OF APPLICATION

1. **Robust Retrofit Decision-Making**: Linus Walker et al. (2022) examine context-specific retrofit strategies for building decarbonization across Europe, highlighting the need for tailored approaches. Linus Walker et al. (2022)
2. **Baseline and Pathways for GHG Emissions**: Martin Röck et al. (2022) provide a baseline for life cycle GHG emissions of buildings in Europe and explore various decarbonization pathways. Martin Röck et al. (2022)
3. **Sustainable Approaches for Deeper Decarbonization**: Rajvikram Madurai Elavarasan et al. (2022) investigate sustainable methods for deeper decarbonization in Europe, aimed at achieving climate neutrality. Rajvikram Madurai Elavarasan et al. (2022)
4. **Energy Services in a 1.5°C Scenario**: Antoine Levesque et al. (2021) discuss the necessary demand and supply transformations in building energy services to align with a 1.5°C climate scenario in Europe. Antoine Levesque et al. (2021)
5. **Development of Nearly Zero Energy Buildings (NZEBs)**: Delia D'Agostino et al. (2021) assess the development and impact of NZEBs in Europe's decarbonization strategies. Delia D'Agostino et al. (2021)

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ZE(m)B: WHERE THE RESEARCH IS GOING

1. **End-of-Life Management Strategies**: Augustine Blay-Armah et al. (2023) focus on strategies for end-of-life management of building components to mitigate climate change impacts.
2. **Circular Economy and Embodied Carbon Drive**: Prerana Bhadane and Pooja D. Nemade (2022) assess the impact of circular economy principles on reducing embodied carbon in sustainable construction.
3. **Embodied Carbon Emissions in Buildings**: Thomas Lützkendorf and Maria Balouktsi (2022) offer insights into reducing embodied carbon emissions in buildings.
4. **Baseline and Decarbonization Pathways for Embodied GHG Emissions**: Marcus Röck et al. (2022) work on establishing a baseline and pathways for the decarbonization of embodied GHG emissions in European buildings.
5. **Reducing Embodied Carbon Through Materials Selection**: Fiona Cousins et al. (2018) discuss the potential of materials selection in reducing embodied carbon in buildings.
6. **Potential of Circular Economy in Sustainable Buildings**: Leonora Charlotte Malabi Eberhardt et al. (2019) examine the potential of circular economy in sustainable building practices.
7. **Embodied Carbon Reduction Strategies for Buildings**: L. M. T. Kumari et al. (2018) provide various strategies for embodied carbon reduction in buildings.
8. **Whole Life Carbon Assessment**: Maryam Keyhani et al. (2023) assess the whole life carbon of a typical UK residential building using different embodied carbon data sources.

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SUSTAINABLE BUILDINGS

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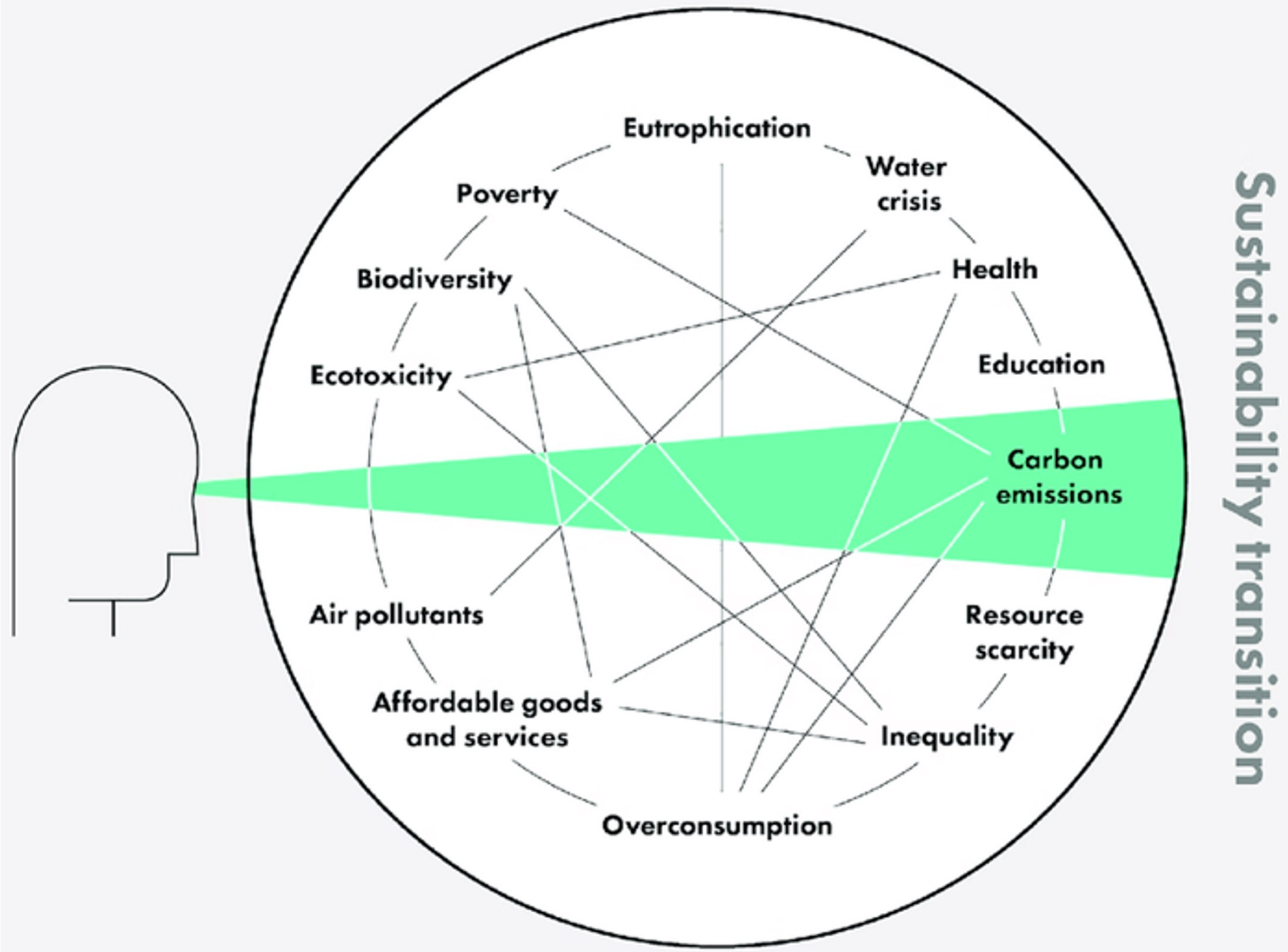
SECCA
Sustainable Energy Connectivity in Central Asia

CARBON TUNNEL VISION



1. **Defining Carbon Tunnel Vision**: Focus on carbon emissions often overlooks broader environmental issues.
2. **Limitations**: Carbon reduction is crucial but not sufficient for overall environmental health.
3. **Broader Approach Needed**: Include biodiversity, water management, and pollution control for comprehensive environmental strategies.

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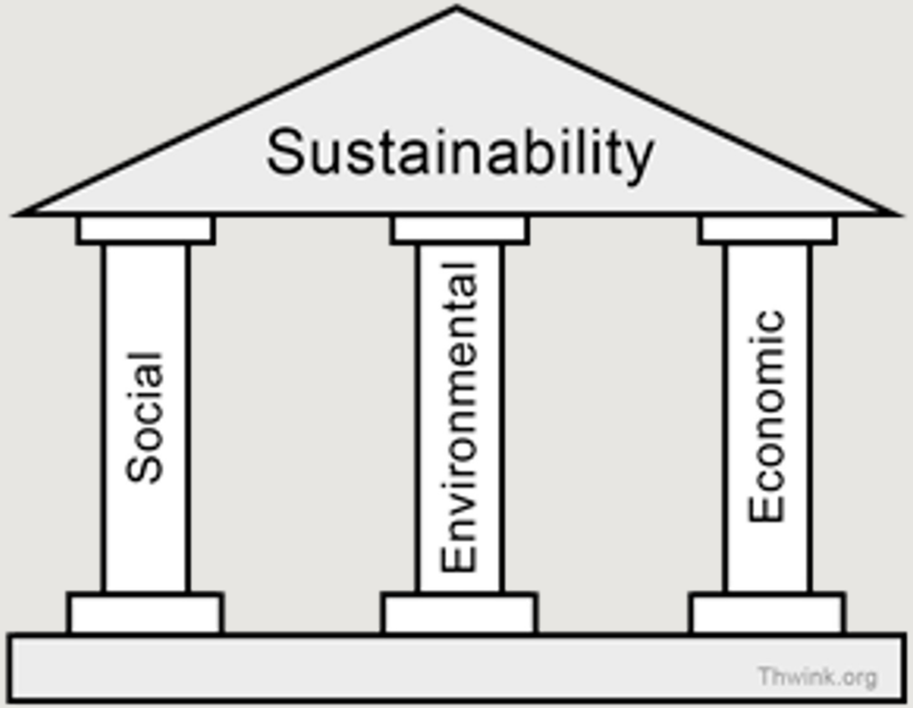
BUILDINGS CONTRIBUTING TO SUSTAINABLE DEVELOPMENT

⑤ **BUILDING DECARBONISATION AND ZERO-EMISSION BUILDING**



Sustainable development is a concept that refers to the balanced and responsible approach to **meeting the needs of the present generation without compromising the ability of future generations to meet their own needs**. It involves considering economic, environmental, and social factors to create a harmonious and long-lasting framework for progress

<u>A sustainable building</u> is a thoughtfully designed, constructed, and operated structure to minimize its negative impact on the sustainability aspects (Social, environmental, Economic). It prioritises resource conservation, reduces energy consumption, and fosters a healthy and comfortable living or working environment for its occupants.

⑥ **SUSTAINABLE BUILDINGS**

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HOW IT STARTED: BRE ENVIRONMENTAL ASSESSMENT METHOD (BREEAM)

- Created in 1988 and launched in 1990

- Certified buildings in more than 50 countries

- Over 254,000 buildings certified, and over a million registered for assessment since it was first launched.

BREEAM®

Certification scheme

Environmental assessment method

Holistic

Covers:

- Energy
- Water
- Waste
- Pollution
- Land use & ecology
- Health & wellbeing
- Transport
- Materials
- Management

Voluntary

Issue Based

Tailored to project type:

- New buildings
- Existing buildings (BREEAM In-Use)
- Community developments
- Refurbishment projects

Independent & credible

Customer focused

Specified by organisations

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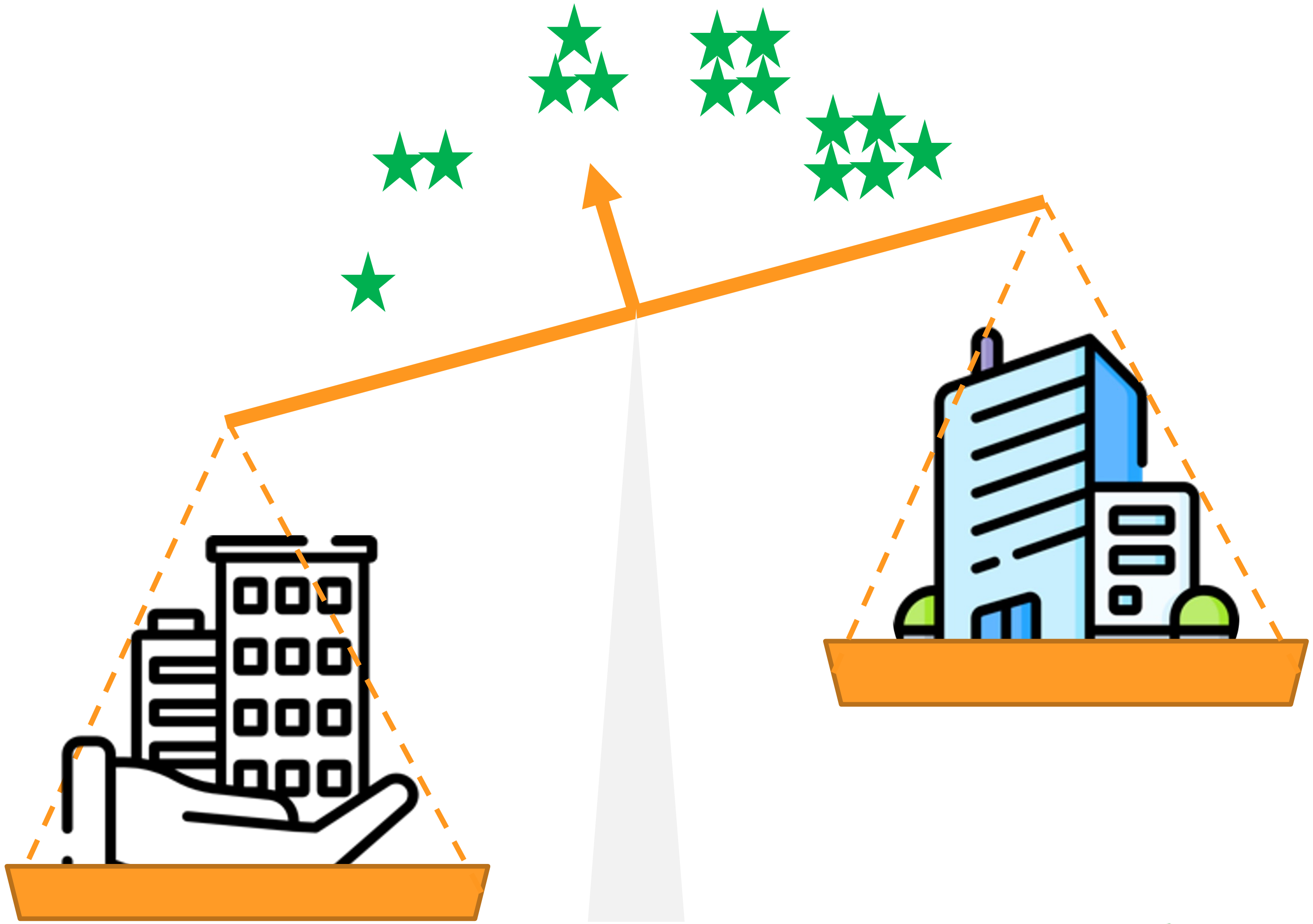
THE BUILDING ASSESSMENT METHODS RELIES ON PROCESS WHICH PROVIDES SIMPLE TO UNDERSTAND RESULTS

The evidence provided to show that the sustainability criteria have been met can be used to assign a score to a particular rating system.



THE KEY ELEMENTS OF RATING SYSTEMS CONSIST OF BENCHMARK AND RATING SCALE

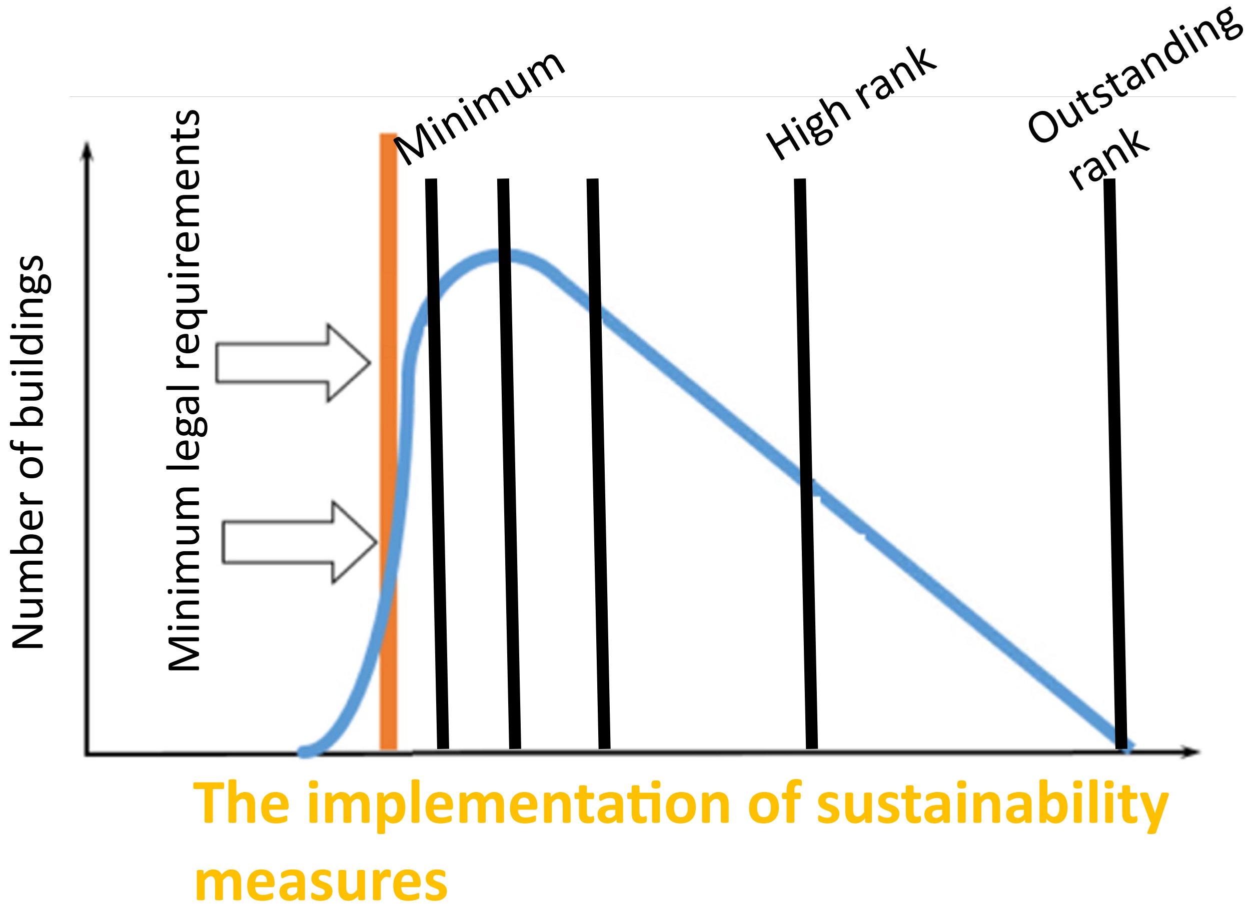
The Sustainability Rating System for Buildings is characterized by:

Sustainable Building Benchmark - all the qualities of a top-rated building

Rating scale - the "steps" used to describe the gap between the assessed building and the benchmark

Criteria and groups of criteria *define the focus of the assessment system and how identity with the* ***benchmark*** *is measured.*

The “step” in scheme represents:



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THE EVIDENCE ENSURES THAT THE RESULT IS TRACEABLE, REPEATABLE AND TRANSPARENT

Supporting evidence must include:

1. **Complete** - answering the assessment criteria
2. **Understandable** to third parties (independent review compatibility)
3. **Robust** and from a reliable source.
4. **Traceable** - clear sequence and origin of compilation.

Evidence may include :

- Communication records.
- Formal letters of correspondence
- Meeting minutes
- Drawings
- Specifications
- Site inspection report
- Measurement protocols
- And other documents recording the situation

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SECCA Sustainable Energy Connectivity in Central Asia

EU LEVEL(S) FRAMEWORK TOUCHES MOST IMPORTANT MACRO OBJECTIVES AND PROVIDES CLEAR INDICATORS

Level(s) is the EU initiative that joins up sustainable building thinking across the EU by offering guidance on the key areas of sustainability in the built environment and how to measure them during design and after completion.

Macro-objective	Indicator
1. **Greenhouse gas emissions along a building's life cycle**	1.1. Use stage energy performance
	1.2. Life cycle Global Warming Potential
2. **Resource efficient and circular material life cycles**	2.1. Building bill of materials
	2.2. Scenarios for building (i) lifespan; (ii) adaptability and (iii) deconstruction
	2.3. Construction & demolition waste and materials
	2.4. cradle to cradle Life Cycle Assessment (LCA)
3. **Efficient use of water resource**	3.1. Use stage water consumption
4. **Healthy and comfortable spaces**	4.1. Indoor air quality
	4.2. Time out of thermal comfort range
5. **Adaptation and resilience to climate change**	5.1. scenarios for projected future climatic conditions
6. **Optimised life cycle cost and value**	6.1. Life cycle costs
	6.2. Value creation and risk factors

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CHALLENGES OF APPLICATION

1.Complex Certification Processes: Achieving sustainability certification, especially for building renovations, is often complex and requires more responsive and flexible systems. This is highlighted in the study by Cristina Jiménez-Pulido et al. (2022).
2.Integrating Sustainability into Design: Shifting sustainability certification from a mere evaluation tool to a fundamental part of the design process is crucial, as discussed by Camilla Brunsgaard and Tine Steen Larsen (2019).
3.Technological Integration: Utilizing tools like Building Information Modeling (BIM) for Life Cycle Assessment (LCA) is essential but challenging. This aspect is explored by A. Naneva (2022).
4.Evaluation Challenges in Integrated Design: Assessing and implementing strategies to reduce environmental impact through integrated design pose significant difficulties, as pointed out by Ricardo Leoto and Gonzalo Lizarralde (2019).
5.Understanding of Sustainability Concepts: There's a need for improved understanding and education about sustainability in the building industry. This is emphasized in the research by Cathy T. Mpanga Kowet and Aghaegbuna Obinna U. Ozumba (2022).

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WHERE THE RESEARCH IS GOING

1. **Beyond Certification**: Exploring sustainable building practices independent of formal certification systems (Yewande S. Abraham et al., 2022).
2. **Regional Sustainable Standards**: Investigating the development and future of sustainable building standards in specific regions like Saudi Arabia (Bassem Jamoussi et al., 2022).
3. **Building Rating System Reviews**: Comprehensive analyses of existing building rating systems, their capabilities, and limitations (Fabrizio Ascione et al., 2022).
4. **Sustainability Assessment Indicators**: Developing measurable indicators for assessing building sustainability (Leonardo Rodrigues et al., 2023).
5. **Sustainable Design Processes**: Examining the integration of sustainable practices in design processes, particularly in projects aiming for certifications like Passivhaus (Alberto Sangiorgio and Arianna Brambilla, 2020).
6. **Certification's Impact on Design**: Studying how sustainability certification influences architectural design processes (Mathilde Landgren and Lotte Bjerregaard Jensen, 2018).
7. **BIM and LCA in Certification**: Integrating Building Information Modeling (BIM) and Life Cycle Assessment (LCA) for sustainable building certification (A. Naneva, 2022).
8. **Systems Engineering for BREEAM**: Applying systems engineering in construction to achieve certifications like BREEAM (Hanne Lunden Helseth and Cecilia Haskins, 2022).

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SUMMARY: KEY TAKE AWAYS

1. **Methodical Progress Tracking**: Evaluation methods are crucial for setting and achieving incremental sustainability targets in buildings.
2. **Localization is Key**: To ensure effectiveness and applicability, sustainable building solutions must be adapted to local contexts.
3. **Implementation Challenges**: The existence of advanced technical solutions does not inherently lead to their adoption; overcoming implementation barriers is essential.
4. **Interdisciplinary Approach**: Effective energy policy research and implementation require a blend of technical, financial, and social considerations.
5. **Energy Efficiency's Central Role**: Despite the broad scope of sustainability, energy efficiency remains a dominant factor influencing sustainable building outcomes.

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WHAT GOES BEYOND THE ENERGY EFFICIENCY IN THE BUILDING SECTOR?

THANK YOU FOR YOUR ATTENTION !

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„Helping to Unlock the Value of Energy Efficiency and Sustainability for a More Resilient Future "

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