Energy Transitions Commission

Buildings decarbonisation – commercial buildings

17th June, 10.00-11.30 UKT

Agenda

	Mins	UK time
1.Recap on workshops 1-3	10	10.00
2.Understanding commercial buildings – energy use and emissions	10	10.10
3.New commercial buildings - Design choices - Clean heating and cooling technologies - Other technology choices and efficiency	20	10.20
Discussion	15	10.40
4.Retrofit of existing commercial buildings	5	10.55
5.Refrigerant leakage	5	11.00
6.Barriers and implementation	10	11.05
Discussion	15	11.20
		11.30

Recap on workshops 1-3

Emerging conclusions: clean heating technologies in existing buildings

Pre-read

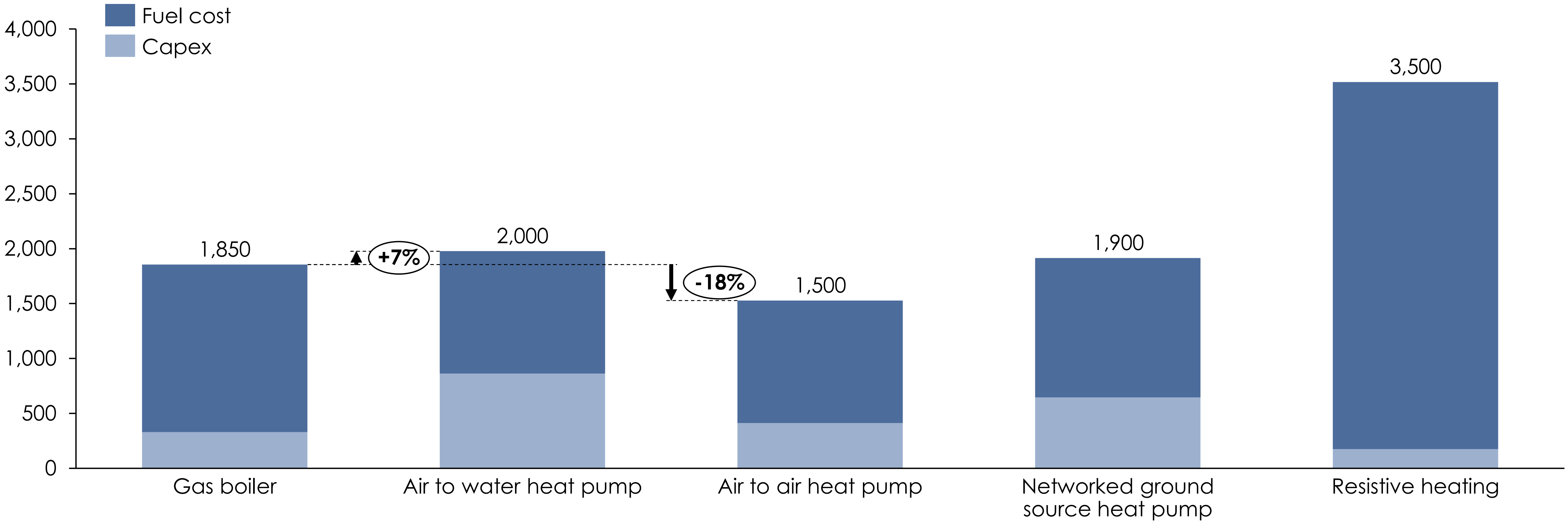
What did we conclude with members?

- There **is no one-size-fits-all solution** to decarbonising building heating, and a wide variety of solutions will be used
- The solution will be **predominately electric**, but with a range of technologies depending on buildings and household preferences
    - ➢ **Networked ground source heat pumps** in denser urban areas, blocks of flats and terrace housing
    - ➢ **Air to air** in countries with cooling needs and those with ducted heating systems, **Air to water** in countries with existing water-based heating systems, **Ground source** in larger properties
    - ➢ **Resistive heating** where heat pumps are unsuitable / unfinanceable
- Air to air heat pumps are already **cheaper than gas boilers** on a total cost of ownership basis at 300% efficiency, and **air to water heat pumps** are 5-10% more expensive, but have **25-30% lower running costs** even with electricity costing ~2.5 times more than gas
    - **Rebalancing gas and electricity prices** will be key to closing that gap
    - The **upfront costs** of heat pumps are also expected to fall, potentially **~25% by 2030**, as the market scales
- **Insulation is always a good thing for reducing overall demand and emissions, and often improving comfort** – but in most cases, lack of insulation **shouldn't be a barrier** to mass heat pump adoption; in general, households can install a heat pump first, then consider insulation
    - This is because of the **high upfront costs**, the disruption and time involved, and because in most cases, upsizing radiators will enable a heat pump to work effectively
    - Where households can combine insulation with home improvement (e.g. low cost draught-proofing) or afford the upfront cost, it will **improve the fuel cost comparability** of heat pumps to gas, making them more attractive
- There is a **reasonable payback to investing in light insulation** (e.g., cavity wall at ~€2,000-3,000) for resistive and low efficiency heat pumps
    - But for the average heat pump operating at 300% or above, and for more expensive insulation (e.g., external wall insulation at ~€10,000), the energy bill savings take a **very long time to repay the high upfront costs**
- However, there is **value beyond energy bill savings** to investing in insulation – improved **health** outcomes, **comfort**, **building condition** and value. There is often a very strong willingness to pay for these – for both households and government.
    - Improving the efficiency of the least efficient properties should be prioritised, including for fuel poverty reasons.

In workshops 1-2, we outlined a strong conviction for heat pumps to replace gas boilers, where upfront costs are a key barrier but on a total cost of ownership they are cost competitive

Equivalent annual cost of ownership (technology + installation and running costs – European average

€ per year



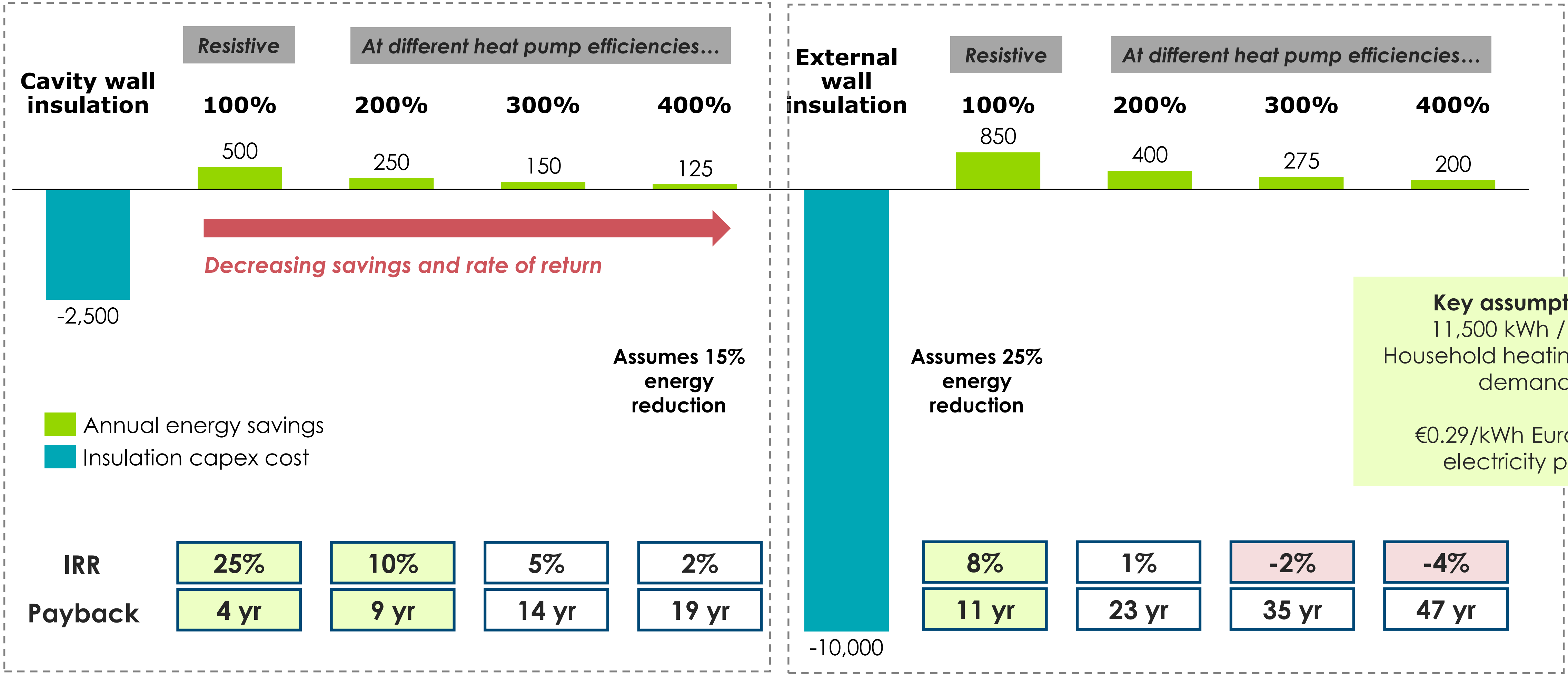
Efficiency assumption	90%	300%	300%	500%	100%

Sources: Systemiq analysis for ETC (2024); Eurostat for Europe electricity and gas prices.
Note: Assumes an average heat demand of 11,500 KWh a year per household, based on an average across the US and select European countries. Fuel prices reflect averages from 2023; no carbon price on gas is assumed. Assumes 5% discount rate.

For existing buildings in countries with a heating need, investing in insulation takes a very long time to payback for heat pumps with >300% efficiency, given the very high upfront costs

Estimated annual energy bill savings for electric heating with light or deep retrofit, and the associated retrofit capex costs

€



Key assumptions:
11,500 kWh / year Household heating energy demand

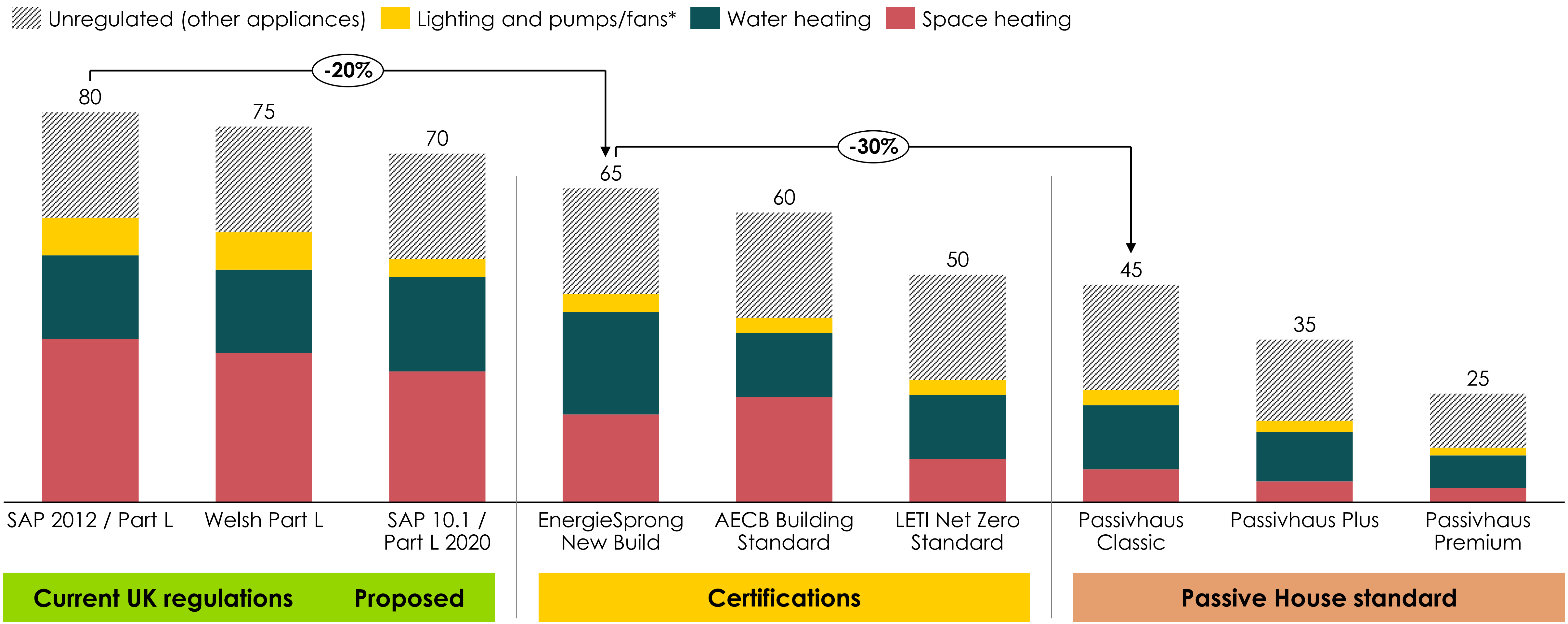
€0.29/kWh European electricity price

Sources: Systemiq analysis for the ETC (2023); Eurostat for Europe electricity and gas prices; Energy Information Administration for US prices.
Note: Assumes an average heat demand of 11,500 KWh a year per household, based on an average across the US and select European countries. Assumes energy reductions of 15% for light retrofit and 25% for deep retrofit. Assumes a discount rate of 5%, assessed over a 25 year period.

In workshop 3, we explored the potential to improve energy efficiency in new residential buildings; where certified and passive house buildings consume 20-50% less energy per m²

Final energy per m2 by end use by building energy standards (UK)

Annual kWh/m2 for a 3-bedroom semi-detached house; air source heat pump as the heat source for heating and hot water

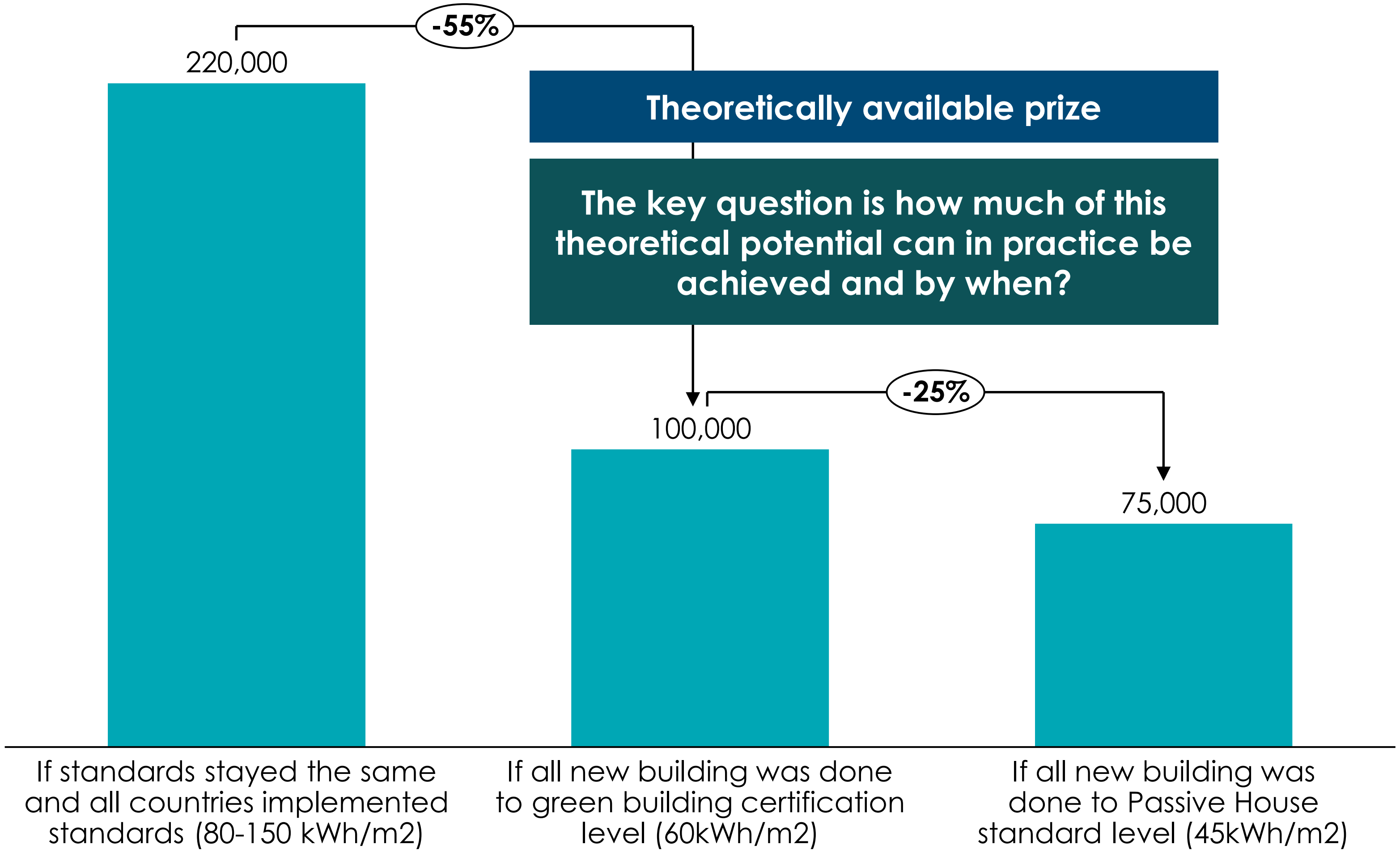


Note: Pumps/fans – energy use associated with the HVAC system besides space and water heating

Source: Good Homes Alliance & Woodknowledge Wales (2020), *Building Standards Comparison*

If action were taken immediately to introduce better building codes, total cumulative energy consumption from new builds could be 50-75% lower between now and 2050

Global cumulative household energy consumption, new residential buildings from 2023 to 2050
TWh



Approach:

- In a given year, typical household energy use (kWh/m2) x increase in global floor area (m2) = operational energy use from new builds
- Cumulative total to 2050, assuming new builds consume the same kwh/m2 every year from their construction to 2050

Source: Systemiq analysis for the ETC (2024); IEA (2023), *World Energy Outlook 2023.*
Note: Typical household energy use (kWh/m2) based on current standards today (~80kWh/m2 in high-income countries, and ~150kWh/m2 in middle and low income)

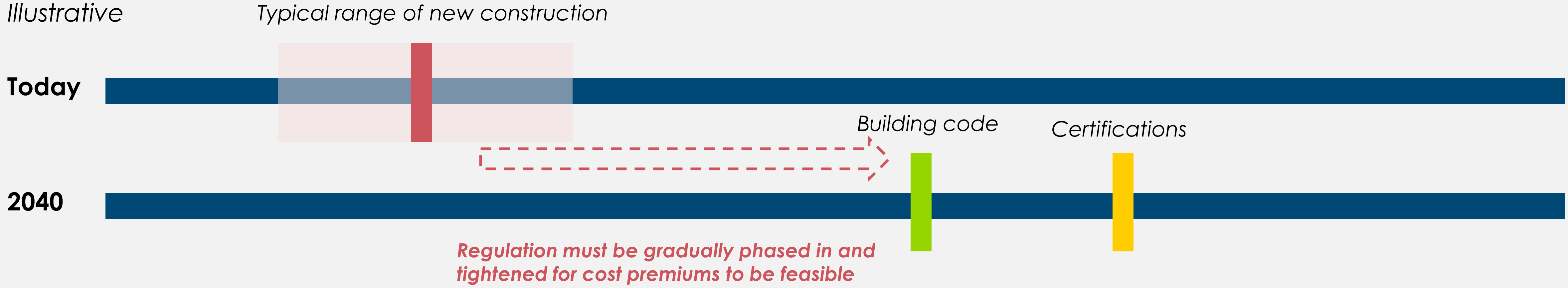
But implementing better building codes will be a gradual process, especially in countries without an established building code today

Country with long established building energy codes

Illustrative

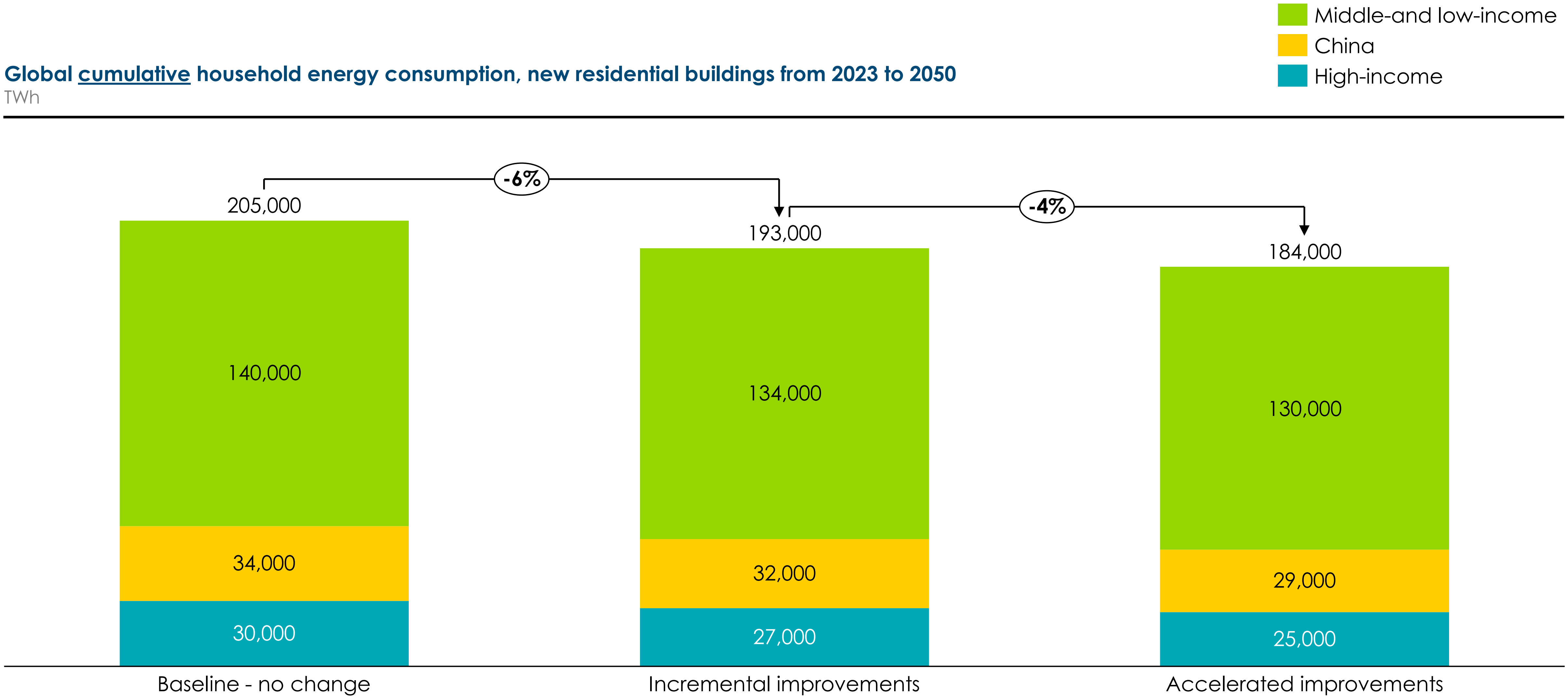
Country with no established building energy codes

Illustrative



This means that only a fraction of the theoretically possible efficiency improvements can likely be achieved – underpinning the critical importance of better building codes this decade

Global cumulative household energy consumption, new residential buildings from 2023 to 2050
TWh



Source: Systemiq analysis for the ETC (2024); IEA (2023), *World Energy Outlook 2023.*

Emerging conclusions: the new build opportunity

Pre-read

What did we conclude with members?

- There is **significant scope** to build new buildings to higher energy efficient standards – the biggest opportunity is improving the **building envelope** and incorporating other **passive heating/cooling techniques** to reduce space heating and cooling energy consumption
- **Building codes** currently set a minimum floor, **certifications** reward buildings for greater energy efficiency **(~25-50% reduction** in energy intensity compared to building code standard), and the **Passive House standard (~70-90% reduction)** shows the technical potential and has a key role demonstration role
  - Building houses to the Passive House standard has a **cost premium of ~5-20%,** but can be higher in countries without established building codes
  - In countries with established codes, building homes to typical green building certification standards has a **cost premium of around 1-5%**; but this is likely to be larger in countries starting from a much lower base (i.e., those with no building regulations)
- Governments should gradually increase the ambition of building codes **towards the level of certifications** (e.g., in the middle of current building codes and the Passive House standard). Moving regulation to Passive House standard in the 2020s and 2030s is unlikely to be cost-effective in most instances.
- **Regulation should specify:**
  - Ambitious minimum standards for the quality and insulation of building envelope (e.g., U-values)
  - Encouragement of a wide range of passive heating and cooling techniques
  - Mandate the most efficient clean heating technology; in almost all cases, this will be heat pumps
  - Minimum energy efficiency standards for heating/cooling technologies (heat pumps and ACs) and appliances (e.g., LED lighting)
  - Ensure all homes are "solar ready" (e.g., south facing roof, grouped obstructions)

Emerging conclusions: barriers and implementation to better new buildings

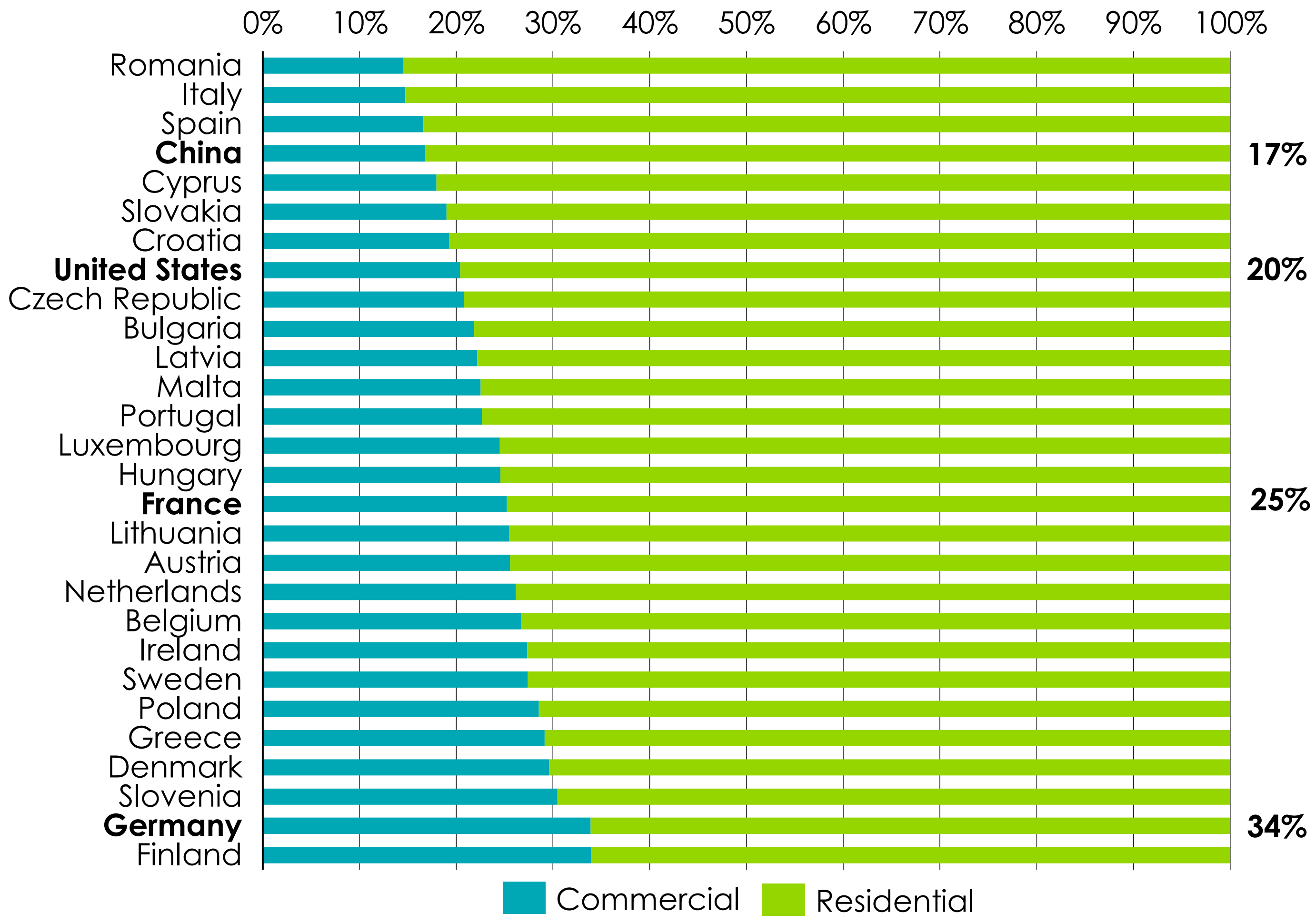
Pre-read

- Getting new build design and fabric right is critical
  - Choices about materials and envelopes made today will **have implications** for operational energy use for **decades**
  - It is **significantly cheaper** to do energy efficiency in a new build than to retrofit an existing building; in particular, investing in marginal improvements to new building stock will never be economic
- Policies to maximise the potential efficiency improvement are key:
  - **Education and awareness** of cost effective passive techniques, skills and training, pilots and demonstrations
  - **Incentives** to drive efficiency up the agenda for developers (e.g., fast-track permitting)
- **Market and voluntary** actions can play a **supporting role** in driving change, especially in the higher-end residential and commercial sectors - but for the majority of residential real estate (especially in middle/low income countries where 80% of building floor area growth will be), the demand signal from the market is weak
- This means **regulation will be the most critical lever**, setting a minimum floor for energy efficiency
  - In high-income countries and China, with established building codes, regulation should aim to **move towards the level of green building certifications** and set out a clear trajectory of tightening criteria to 2050
  - In middle- and low-income countries, regulation should first focus on **playing an educative role** with **prescriptive criteria** (e.g., specifying passive techniques and materials and creating awareness of the very low-cost options) and on developing **enforcement and monitoring schemes**

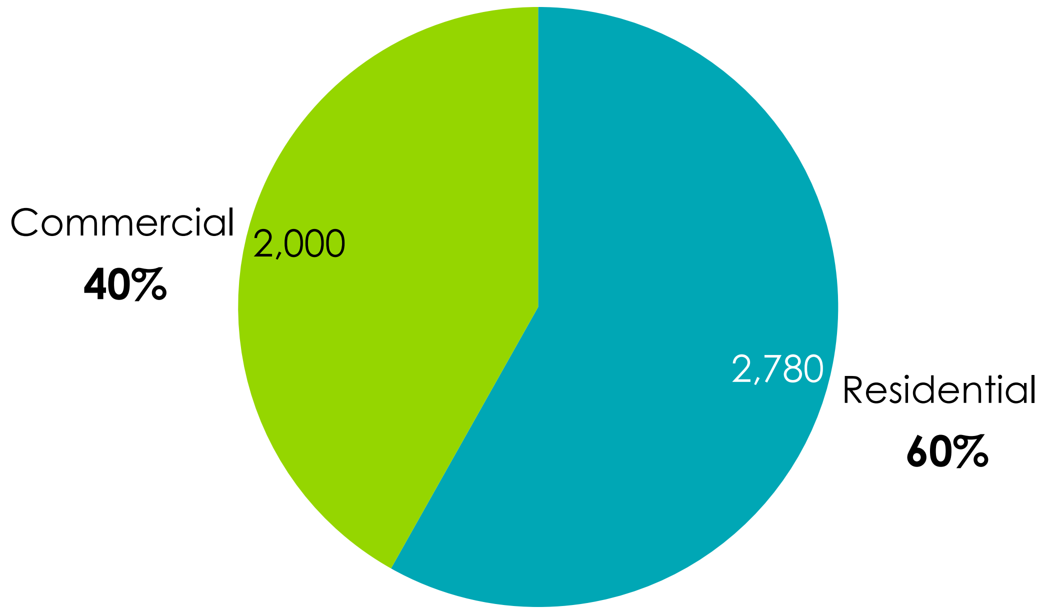
Understanding commercial buildings

Commercial buildings as a share of built floor area ranges from ~20% in China and the US, to ~35% in Germany; in the US they account for ~40% of total building energy use

Built floor area by residential / commercial
% of total floor area, 2015



Share of total building energy consumption in the US
TWh

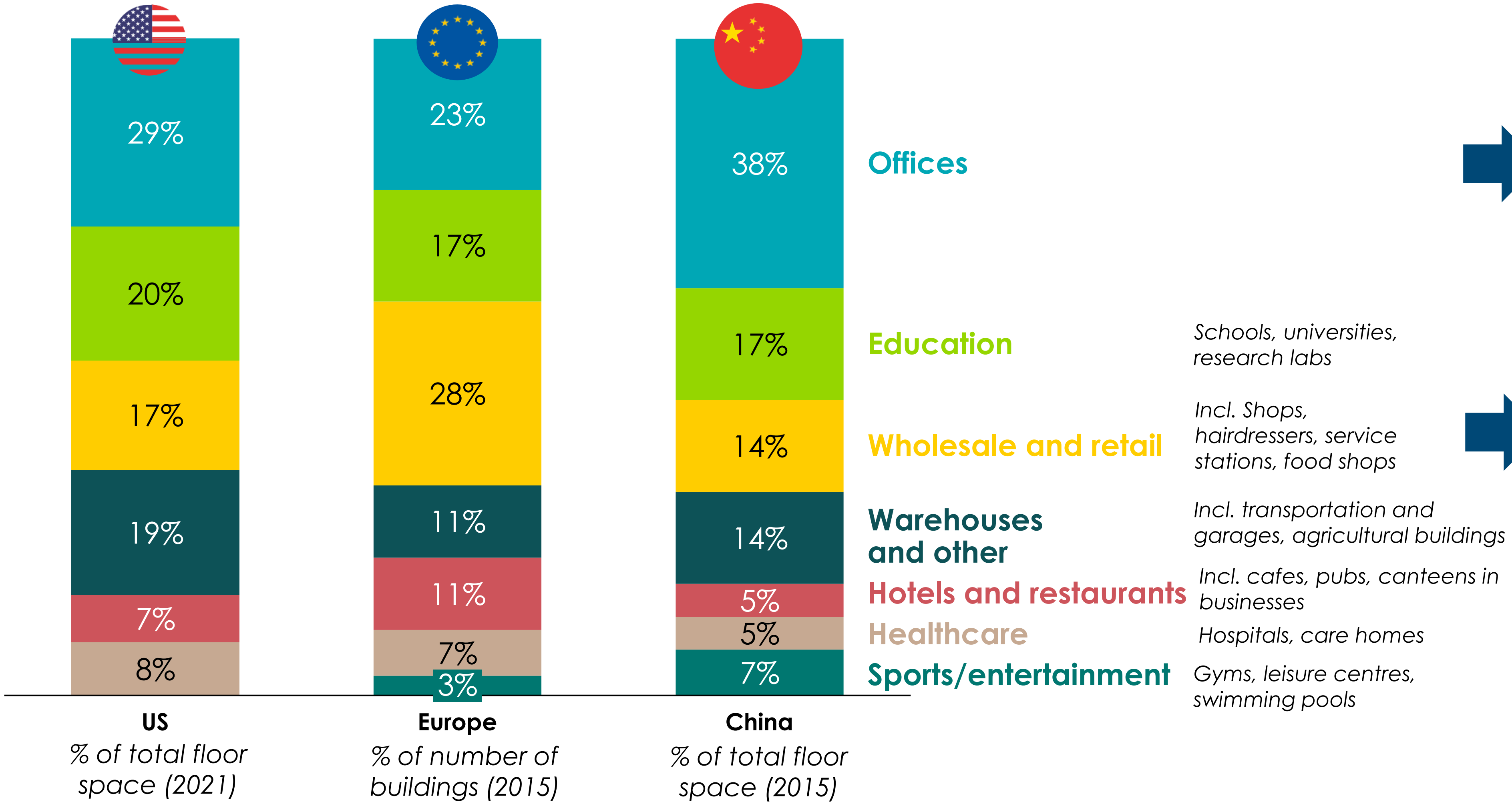


Sources: EU Building Stock Observatory for Europe; National Renewable Energy Laboratory for United States; Pan L, Zhu M, Lang N, Huo T. (2020), *What Is the Amount of China's Building Floor Space from 1996 to 2014?*

"Commercial buildings" refers to a very large and heterogenous group of sectors; offices only account for 25-40% of building stock, with schools and wholesale/retail also key

Commercial buildings by sector

% of total floor area for the US and China, % of number of buildings for Europe



Significant heterogeneity in:

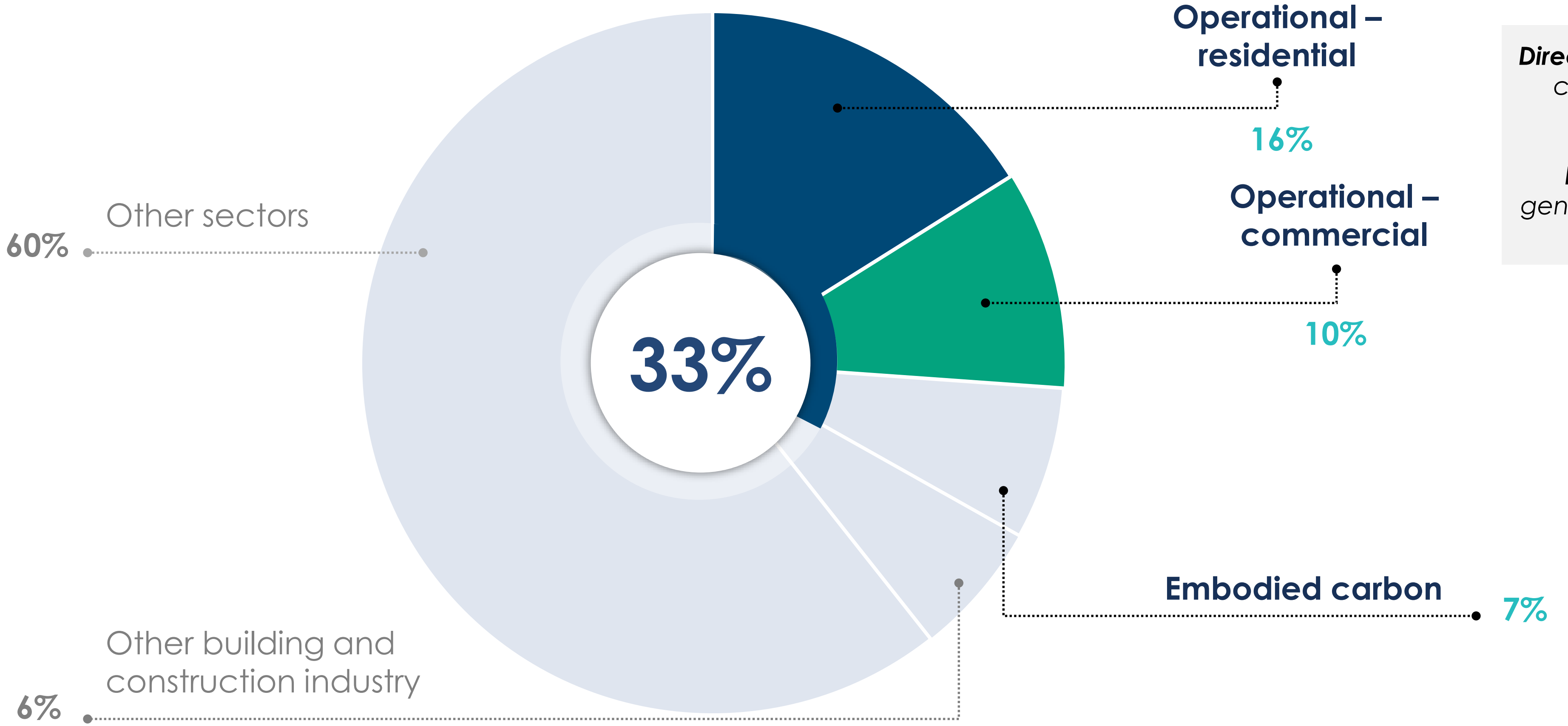
- Heating, cooling, lighting & appliances needs: e.g., offices vs hotels and restaurants
- Energy usage patterns: e.g., school hours vs hotel
- Energy intensity: e.g., hospital vs storage rooms in retail

Sources: US National Renewable Energy Laboratory; Building Performance Institute Europe (2015), *Europe's Buildings Under the Microscope*; Baijiahao (2018), *Real estate and constructions: What are the sub-sectors? What are the sizes?* Note: For the US, sports facilities is included in "warehouses and other"

Commercial buildings account for 1/3 of operational emissions from buildings, or 10% of global emissions

Global emissions by sector, 2022
$GtCO_2$

Total buildings emissions 12.3 $GtCO_2$



Direct use *of fuels in buildings (e.g., coal or gas heating, TUOB for cooking)*

Indirect use *of fuels used to generate electricity for power and heat in buildings*

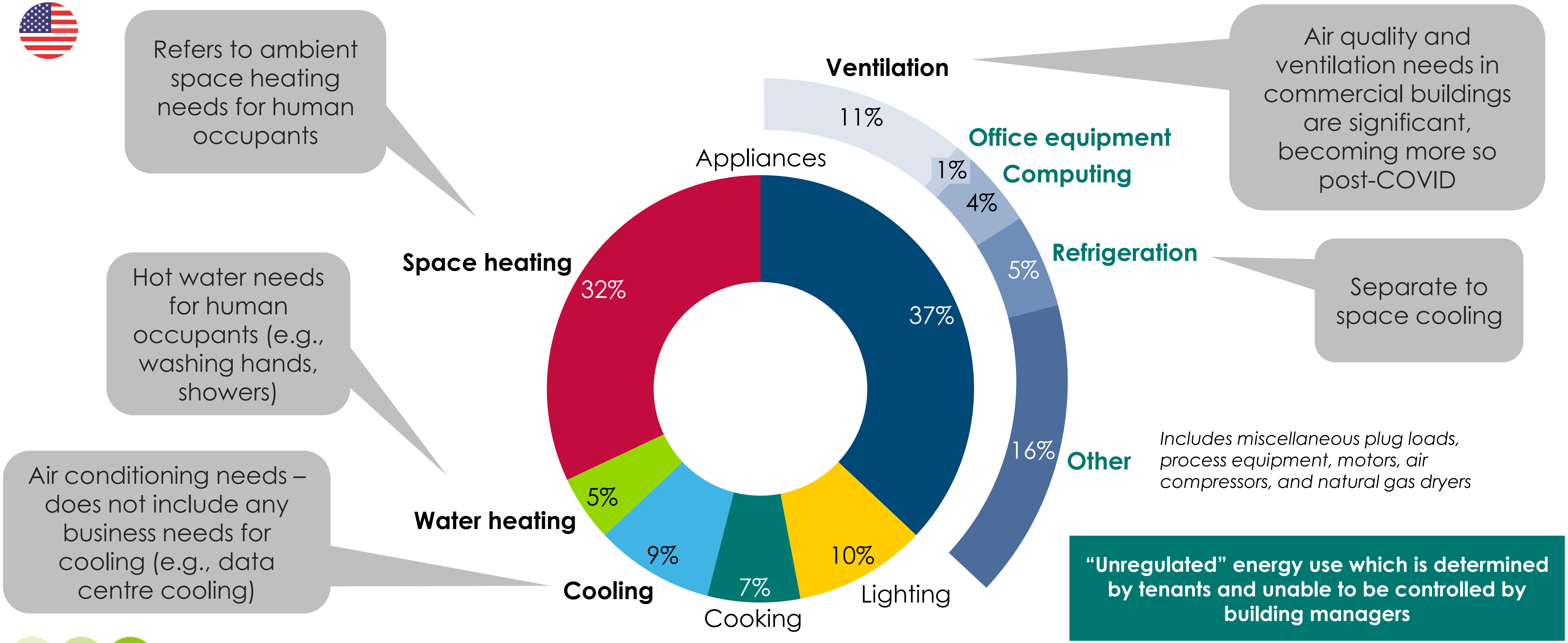
Embodied emission from construction, including manufacturing and processing of cement, steel, and aluminium for buildings

Note this shows annual carbon flows as opposed to stock. Direct GHG emissions are from sources that are owned or controlled by the reporting entity (e.g. on-site fuel combustion – scope 1) whereas indirect GHG emissions are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity (e.g. electricity purchased from the grid – scope 2).
Sources: International Energy Association (2023)

Heating, cooling and ventilation accounts for ~60% of commercial building energy use; heating and cooling refers to creating comfortable room temperatures for human occupants

Commercial buildings energy consumption by end-use in the US
% of energy consumption

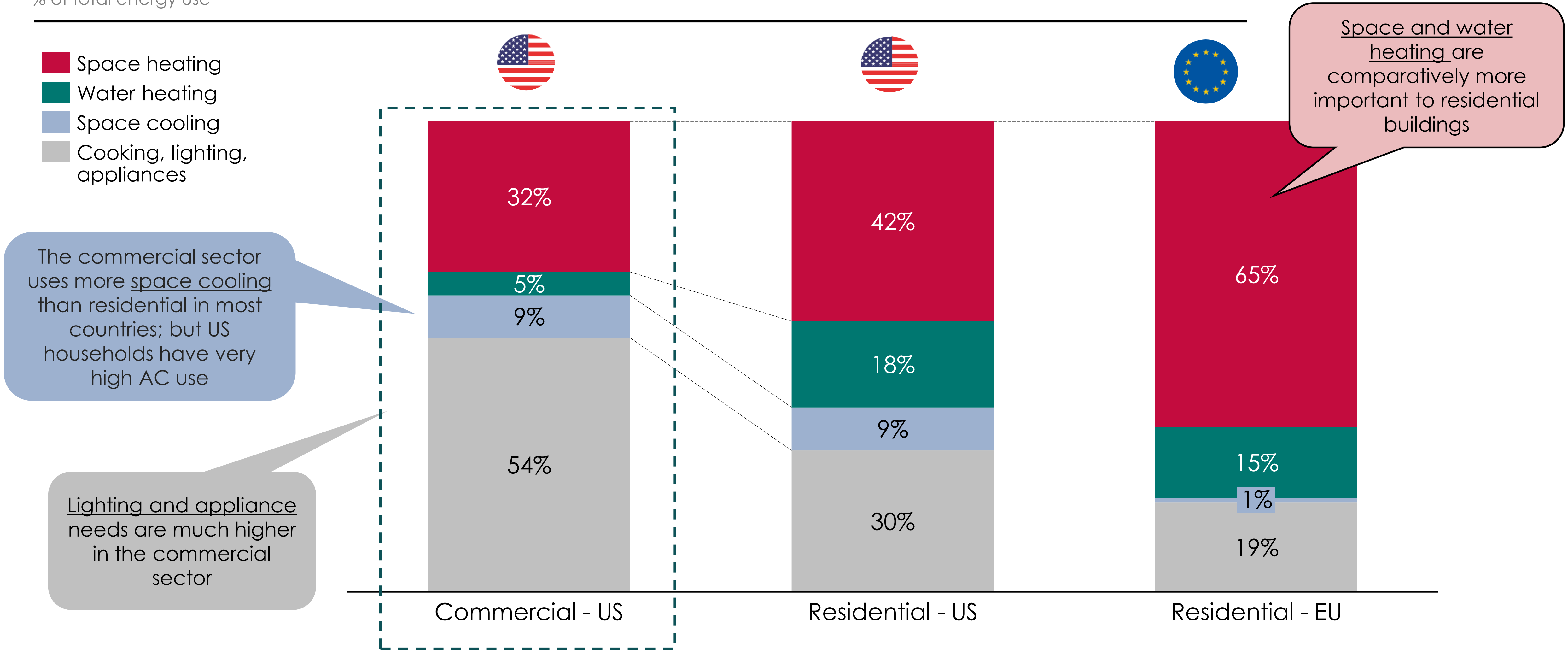
Heating, ventilation and air conditioning (HVAC) in bold



Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey*.

Compared to residential buildings, significantly more energy is used for lighting and appliances and relatively less for space and water heating

Energy end-use, commercial vs residential in the US and EU
% of total energy use



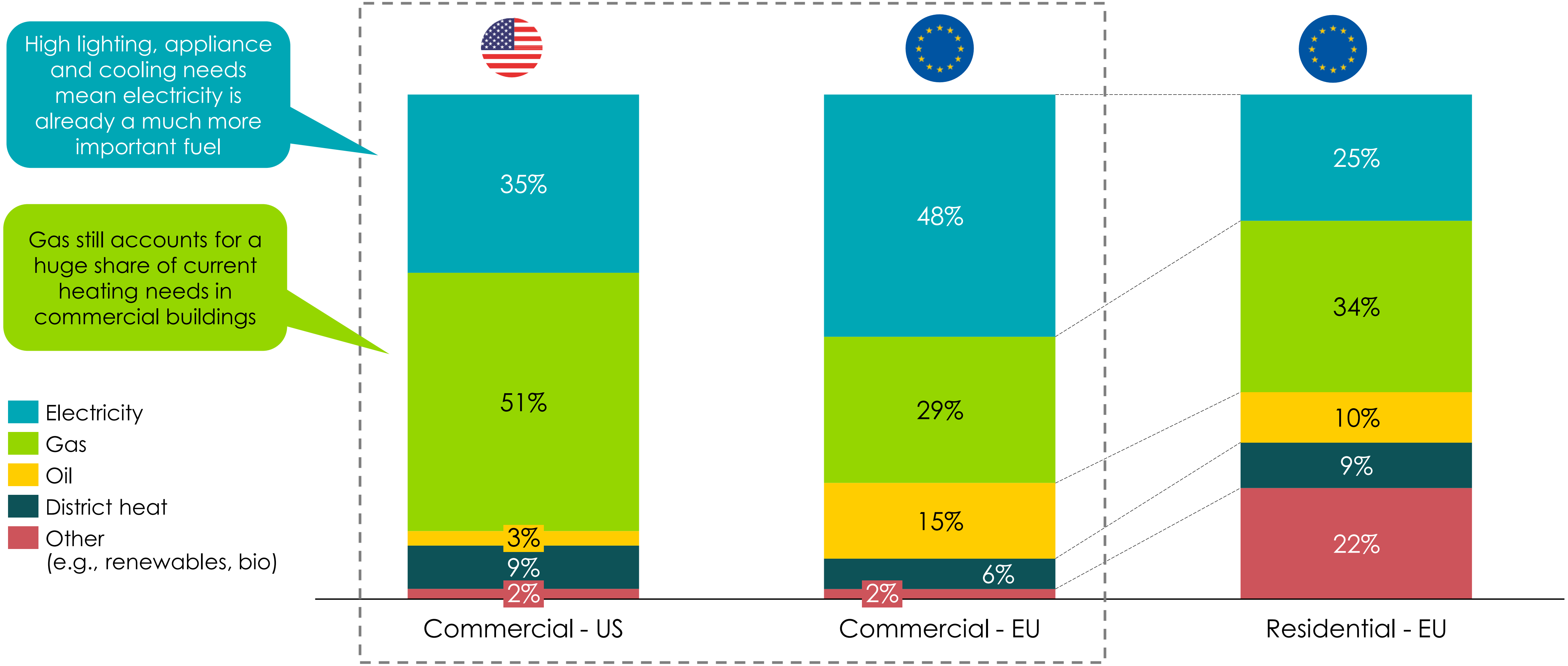
Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey;* EIA (2023), *Annual household site end-use consumption, 2020;* Eurostat (2023), *Energy consumption in households;* Building Performance Institute Europe (2015), *Europe's Buildings Under the Microscope.*

Compared to residential buildings, significantly more energy is used for lighting and appliances - meaning electricity is already a more important fuel

Fuel use, commercial vs residential in the EU % of total energy use

High lighting, appliance and cooling needs mean electricity is already a much more important fuel

Gas still accounts for a huge share of current heating needs in commercial buildings

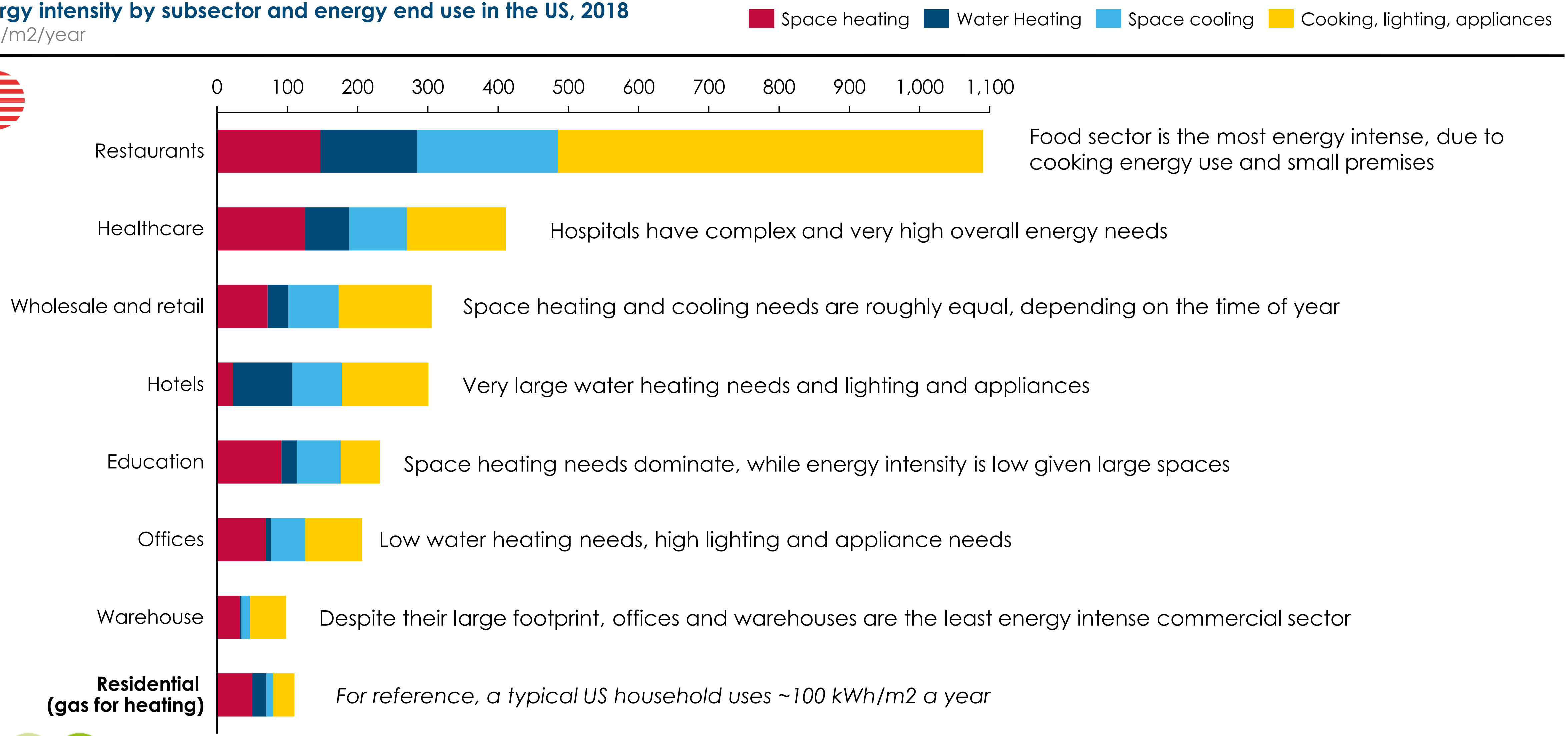


Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey;* EIA (2023), *Annual household site end-use consumption, 2020;* Eurostat (2023), *Energy consumption in households;* Building Performance Institute Europe (2015), *Europe's Buildings Under the Microscope.*

Energy needs differ significantly across different types of commercial building; there are no one-size-fits all technologies

Energy intensity by subsector and energy end use in the US, 2018

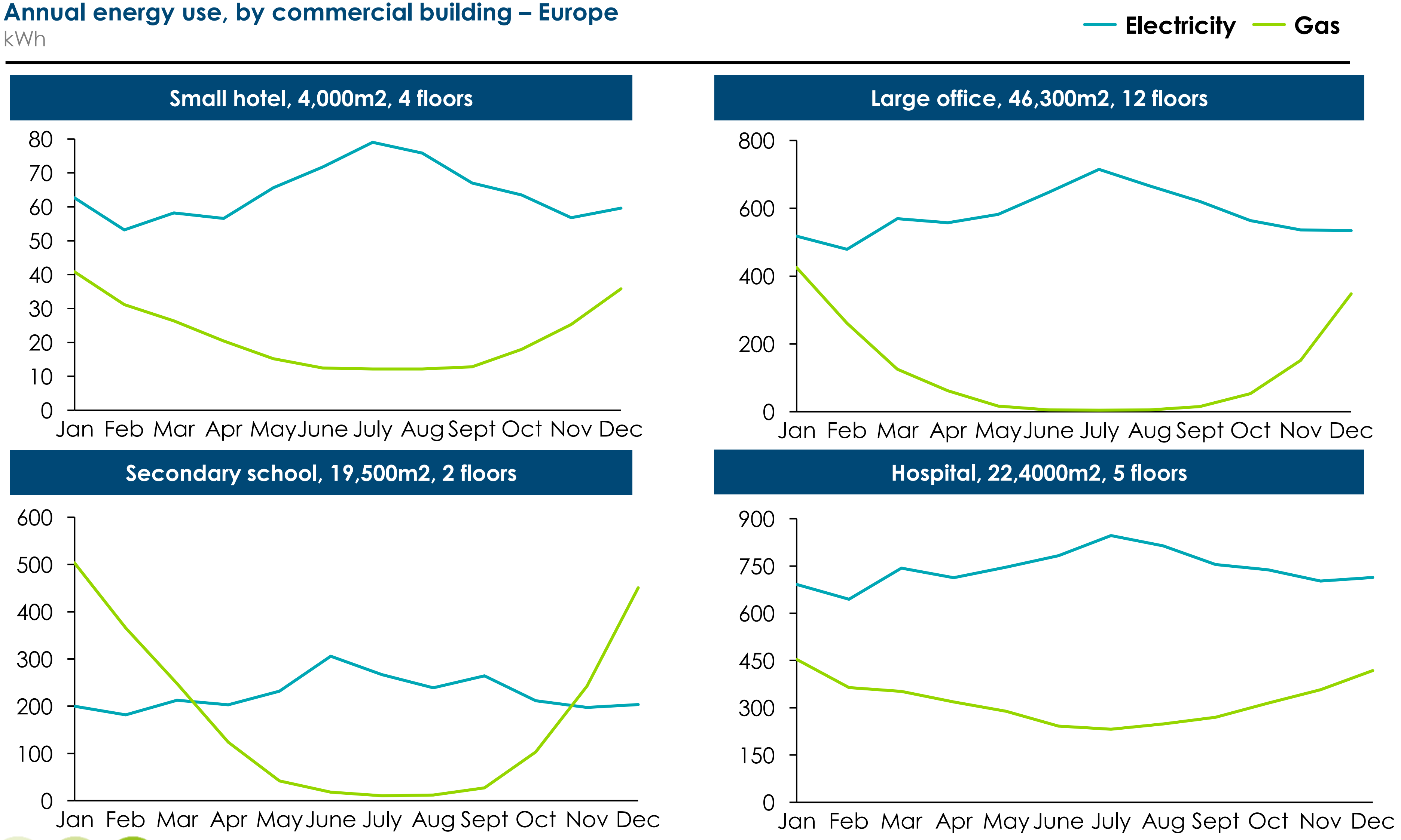
kWh/m2/year



Sources: National Renewable Energy Laboratory

Most commercial buildings have seasonal heating and cooling needs; but hospitals experience much smaller monthly changes

Annual energy use, by commercial building – Europe
kWh

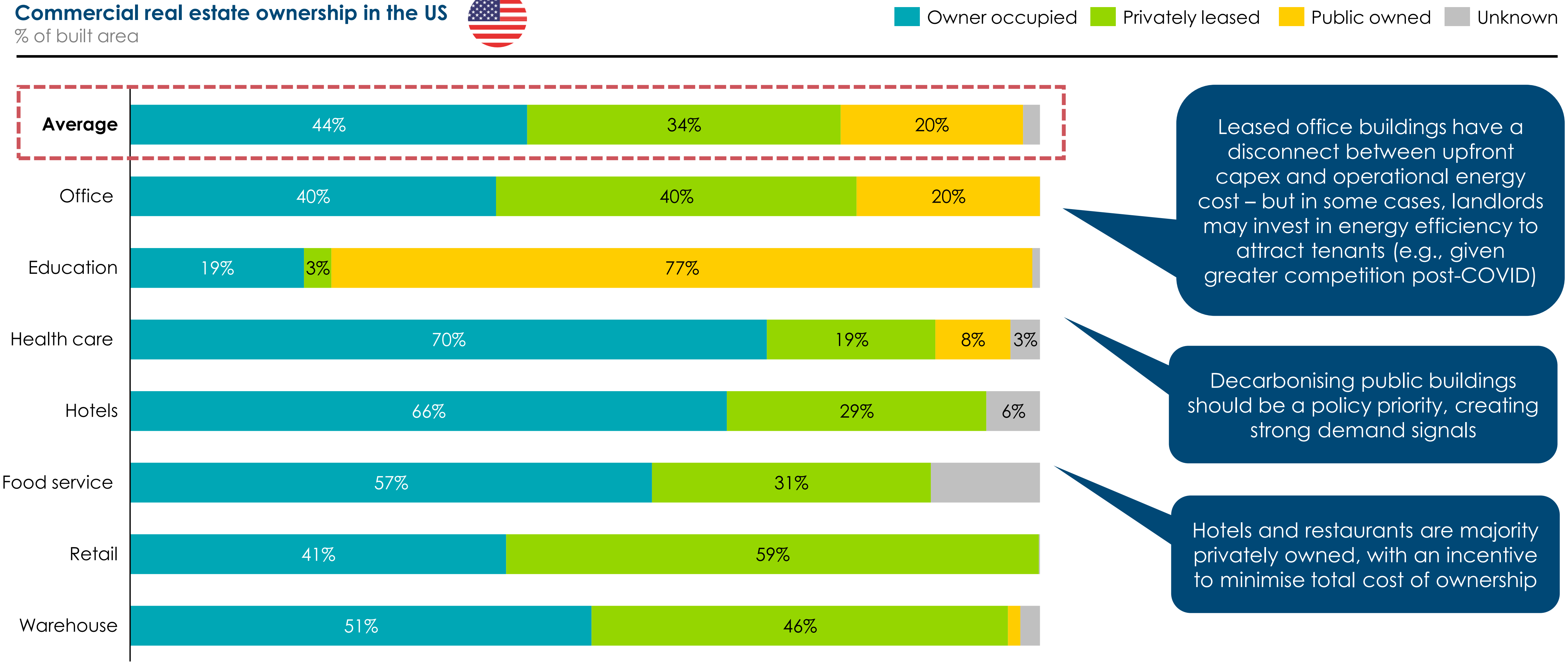


- Hotels and offices have very large summer electricity peaks, driven by cooling demand
- Offices and schools have very low summer gas needs → the fall is smaller in hotels due to hot water needs
- Hospitals have much more consistent energy needs all year round

Source: Systemiq analysis for the ETC (2024) of Schneider Electric Sustainability Research Institute

The ownership of commercial real estate varies massively, requiring targeted policies to drive action across private owners, landlords and public buildings

Commercial real estate ownership in the US
% of built area



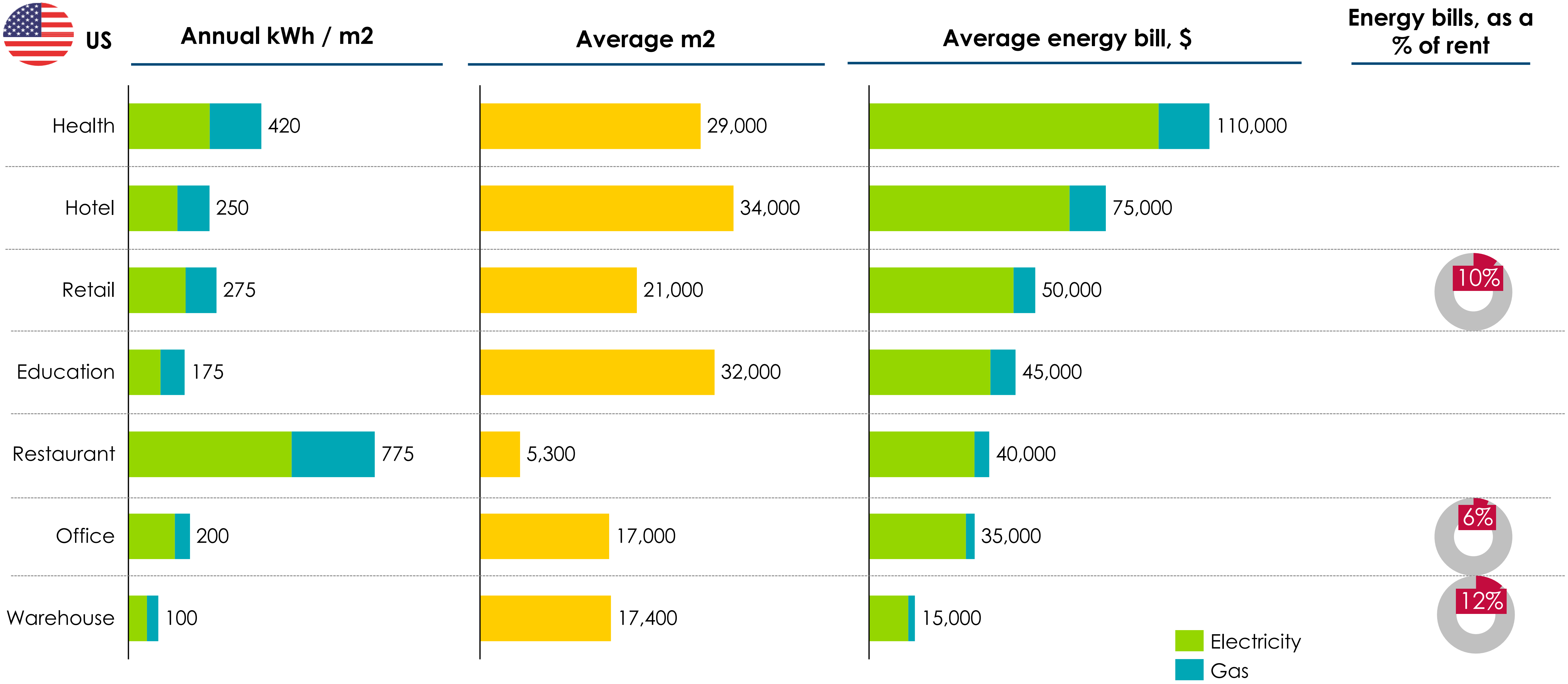
Leased office buildings have a disconnect between upfront capex and operational energy cost – but in some cases, landlords may invest in energy efficiency to attract tenants (e.g., given greater competition post-COVID)

Decarbonising public buildings should be a policy priority, creating strong demand signals

Hotels and restaurants are majority privately owned, with an incentive to minimise total cost of ownership

Sources: McKinsey Global Institute, 2023; Arup, United States Green Buildings Council, Arup, 2023, US Energy Information Agency - Commercial Buildings Energy Consumption Survey (CBECS), 2018

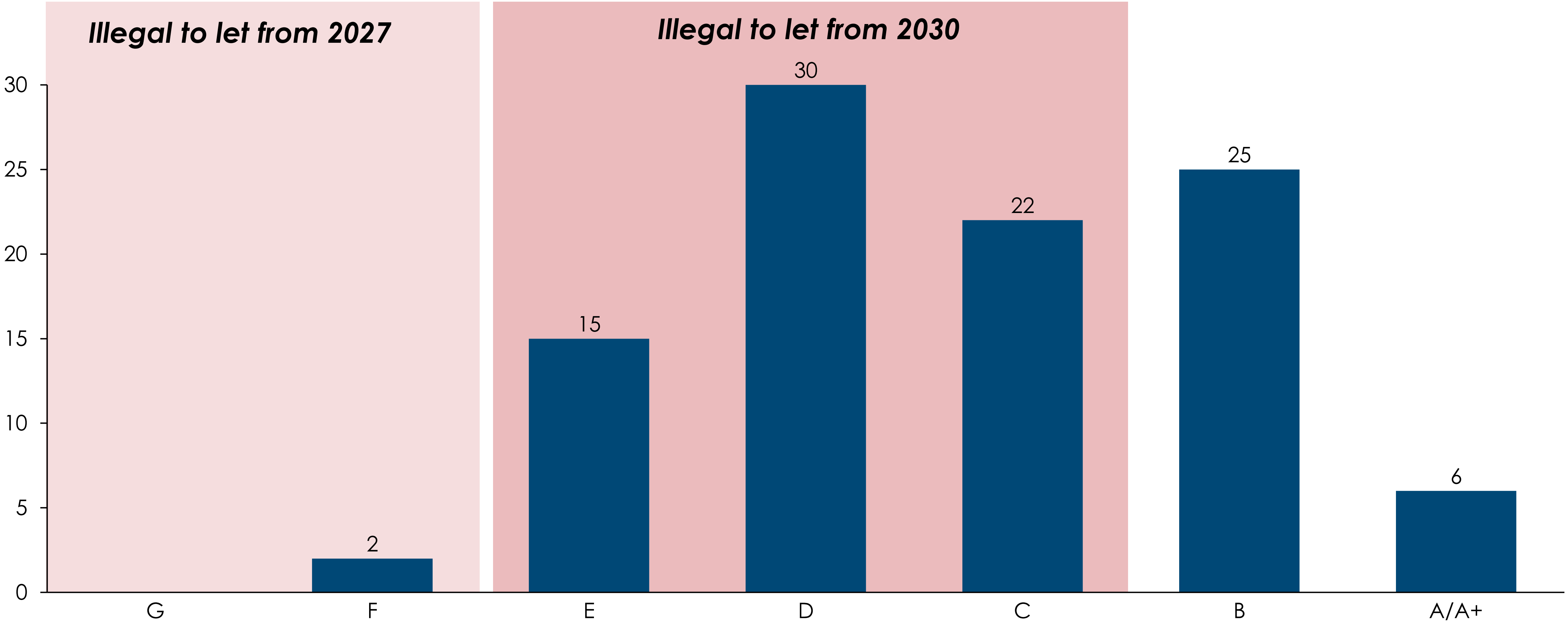
Energy expenditures vary massively across commercial building types, equivalent to around 5-10% of rent in retail and offices



Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey;* Doorloop (2024), *US Commercial real estate statistics.*
Note: based on 2023 electricity and gas prices of $0.13/kwh for commercial electricity and $0.04/kwh for commercial gas.

Data to understand the energy efficiency of commercial buildings today is very limited, but just as with residential, performance varies significantly

EPC ratings of London's office stock
% of total number of offices



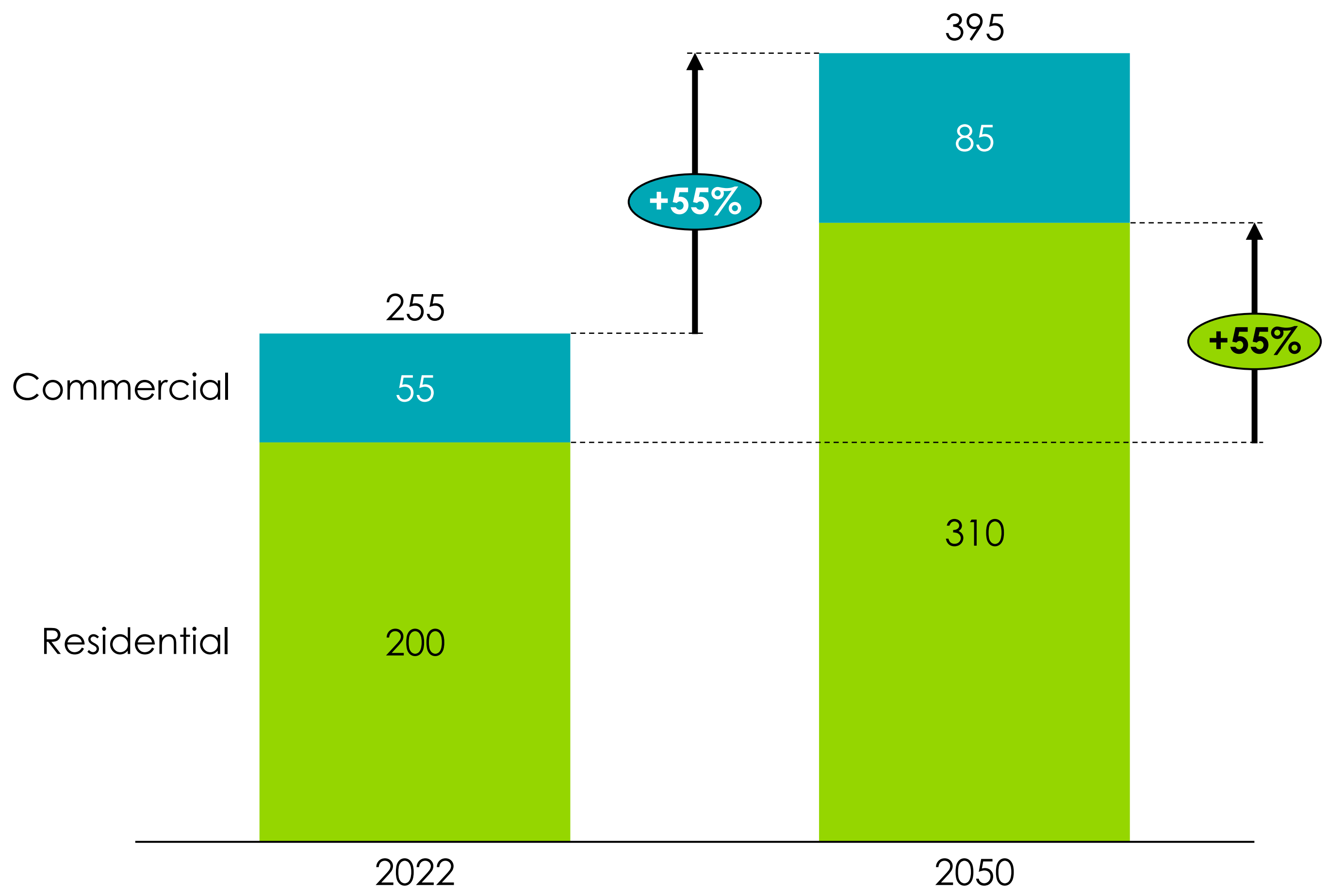
Sources: Savills (2021), *How sustainable is the office stock in the UK?*

New commercial buildings

Commercial building floor area is set to increase by 50% to 2050

Growth in global floor area by type

2022-2050; Billion m2; IEA NZE Scenario



Source: IEA (2023), *World Energy Outlook 2023;*

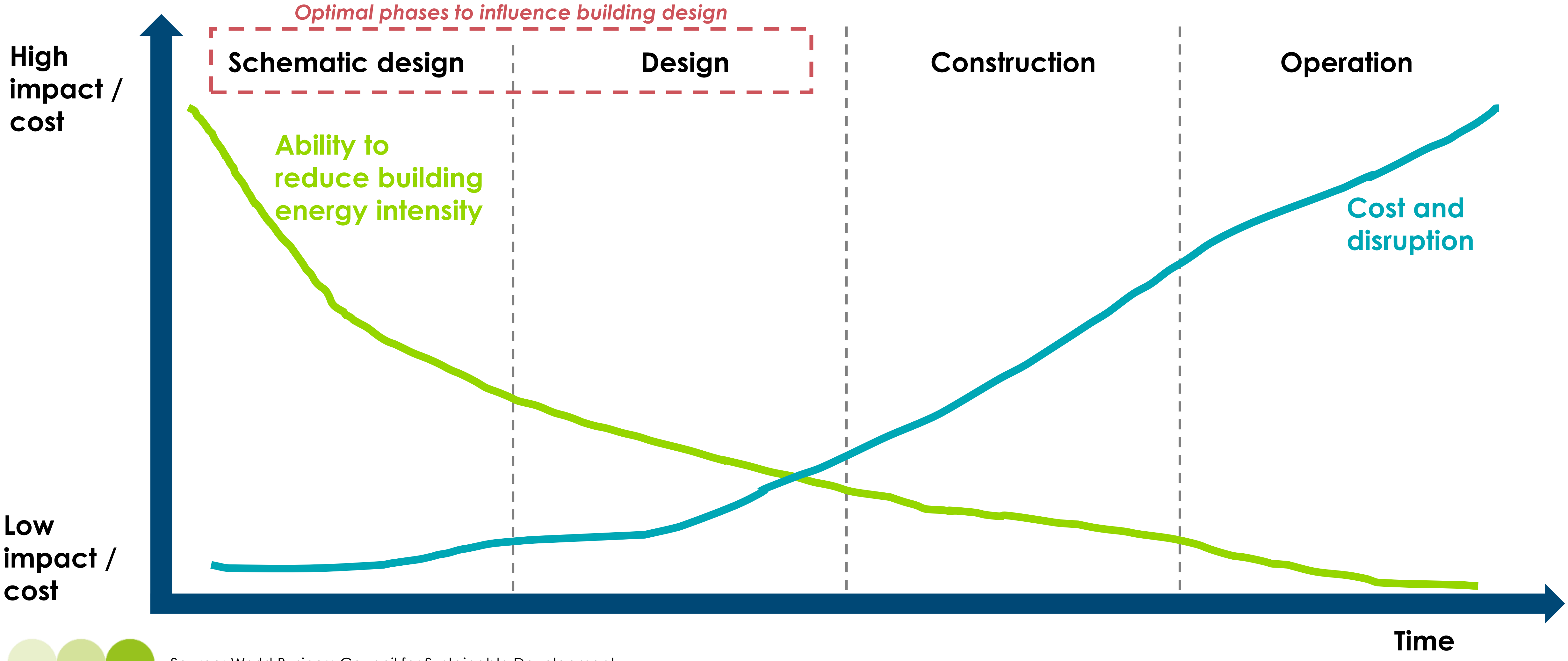
Three opportunities to reduce operational energy requirements in new commercial buildings:

1. *Passive heating and cooling design choices*
2. *Clean heating and cooling technologies*
3. *Other technology choices to maximise efficiency (e.g., building management systems, efficient lighting)*

The optimal time to influence a building's energy efficiency is in the schematic and design phase; retrofitting existing buildings is costly, disruptive and less impactful

Potential to reduce operational energy intensity at different stages of a building's lifecycle

ILLUSTRATIVE

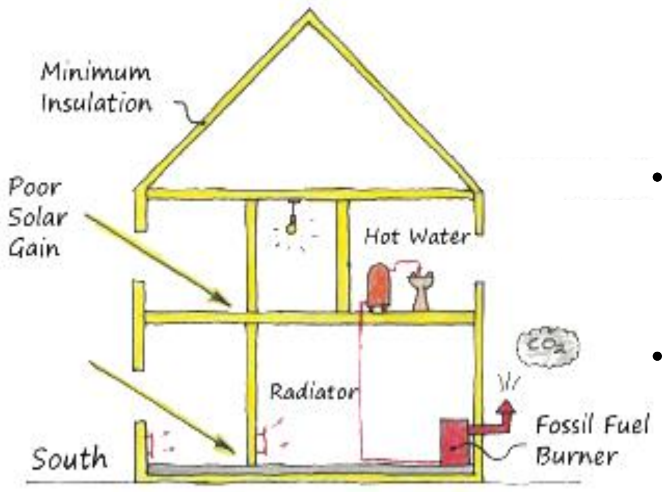


Source: World Business Council for Sustainable Development

Design choices

In workshop 3, we explored the passive techniques in building design that can reduce the extent to which active heating and cooling is required

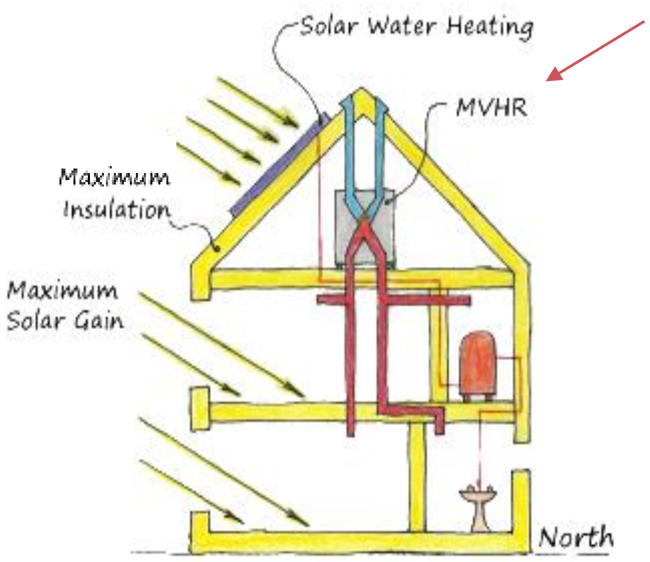
Active systems **rely on mechanical equipment** to regulate indoor temperatures. While these systems typically consume energy, there are several ways to reduce energy requirements



• Active Design

- **High-efficiency HVAC systems**: heat pumps over gas boilers, high-efficiency ACs and fans
- **Smart systems**: allows for more precise control over temperature settings
- **Renewable energy**: installing solar panels to generate heating and electricity

Passive techniques **rely on the natural elements and design features of a building** to maintain comfortable indoor temperatures, minimising the need for mechanical systems



• Passive Design (heating)

Passive heating

- Orientation / passive solar design
- Insulation
- Double / triple glazing
- Thermal mass
- Mechanical ventilation with heat recovery (MVHR)

Passive cooling

- Orientation
- Building shape and form
- Shading
- Natural ventilation
- Insulation
- Reflective roofing

Source: Passive Case Study (2012), *Passive Design*

Passive cooling techniques focus on minimizing heat gain and maximizing natural ventilation

Orientation: orientating buildings relative to the sun's path to maximise or minimize solar heat gain

Building design: incorporating shading elements, strategic ventilation structures, and optimizing building shape and form enhances natural airflow

Building envelope: insulation, air tight construction and appropriate window glazing to retain heat / cooling in a building and/or decrease solar gain

Material and colour choice: using high-reflectivity materials and light-coloured surfaces on roofs and walls minimizes heat absorption

City design and site adaptation: adapting to local climate conditions and implementing green spaces

In residential buildings, a **low window-to-wall ratio** (e.g., windows < 20% of total area) is recommended to reduce solar gain. **But many office and other commercial buildings have a significant glass façade**

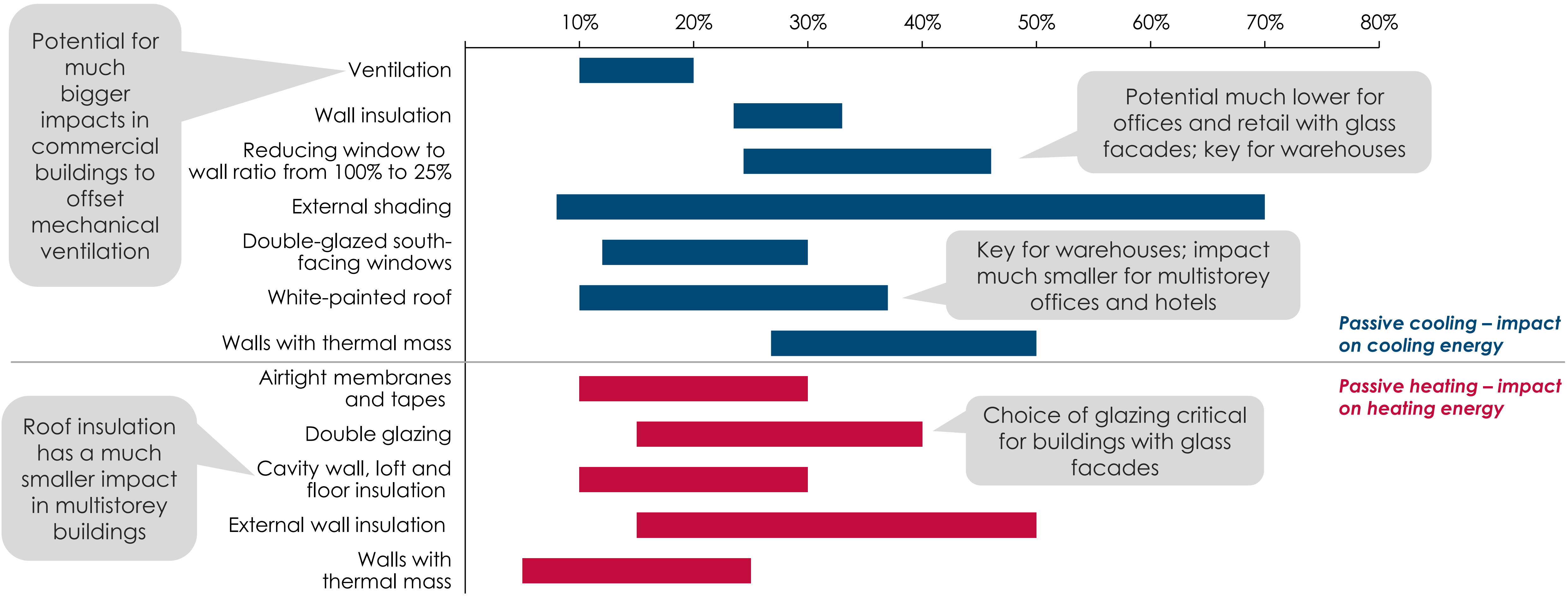
Bright and reflective coatings on roofs (reflect sunlight)

Walls and ceilings painted white (don't absorb heat as much)

Passive techniques in commercial buildings are expected to have similar impacts as in residential buildings, where heating/cooling energy can reduce by 15-40% on average

Heating and cooling energy consumption reduction by passive techniques in residential buildings

% reduction



Source: Systemiq analysis for the ETC (2023); Energy Saving Trust; Checkatrade; The Eco Experts; Department of Energy and Climate Change (2014), National Energy Efficiency Data-Framework; Kattenberg, L., et al. (2023), The Efficacy of Energy Efficiency: Measuring the Returns to Home Insulation; Adan, H., Fuerst, F. (2016), Do energy efficiency measures really reduce household energy consumption? A difference-in-difference analysis. Energy Efficiency 9, 1207–1219; Hamilton, I., et al. (2013), Energy Efficiency in the British Housing stock; Tuohy et al. (2005), Thermal mass, insulation and ventilation in sustainable housing - An investigation across climate and occupancy Ahmed et al. (2023), The impact of window orientation, glazing, and window-to-wall ratio on the heating and cooling energy of an office building: The case of hot and semi-arid climate; Song et al. (2021), A review on conventional passive cooling methods applicable to arid and warm climates considering economic cost and efficiency analysis in resource-based cities.

Note: heating reductions are based on a single-family house of 100m2; cooling reductions are based on a single-family house/flat or 60-80m2

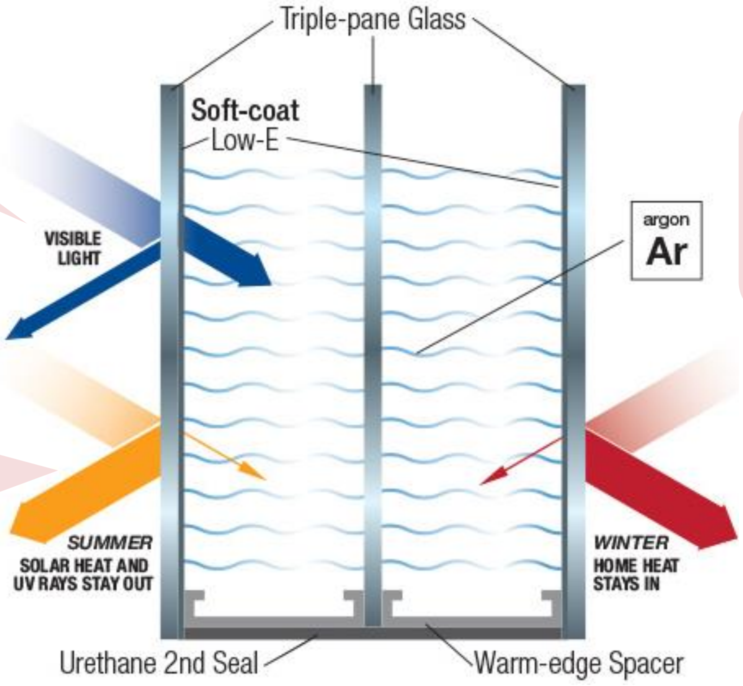
Windows are a critical part of building façades for many offices, hotels, schools and hospitals; various glass technologies exist to aid in passive heating and cooling

Low-emissivity glass

- Minimises the amount of **infrared and ultraviolet light** that comes through glass – without minimising the amount of light
- Coating (of silver) which is a **poor radiator of** heat, **reflecting heat** for a consistent indoor temp

Light still enters building

Heat from solar reflected back



Heat from room reflected back inside

Electrochemical / smart glass

- Allows you to **control the amount of light** and solar radiation that enters a building through variable glazing
- Works by ionising particles within a conductive coating
    - When **electricity** is applied, the **metal ions** within the coatings are all attracted to one face of the coating
    - This build up provides **tinting** within the double or triple glazed unit
- Works best as part of a **smart system** → predictive and real-time inputs (e.g., weather, location, cloud cover)

1 Small electric charge causes lithium ions to transfer layers

This makes the glass tint Reversing the polarity causes the glass to clear 2

In commercial buildings, structures for shading and green facades can be much more innovative and have significant impacts on energy consumption

Structures for shading

Offices, schools, hospitals, retail, hotels

- Fins on Northeastern University's façade mitigate direct solar gains from the southwest, while allowing light in and protect windows from direct exposure to elements

Northeastern University, US – Arup

Green façades + roofs

Offices, retail, hotels

- Reduce heat island effects
- Reduce noise levels
- Improve air quality
- Reduces thermal gain – constant building temperature year round

Citibank data centre, Frankfurt – Arup

Commercial buildings face a different set of considerations and trade-offs compared to residential buildings

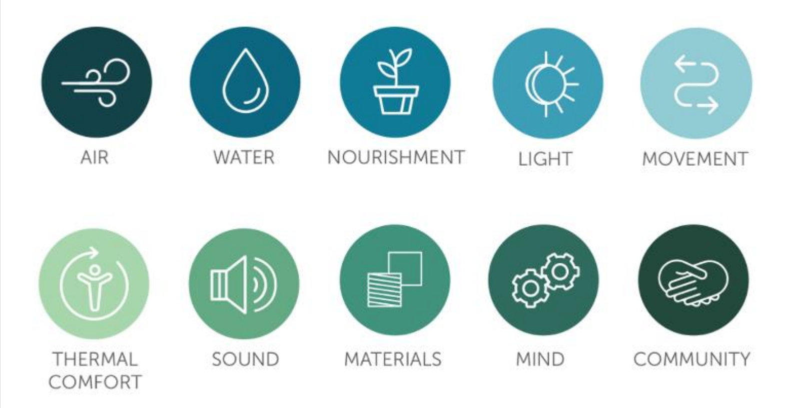
Key trade-offs for operational energy savings

- **Aesthetics:** certain design features can increase heating or cooling needs
- **Natural lighting vs cooling/heating needs:** more windows can greatly reduce lighting requirements but can increase heating/cooling needs
- **Air quality:** natural ventilation can come at the expense of heating/cooling energy loss

Other considerations for building design

- **Safety and fire risk**
- **Accessibility**
- **Noise and acoustics**

The WELL standard certifies buildings which have strong human health and wellbeing performance (e.g., air quality and circadian lighting)



For most offices, windows and glazing choices will have the biggest impact on energy consumption; roof and wall insulation are relatively less important

Offices

Small roof space relative to number of occupants and energy needs

Tall buildings increase solar gain

Very large window to wall ratio increasing solar gain

Key considerations:

- Ventilation is key, especially post-COVID
- Aesthetics and natural light are very important

Implications:

Passive heating

- Choice of glass is critical - wall insulation is relatively less important
- Roof insulation less important

Passive cooling

- Low-emissivity and electrochemical glass likely to have the biggest impact on energy consumption
- Orientation can be more challenging if all sides of building are used

In comparison, roof and wall insulation is much more important for warehouses, with little focus on windows

Warehouses

Typically just one story high

Large roof space

Small window to wall ratio

Many access points required

Key considerations:

- Perishable items which require exact temperatures
- Large external doors which are frequently opened
- Aesthetics less important

Implications:

Passive heating

- Roof insulation is critical given very large surface area
- Wall insulation is very important

Passive cooling

- Potential for shading structures and landscapes is limited
- Painting roofs white can have a significant impact on reducing solar gain

In Indonesia, indoor temperatures dropped by around **10°C** following the application of cool roof coating at one industrial site

Passive heating and cooling techniques are vital in hotels, where occupants have control over their active heating and cooling

Hotel

Many stories high

Individual temperature controlled rooms

Need to balance natural light and privacy

High window to wall ratio

Key considerations:

- Vital importance of ventilation and health and safety
- Aesthetics important

Implications:

Passive heating

- Sufficient wall insulation and window glazing are very important considerations

Passive cooling

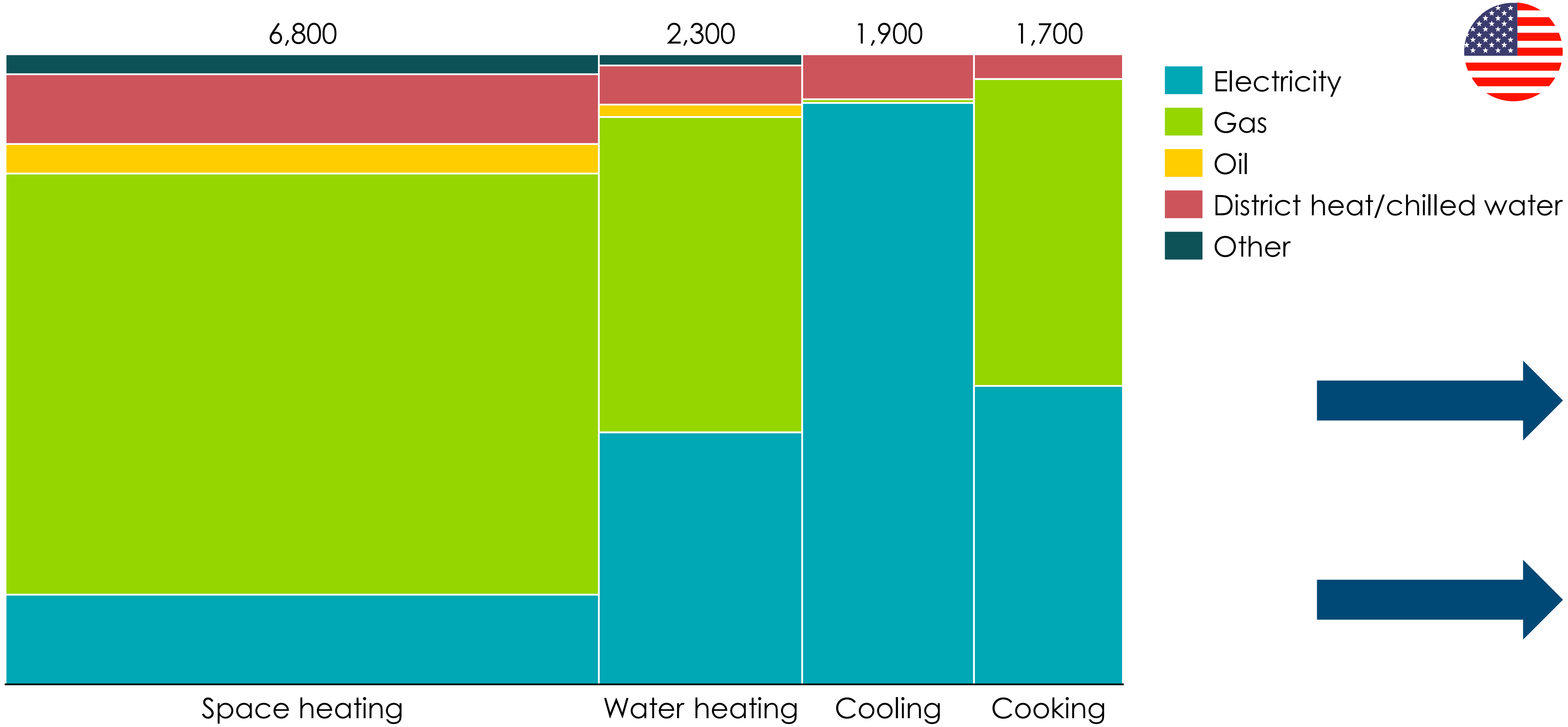
- Shading on windows to reduce solar gain
- Orientation can be more challenging if all sides of building are used
- Painting hotels white likely limited by aesthetic preferences

Clean heating and cooling technologies

Fossil fuels are currently the dominant source of space and water heating needs in most commercial buildings in Northern latitude countries

Commercial building fuel use by selected end-uses, US

TWh, 2018



Two key challenges for the commercial building transition:

1. Decarbonise heating and cooking
2. Manage the massive increase in clean power needs as they electrify

Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey*

In workshop 3, we concluded that heat pumps should be the default solution in new build residential buildings – although there is no one-size-fits-all and a range of technologies exist

	Conclusion for new residential buildings	Conclusion for new commercial buildings
Air to air heat pump	Level of insulation is much stronger in new builds, making them more suitable Cooling needs increasing, making it more desirable to prospective buyers	Potential for even stronger paybacks due to higher efficiencies in a combined heating + cooling system *(see next slide)*
Networked ground source heat pump	Many new developments should have sufficient scale (e.g., blocks of flats, terrace housing) and likely easier to finance (e.g., investors in ground arrays are guaranteed returns given all properties signed up)	Potential for new commercial buildings to have even greater scale and easier financing
Resistive space heating	Heat pumps can always be designed to be suitable in new builds. Resistive heating would likely make it hard for developers to meet energy intensity regulations Note: while unlikely to be used at scale for space heating, resistive heating will play a key role in water heating (e.g., combined with an air to air heat pump)	
Air to water heat pump	Capex costs for air-to-water heat pumps are higher, meaning developers are unlikely to select this option – unless they consider buyers will pay a premium for air-to-water (which is likely to be more the case for residential than commercial)	

Traditionally, HVAC systems have been developed in silo (e.g., via mini or multi-splits) but there is a huge opportunity to shift to combined systems which are much more efficient

Ductless mini-split

- Single-zone heat pump or AC
- Single outdoor and single indoor unit
- No need for ductwork
- Suitable in buildings with a limited number of different thermal zones

Ducted multi-split

- One outdoor unit serving two or more indoor units
- Heating and cooling distributed via ducts
- Ability to tailor heating and cooling to individual thermostats in different areas of a building

Variable refrigerant flow (VRF) systems:

A combined heating and cooling electric system, which can **heat and cool simultaneously**

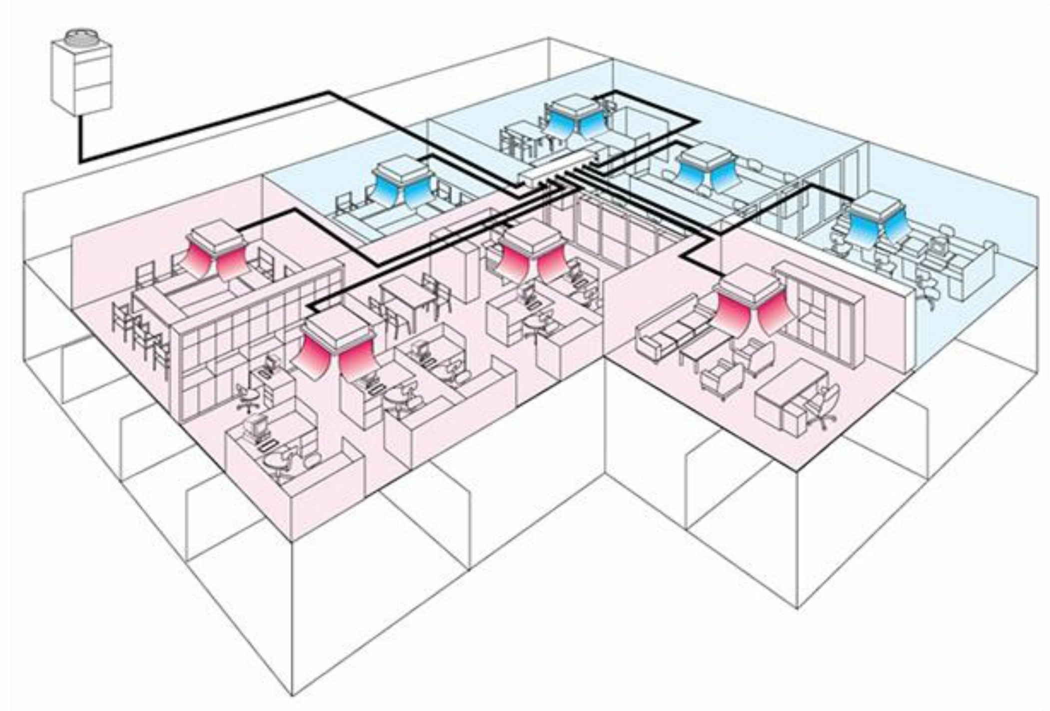
- Multiple indoor units connected to one outdoor
- Residual heat from a cooling zone is absorbed and redirected to a zone requiring heat
- **Variable speed compressor** enables system to operate continuously but at varying speeds to match demand
- Potential to **reduce energy consumption by 30-40%**

See next slide

Note: HVAC = heating, ventilation, and air conditioning. Sources: Trane Technologies, *Electrifying buildings with VRF technology*

Variable refrigerant flow systems offer huge opportunities for efficiency gains from combined heating and cooling systems by utilising waste heat

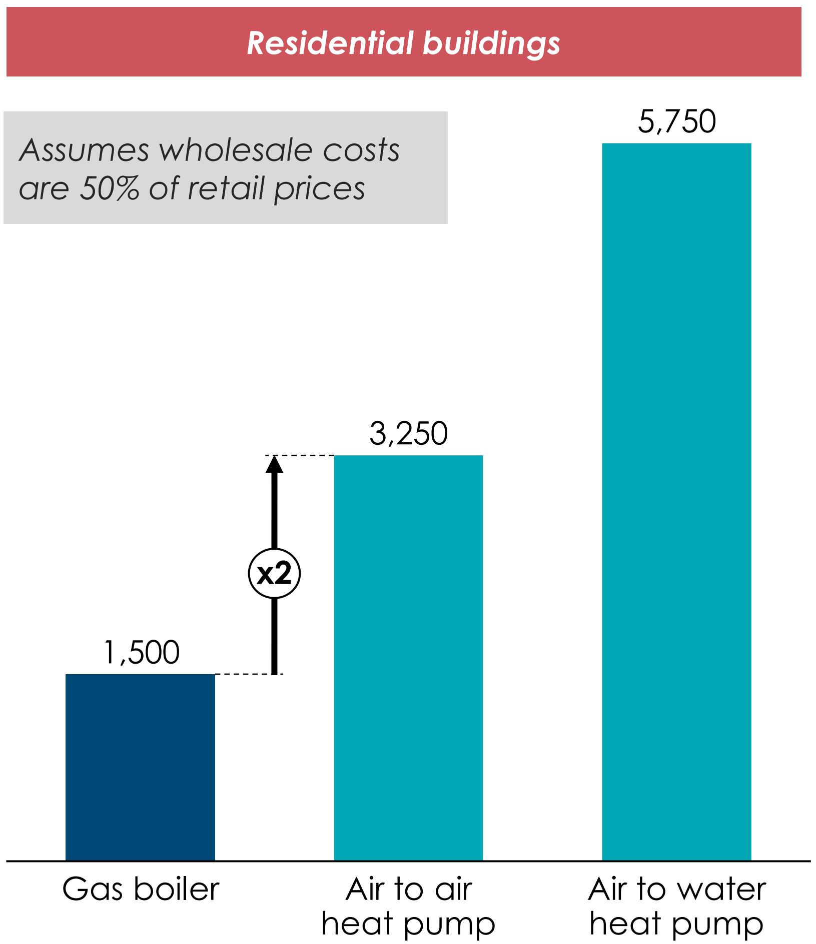
Illustration of heating and cooling in a VRF system



When heating demand is greater than cooling	>	Additional heat from air to water is used to make up for the gap
When cooling demand is greater than heating	<	Excess heat is ejected into the atmosphere
When heating demand is equal to cooling	=	No heat is being ejected into or extracted from the environment

There is likely to be a cost premium for developers to install a heat pump system in a new commercial building; but these are expected to be manageable

Wholesale costs of heating technologies (Europe)
€



Could the cost premium be greater in commercial buildings?

- Systems are larger and more complex
  - Combined heating, cooling and ventilation (e.g., with heat recovery)
- Health and safety standards (e.g., managing refrigerant leakage)

However, these cost premiums can be managed:

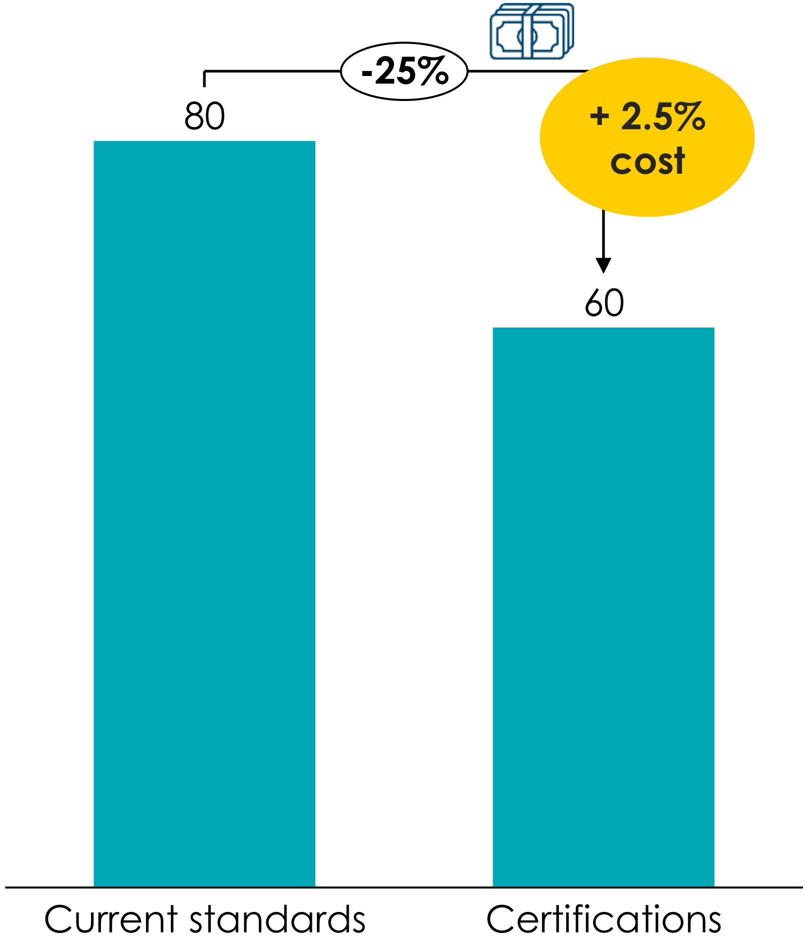
- For large commercial buildings, there is typically a very competitive tender process for architects and construction
- New builds charge a premium anyway
- Potential for huge running cost savings due to greater efficiency

Sources: Systemiq analysis for ETC (2024); Eurostat for Europe electricity and gas prices.
Note: figures presented represent the average of costs from ETC literature review. Costs do not include the cost of retrofit measures or any subsidies.

The total cost of construction premium of moving from current standards to typical certification levels is typically very manageable (1-5%)

Incremental energy reductions and associated cost premium

kWh/m2/year and % cost premium relative



These figures reflect a literature review assessing the average incremental cost in residential and commercial buildings.

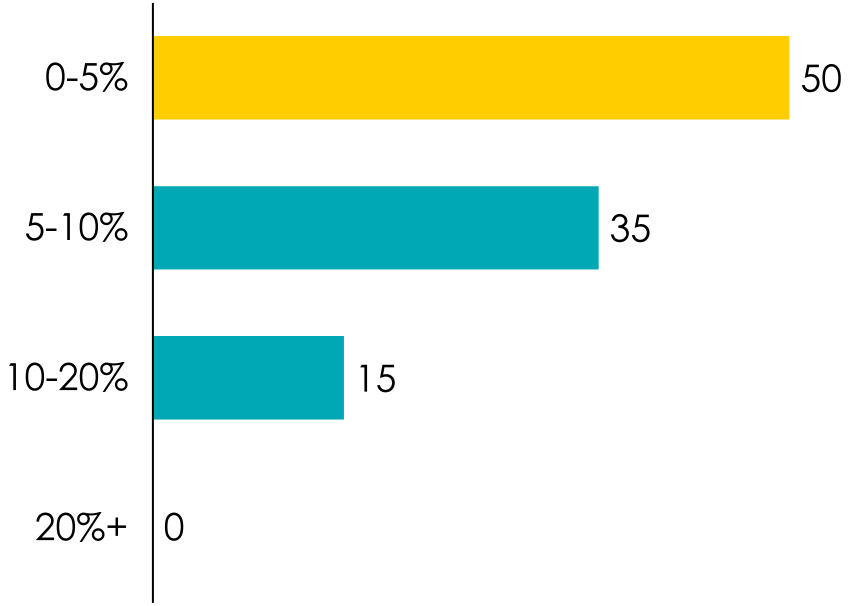
The cost premium in commercial buildings will, however, vary hugely. In some cases, they could be:

- **Smaller** – for example, warehouses where design is much simpler
- **Large** – for example, hospitals and offices where design is much more complex

Survey of real estate investors

% of respondents

What cost premium or return discount would you be willing to accept in the short-term to meet sustainability targets in the medium- to long-term?



Source: Checkatrade (2023), *What is a Passive House and how much does passivehaus certification cost?*; Buildpass (2021), *What is PassivHaus retrofit?*; Statista (2024), *Average construction cost of completed buildings per square meter in China in 2022, by region*; Chen (2020), *Evaluating the economic feasibility of the Passive House in China*; WSP (2019), *Green Building Strategies Cost Analysis*; UK Green Building Council (2020), *Building the case for net zero: A feasibility study into the design, delivery and cost of new net zero carbon buildings*; Davis Langdon (2004), *Costing Green: A comprehensive cost database and methodology*; TERI (2015), *Energy efficient buildings – a business case for India?*; *JLL (2021),* Investor Survey.

Other technology choices and efficiency

There is a disconnect between a building's predicted energy consumption based on its design, and what commercial building tenants actually consume

The performance gap: the difference in energy consumption **predicted based on the design of a building** and its **actual energy use in operation**

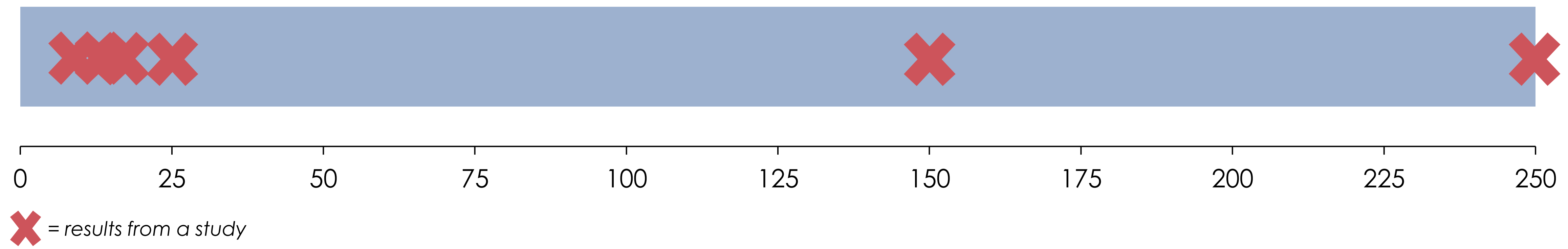
Estimates of the size of the performance gap vary significantly, ranging from 10-25%, to 1.5-2.5 times higher

Generally **higher in commercial buildings:**

- More energy consumption is "unregulated loads" (e.g., plug loads which depend on tenant behaviour)
- Energy loads vary massively depending on occupant types and density.

Increase in actual building energy consumption relative to predicted – literature review of commercial building studies

%



Source: International Partnership for Energy Efficiency Cooperation (2019), *Building Energy Performance Gap Issues: An International Review*

Three actions can manage operational energy use and help close the performance gap which arises from occupant behaviour

Performance gap can be caused in any of the lifecycle stages:

Design stage	▪ Lack of attention to end user ▪ Inappropriate modelling or assumptions ▪ Lack of attention to buildability
Construction stage	▪ Lack of experience or knowledge, poor workmanship ▪ Cutting corners ▪ Poor quality materials or equipment
Operation stage	▪ Occupant behaviour, attitude and comfort ▪ Rebound effects ▪ Lack of training of occupants ▪ Limited control capability

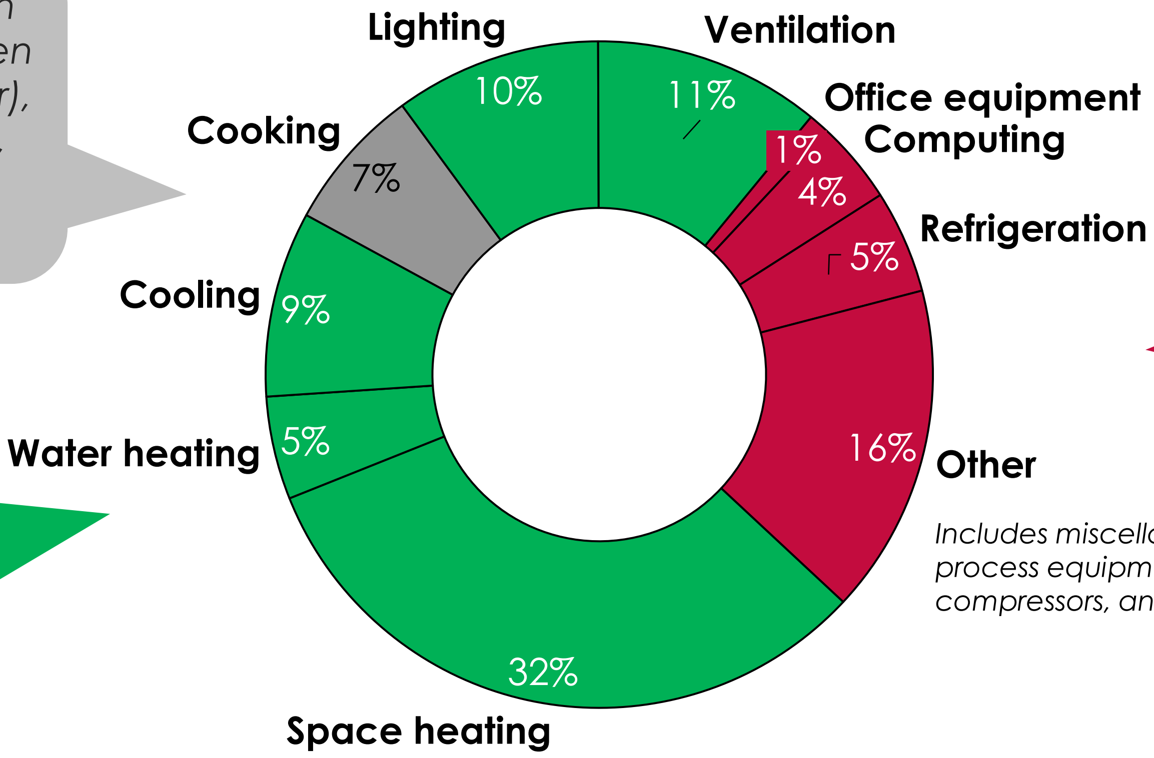
Three key actions required to manage operational energy use in commercial buildings:

1. **Install efficient "regulated" technologies (e.g., AC and lighting)**
2. **Install building management systems**
3. **Install rooftop solar PV and batteries**

Around 25% of commercial building energy use is "unregulated" – i.e. determined by tenant behaviour and needs

Commercial buildings energy consumption by end-use in the US
% of energy consumption

Cooking can be both regulated (e.g., kitchen installed by developer), or unregulated (e.g., tenants add equipment)



Includes miscellaneous plug loads, process equipment, motors, air compressors, and natural gas dryers

~65% of energy use is determined at design stage: fixed building services which can be determined in the building design stage and can be controlled by building managers

~25% of energy use is variable by occupants: appliances which are added by tenants and vary significantly across occupants; these are often poorly modelled in predicted energy consumption

Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey.*

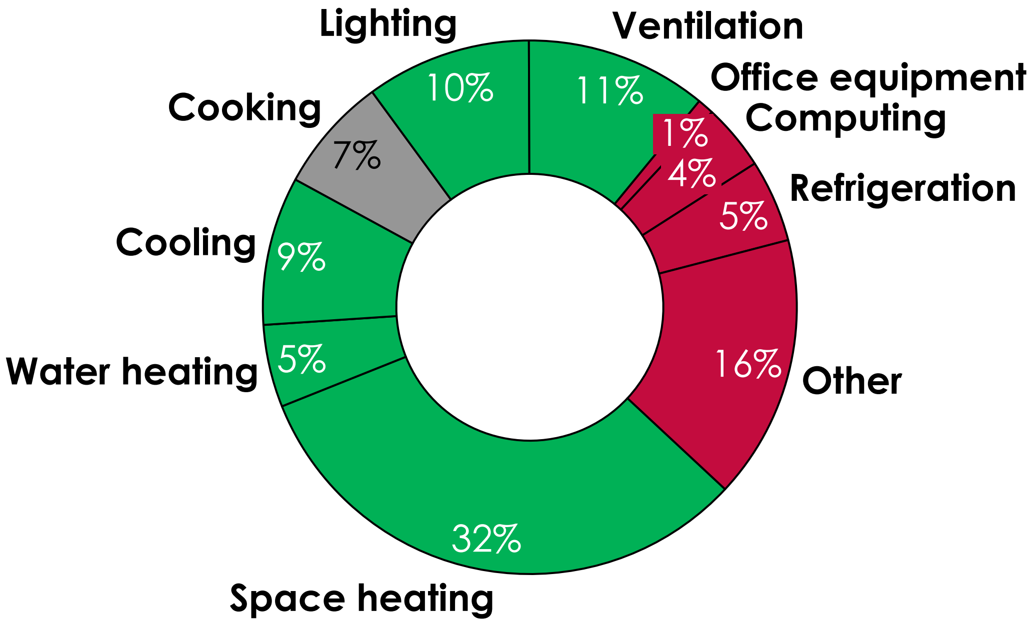
Regulation should push new commercial buildings to install most efficient technologies and lighting, building management systems and ensure they are suitable for rooftop solar

Commercial buildings energy consumption by end-use in the US
% of energy consumption

1 **Install efficient regulated technologies:**

- Heat pumps
- AC
- Mechanical ventilation (e.g., with heat recovery)
- LED lighting

Regulation should mandate minimum energy efficiency standards



2 **Install building energy management systems:**

- Control unnecessary regulated energy use (e.g,. Lighting sensors)
- Provide tenants with information on their unregulated energy use to motivate behaviour change

Regulation should require all buildings to install BMS

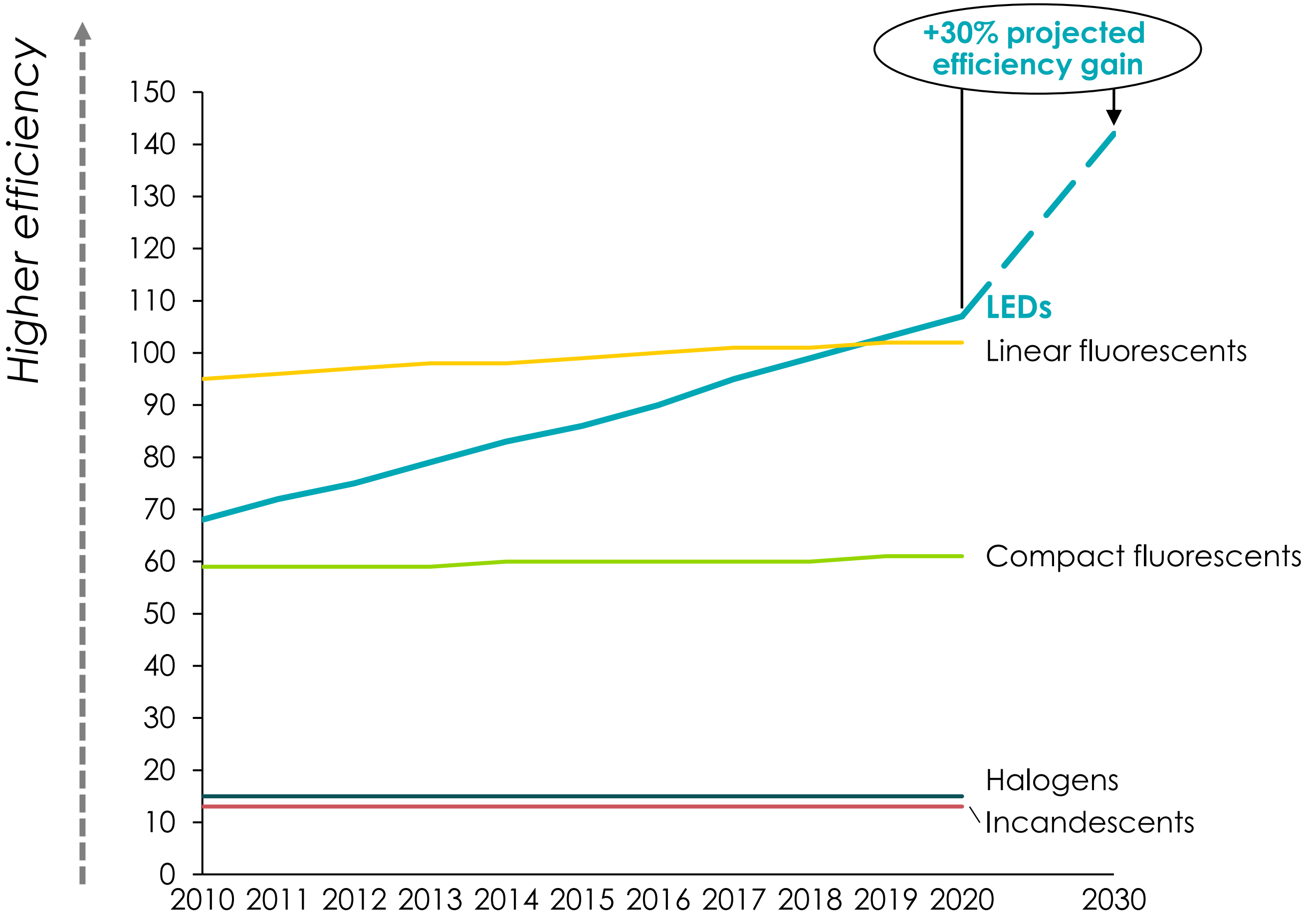
3 **Install rooftop solar PV and batteries,** where roof space relative to energy needs yields a strong payback, to reduce both regulated and unregulated energy consumption, especially at peak times

Regulation should require all buildings to be "solar-ready"

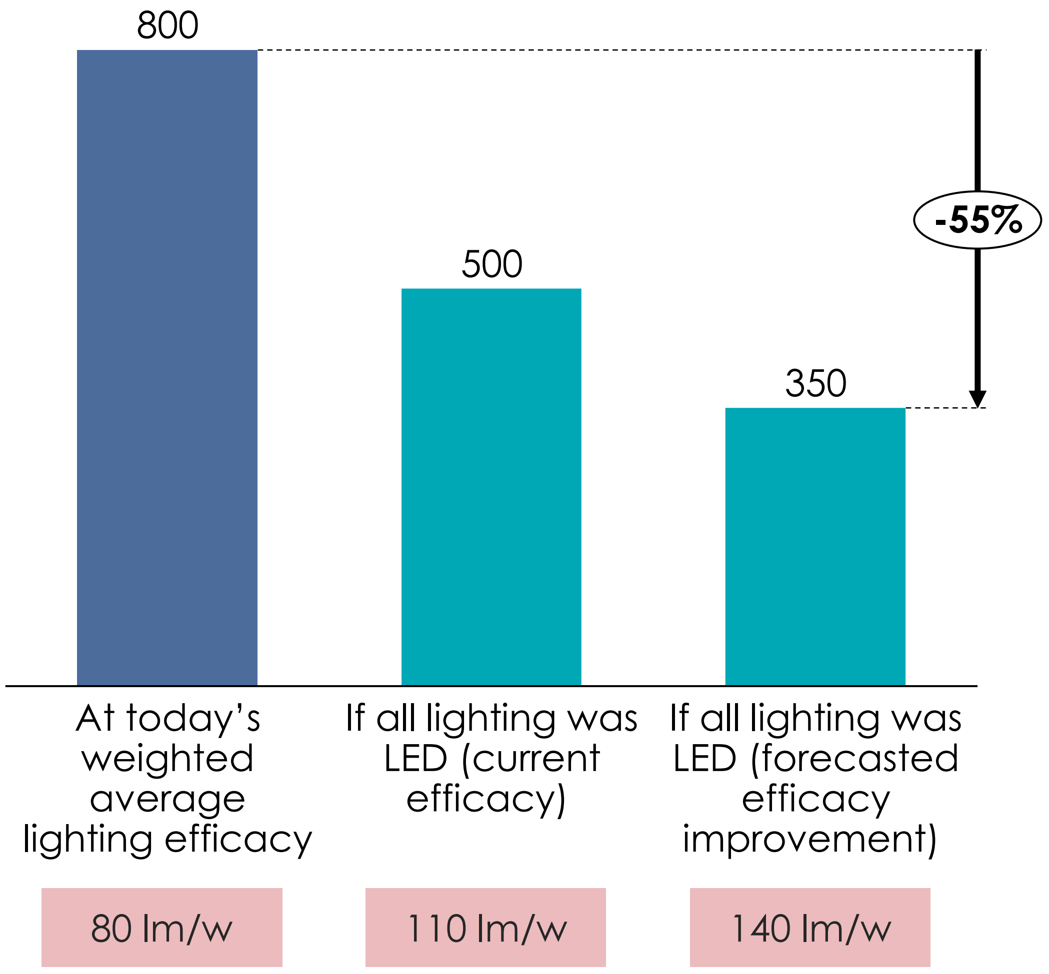
Sources: US Energy Information Administration (2018), *2018 Commercial Buildings Energy Consumption Survey.*

Ensuring all new commercial floor space has LED lighting could lower global annual lighting electricity demand by 35-55%

Global lighting efficacies
Lumens/Watt



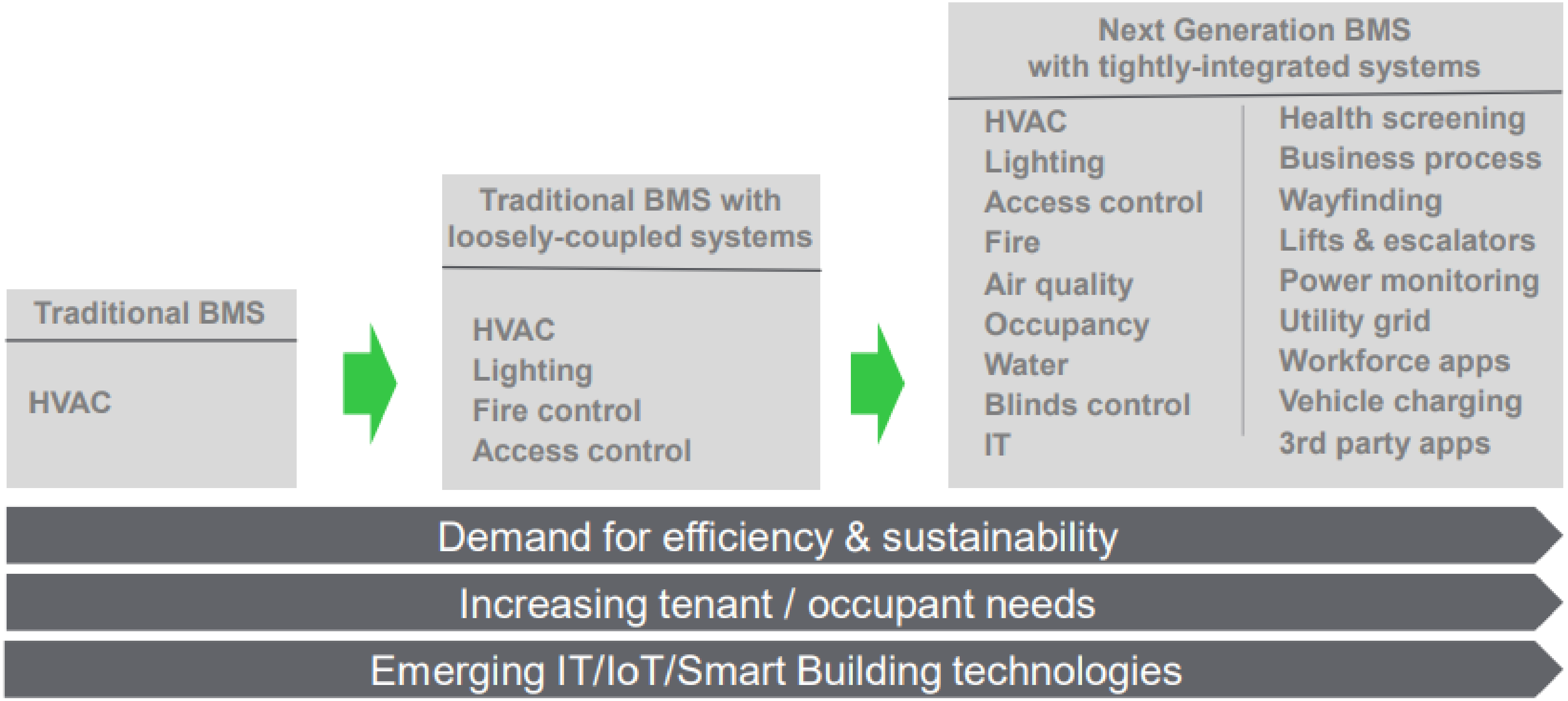
Global lighting electricity from new commercial floor area (built 2023 -50) – 2050 annual consumption TWh



Sources: Systemiq analysis for the ETC (2024); IEA (2021), *Global lighting efficacies*
Note: Commercial building energy use today assumed at 40% of total buildings (based off US commercial vs residential data) and lighting assumed at 10% (based on US data). Energy requirements from new commercial buildings are based on floor space projections (IEA).

Building management systems (BMS) in commercial buildings are much more sophisticated than residential buildings and are typically a no-regrets solution

Increasing sophistication of commercial Building Management Systems



Key features of next generation BMS:

- Sensors (e.g., turning lights off automatically, sensing where office spaces are less occupied)
- Controlling heating and cooling automatically
- Application of analytics and AI (see next slide)
- Predictive maintenance and self-diagnosing
- Knowledge reporting and learning

Sources: Schneider Electric (2020), Three Essential Elements of Next Generation Building Management Systems.
Note: IoT refers to the Internet of Things – describes the network of interrelated devices which connect and exchange data with other IoT devices and the cloud.

Building management systems are becoming even more innovative with the use of AI, to respond in real time to changes in weather, building use and the grid

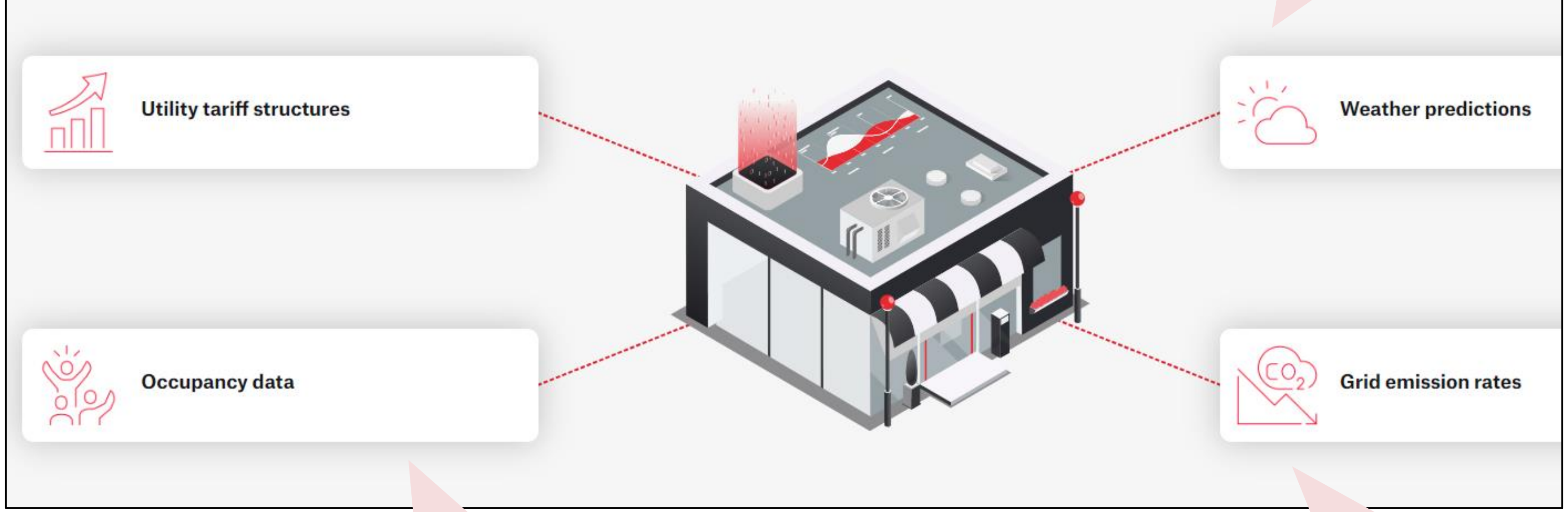
Case study: Brainbox AI

- System uses information on weather, occupants and grid mix/prices
- Autonomously controls individual pieces of HVAC equipment – makes adjustments every 5 minutes
- AI predicts the future state of building over time as it learns behaviours and patterns
- On average:

10-20%
Reduction in HVAC energy consumption

5-10%
Reduction in total energy consumption

Responds in real time to changes in…



If the weather is expected to be warmer than normal, it can automatically reduce pre-heating overnight

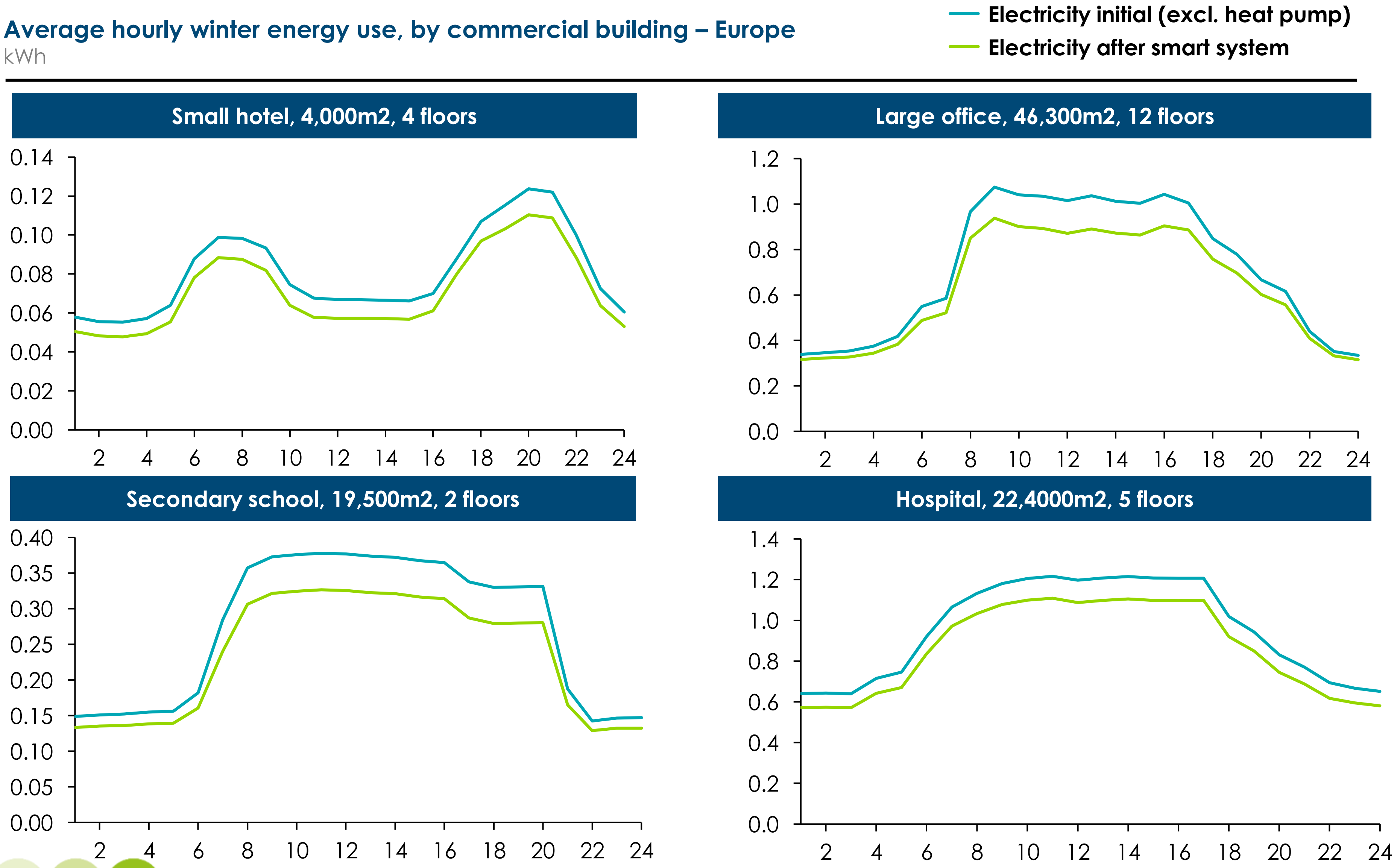
If the building is especially busy, it can anticipate that it might be warmer and increase cooling

If the grid is especially fossils-dominated or if peak prices spike, it can reduce heating/cooling to lower temperature bounds

Source: Brainbox AI

Building management systems typically reduce electricity consumption by around 10-15%

Average hourly winter energy use, by commercial building – Europe
kWh



Paybacks to BMS go beyond just energy savings:

- Reduce HVAC runtimes and extend equipment life
- Defer capex on retrofits
- Improve comfort, wellbeing and productivity

Generally, BMS systems have very positive economic paybacks and are no-regrets solutions.

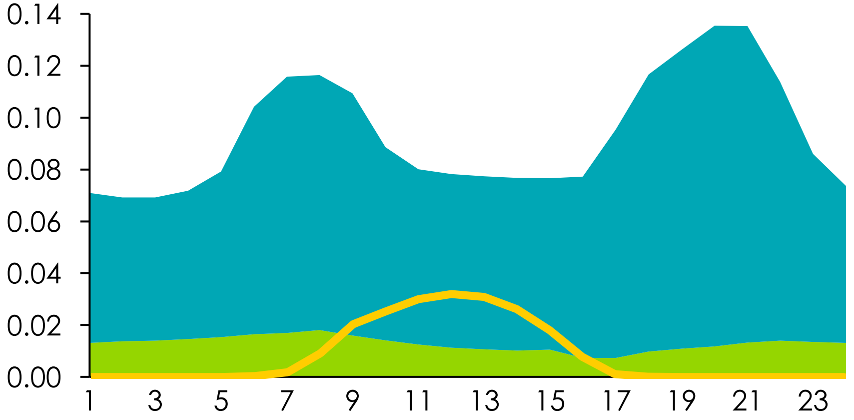
Source: Systemiq analysis for the ETC (2024) of Schneider Electric Sustainability Research Institute
Note: winter is defined as November to February

The payback to solar PV depends heavily on available roof space; generation is only able to meet a tiny share of many multi-story commercial buildings needs

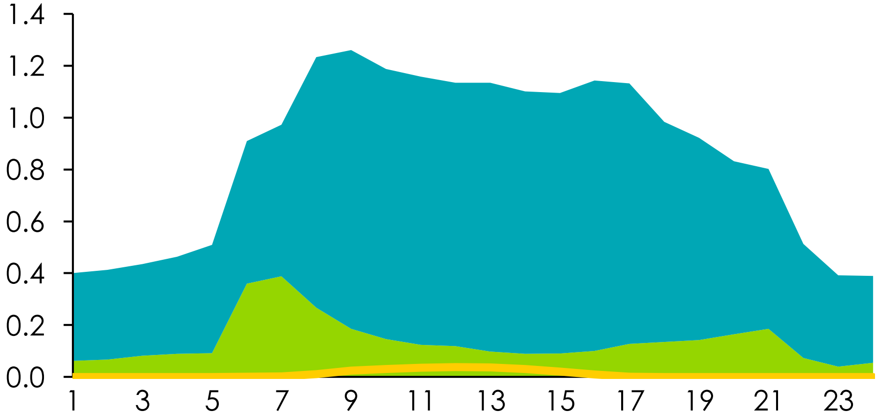
Average hourly winter energy use, by commercial building – Europe
kWh

Electricity - heat pump
Electricity - other
Solar PV

Small hotel – roof space: 1,000m2, 4 floors



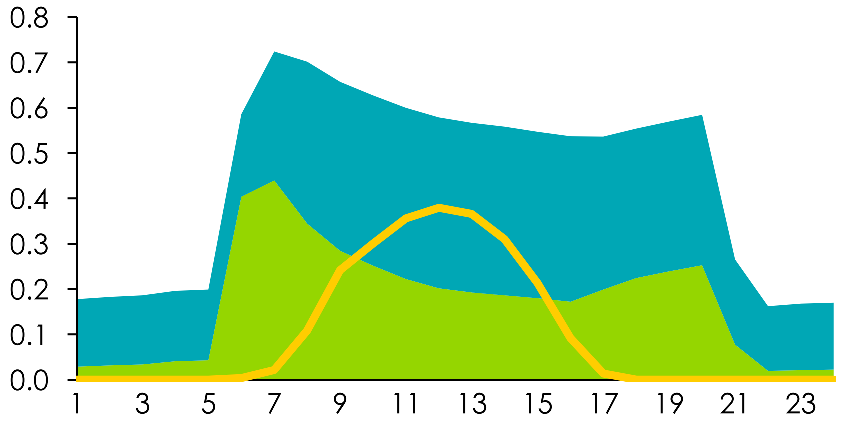
Large office – roof space: 3,500m2, 12 floors



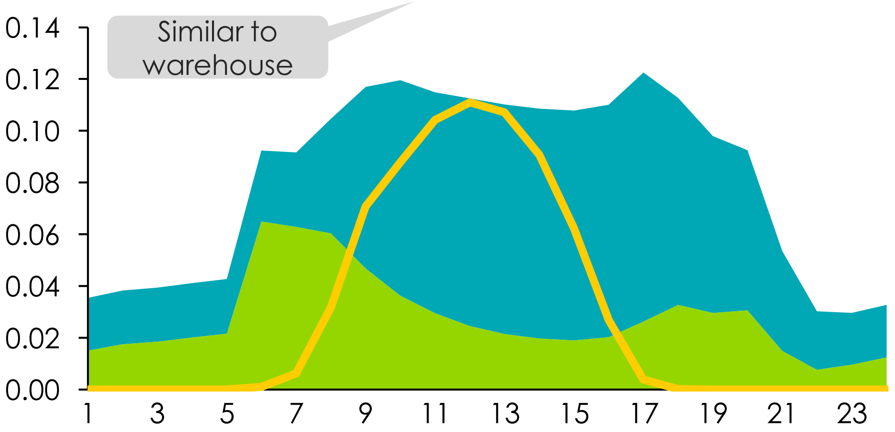
Likely poor paybacks

- Small roofs relative to floor space (roof:floor ratio <20%)
- Roof space further limited by HVAC equipment
- Solar PV can meet:
  - ➢ ~10% of needs in small hotel
  - ➢ ~1% of needs in large office

Secondary school – roof space: 12,000m2, 2 floors



Retail park – roof space: 2,100m2, 1 floor



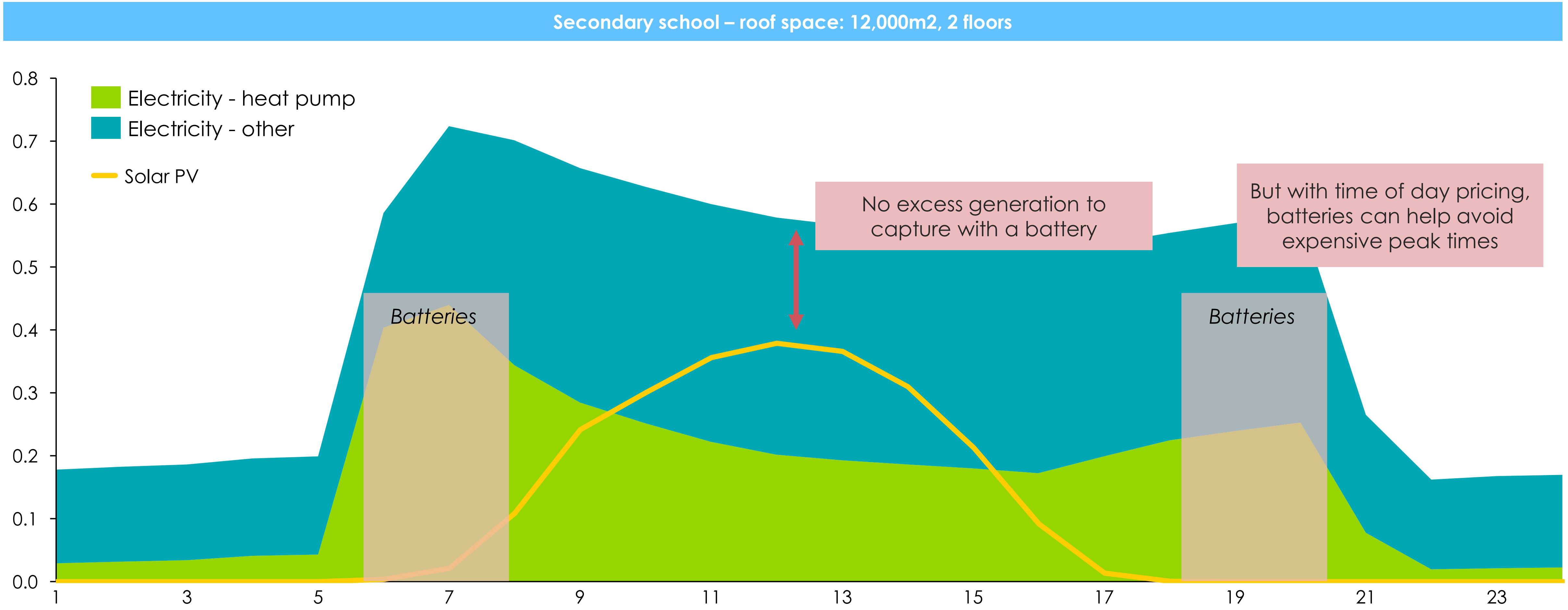
Likely reasonable paybacks

- Much larger roof space relative to floor space → retail parks (and warehouses) have a 100% roof to floor ratio
- Solar PV can meet:
  - ➢ 25% of needs in secondary school
  - ➢ 35% of needs in retail park

Source: Systemiq analysis for the ETC (2024) of Schneider Electric Sustainability Research Institute
Note: winter is defined as November to February

For many commercial buildings, the paybacks to batteries are likely to be low as little excess generation is expected; but time of day pricing could create stronger incentives

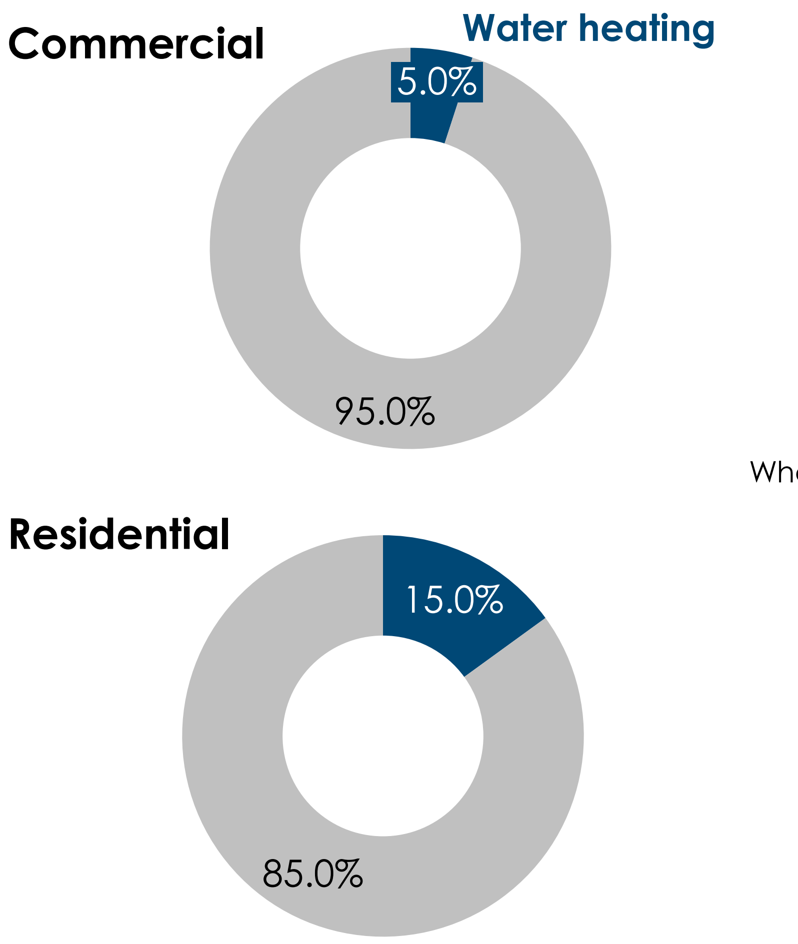
Average hourly winter energy use, for a secondary school – Europe
kWh



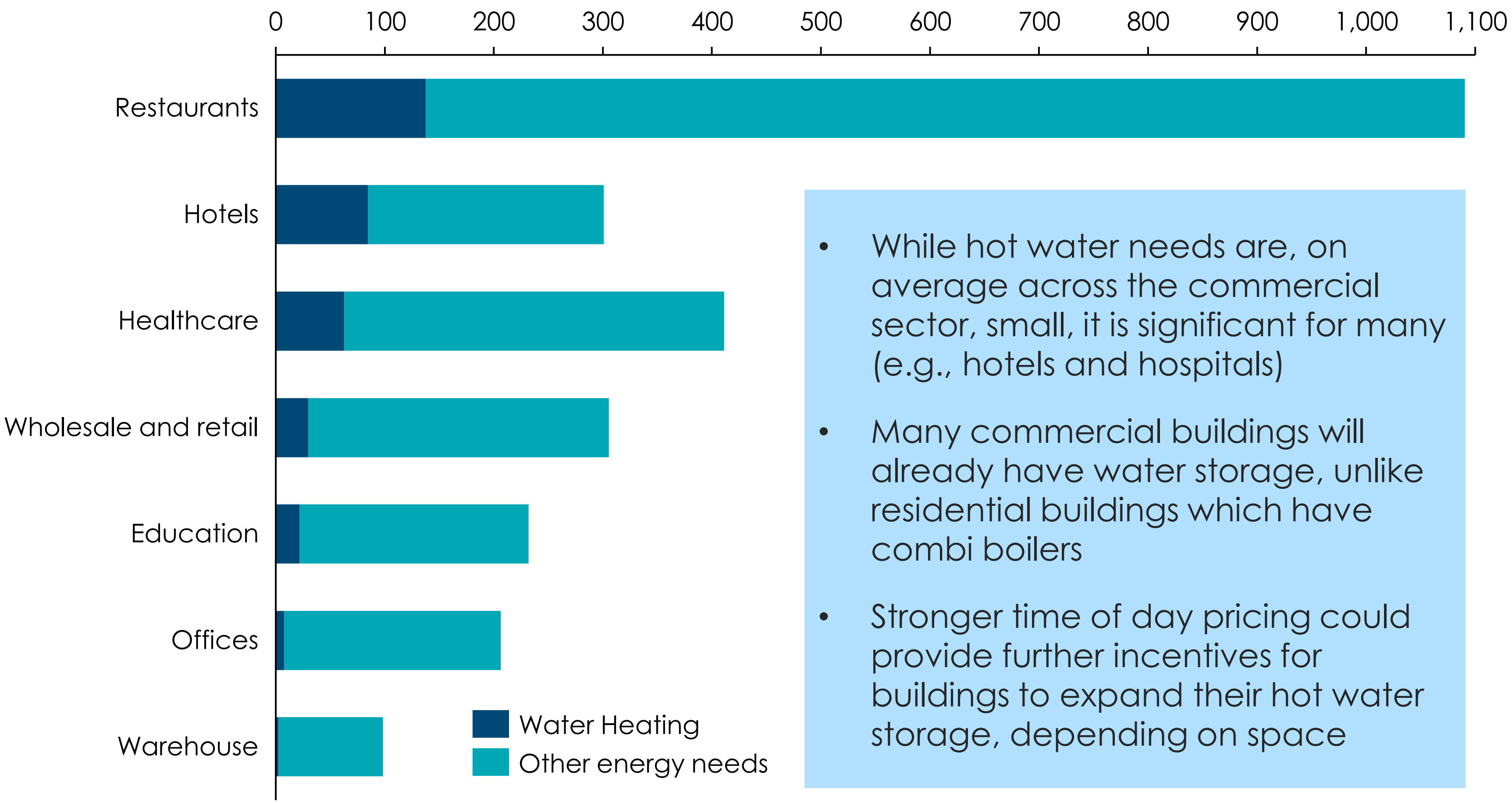
Source: Systemiq analysis for the ETC (2024) of Schneider Electric Sustainability Research Institute
Note: winter is defined as November to February

Water storage will be key in some commercial buildings with high water needs – stronger time of day pricing can help underpin incentives

Water heating share of total energy use – average
kWh



Energy intensity by subsector and energy end use in the US, 2018
kWh/m2/year



- While hot water needs are, on average across the commercial sector, small, it is significant for many (e.g., hotels and hospitals)
- Many commercial buildings will already have water storage, unlike residential buildings which have combi boilers
- Stronger time of day pricing could provide further incentives for buildings to expand their hot water storage, depending on space

Sources: National Renewable Energy Laboratory

Retrofit of existing commercial buildings

On residential buildings, we concluded that the "fabric first" approach should no longer be the default approach for the average existing building

Fabric first approach

1. **Building fabric improvements**

↓

2. **Heating system changes**

What's changed?

1. **Urgency of net zero timelines:** retrofits are lengthy + skills shortages → we don't have time for every property to retrofit before replacing their gas boiler
2. **Relative gas / electricity prices:** higher gas prices have reduced the ratio with electricity, reducing the need for retrofit for electric solutions to be cost-effective; with appropriate power market design that enables renewables to set electricity prices, this ratio should fall further
3. **Carbon intensity of electricity:** this has declined in many countries with a heating challenge, so replacing a gas boiler is by far the most important measure

Is this still the right strategy?

New builds + extensions	Where low-cost efficiency measures can be deployed	The average property
Always ✓	In most cases ✓	No ✗

Retrofit of building fabric in existing commercial buildings is more challenging, but heat pump systems can typically be installed without substantial building fabric changes

Building fabric changes to commercial buildings face a number of additional considerations and trade-offs:

- **Practical challenges** of fabric upgrades with tenants in building → vacating tenants can have significant cost implications
- **Energy costs of heating and cooling relative to lighting and appliances** → potential payback from building fabric changes can often be poor compared to investing in building management systems
- **Significant embodied carbon** of building fabric changes given the size of commercial buildings

There are a number of ways to negate the need for substantial building fabric when installing a heat pump system:

- Pipework and/or radiators can typically be **upsized at manageable cost / disruption**
- **Sizing heat pumps appropriately** → oversizing heat pumps has a trade-off with efficiency
- **Using a cascade system** (e.g., two heat pumps in one) to reach higher flow temperatures → this also has a trade-off with efficiency
- **High temperature heat pumps** (e.g., using different refrigerants) → trade-off with efficiency

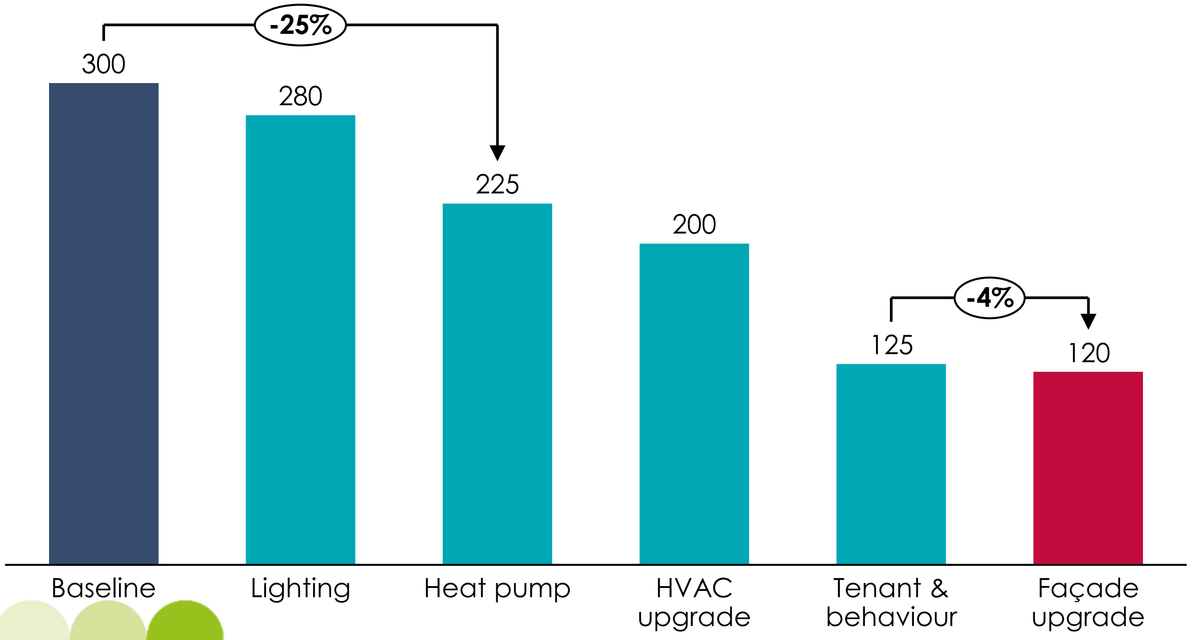
Case studies suggest that substantial energy savings can often be made without major building fabric changes

Carbon reductions

Case study: 5 New Street Square, London

- Replacement façade would have been costly, disruptive and would not deliver sufficient energy savings to offset the embodied carbon impact
- 55% reduction in energy intensity and 60% reduction in carbon achieved with other measures (e.g., heat pump and smart systems)

Cumulative carbon emissions
tCO_2e

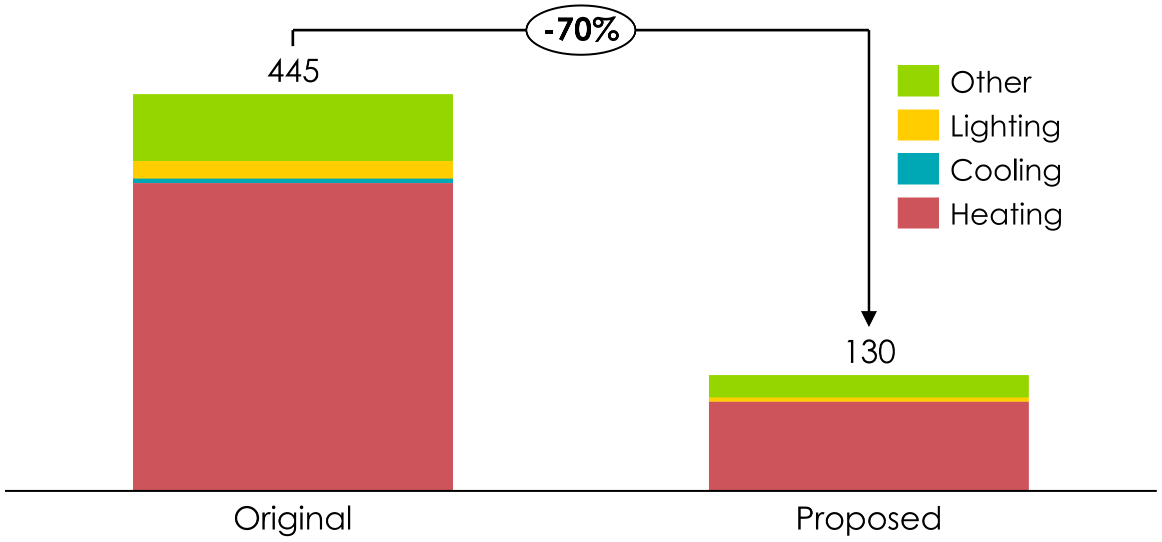


Energy savings

Case study: Pall Mall, Manchester

- Grade II listed building – limited scope for substantial building fabric changes
- Replacement of gas boiler with VRF system – 70% reduction in energy intensity without substantial fabric changes

Annual energy consumption
kW/m2

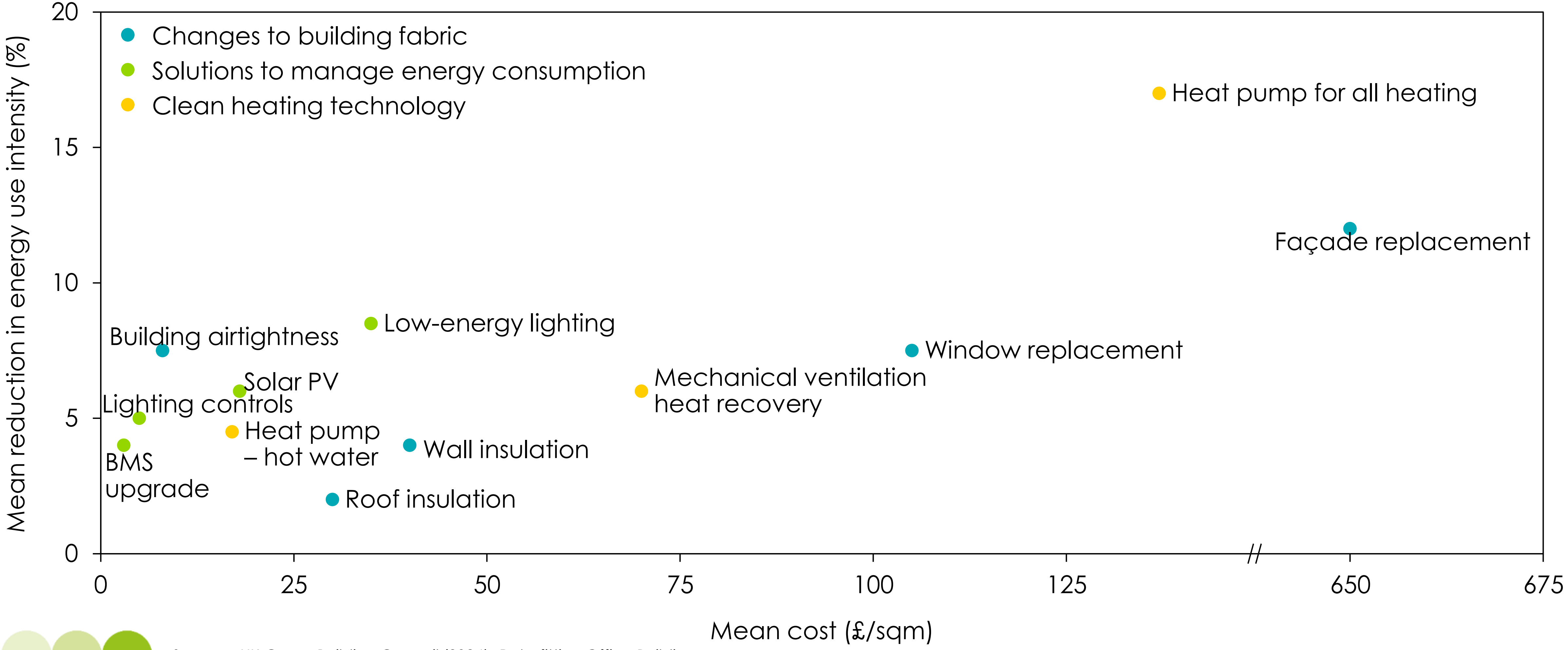


Sources: UK Green Building Council (2024), *Retrofitting Office Buildings*

There are also many low hanging fruit options for reducing energy intensity, which do not involve costly building fabric improvements

Cost effectiveness of individual retrofit measures in UK offices (based on actual project data)

Average cost (£/sqm) vs average reduction in energy use intensity (%)

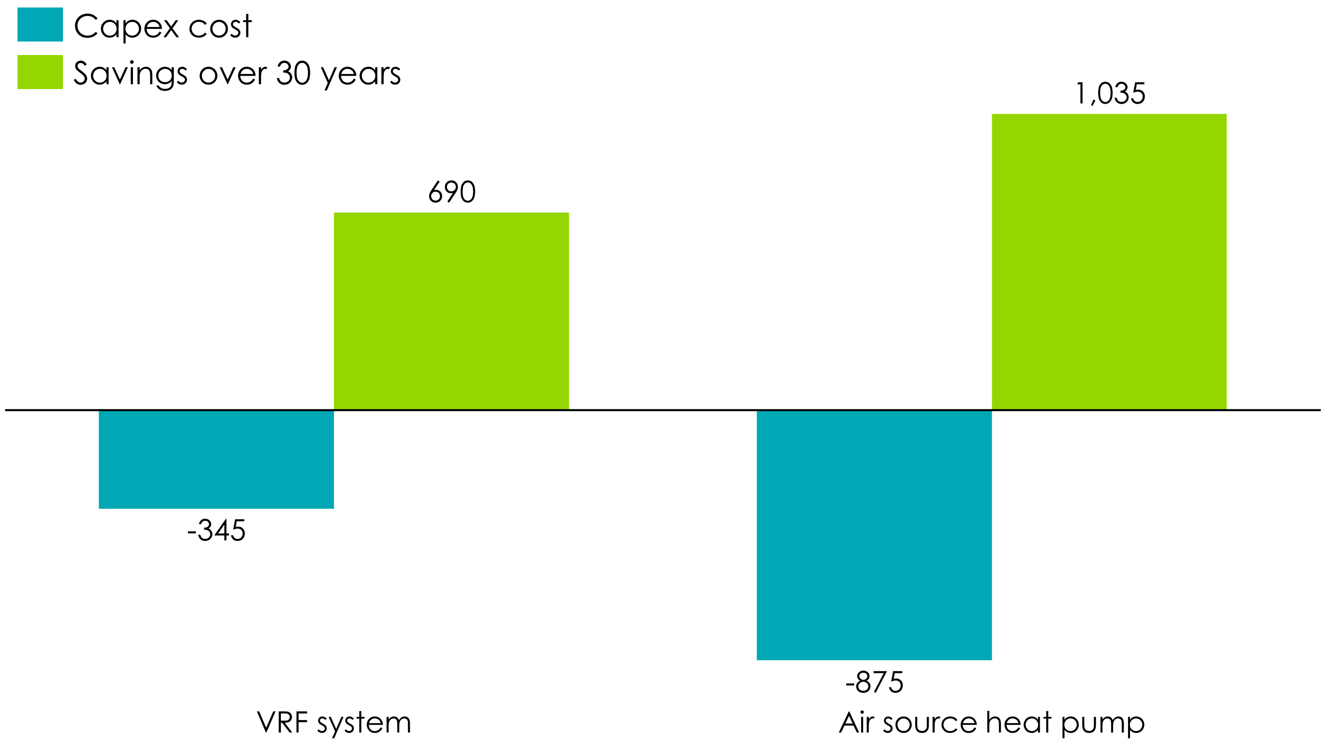


Sources: UK Green Building Council (2024), *Retrofitting Office Buildings*

However, the economic payback to heat pumps remains a challenge; regulation is required to drive this shift and realise huge potential carbon savings

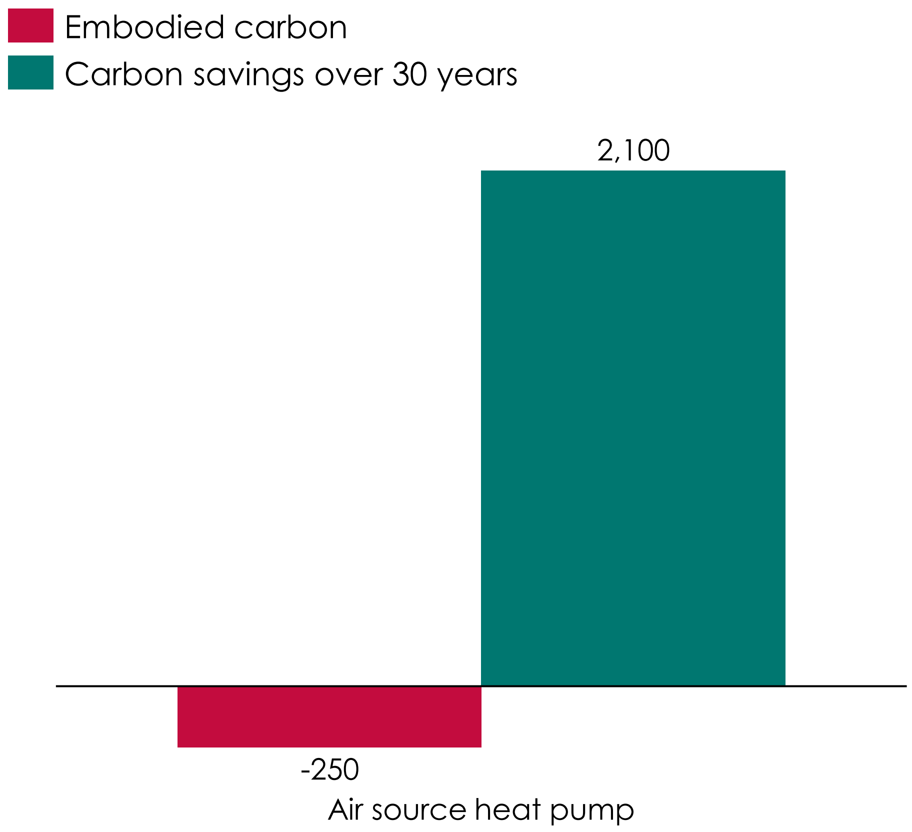
Capex cost and energy savings from decarbonising a UK mid-size hotel £ 000s, 2023 prices

Case study – UK hotel
Arup



VRF system		Air source heat pump
5%	***IRR***	1%
15 yrs	***Payback***	25 yrs

Embodied carbon and carbon savings
tCO2eq



Simple payback 4 yrs

Sources: Systemiq analysis for the ETC (2024); Arup (2022), *Transforming Existing Hotels to Net Zero Carbon*.
Note: Capex and energy savings from Arup case study data in 2019 prices, adjusted for inflation and energy prices in 2023. Assumes a discount rate of 10% over 30 years.

Refrigerant leakage

Refrigerant leakage and venting account for a large proportion of a building's whole-life greenhouse gas emissions

AC and heat pumps contain refrigerants, which can contribute to climate change if leaked and/or vented – however there is a transition towards refrigerants which have a low Global Warming Potential (GWP)

Industry transition

HFCs (Hydroflourocarbons)

Most used today

R-134a	GWP 1430
R410a	GWP 2088
R-32	GWP 675

Driven by the Kigali Agreement from 2016, to phase out high GWP HFCs

Low-GWP HFOs (Hydrofluoroolefins)

Alternatives to HFCs

R1234ze	GWP 7

Natural Refrigerants

Best solutions not readily available

CO2	GWP 1
Propane	GWP 3
Ammonia	GWP 0

Refrigerant leakage occurs when refrigerants escape from AC systems through leaks or improper handling, depending on:

- **Equipment size, age, material and condition**
- **Installation quality**
- **Maintenance quality**

It is estimated that, on average, the annual refrigerant leakage rate is around 2-5%

Refrigerant venting occurs when refrigerants are intentionally released into the atmosphere, typically during servicing, maintenance, or disposal of AC equipment

- **Improper servicing practice**
- **Technicians' lack of training and awareness**
- **Weak or inadequate regulations and enforcement**

Today, industry estimates that close to 90% of ACs at end-of-life are vented in the US. In the developing world, the number is likely even larger

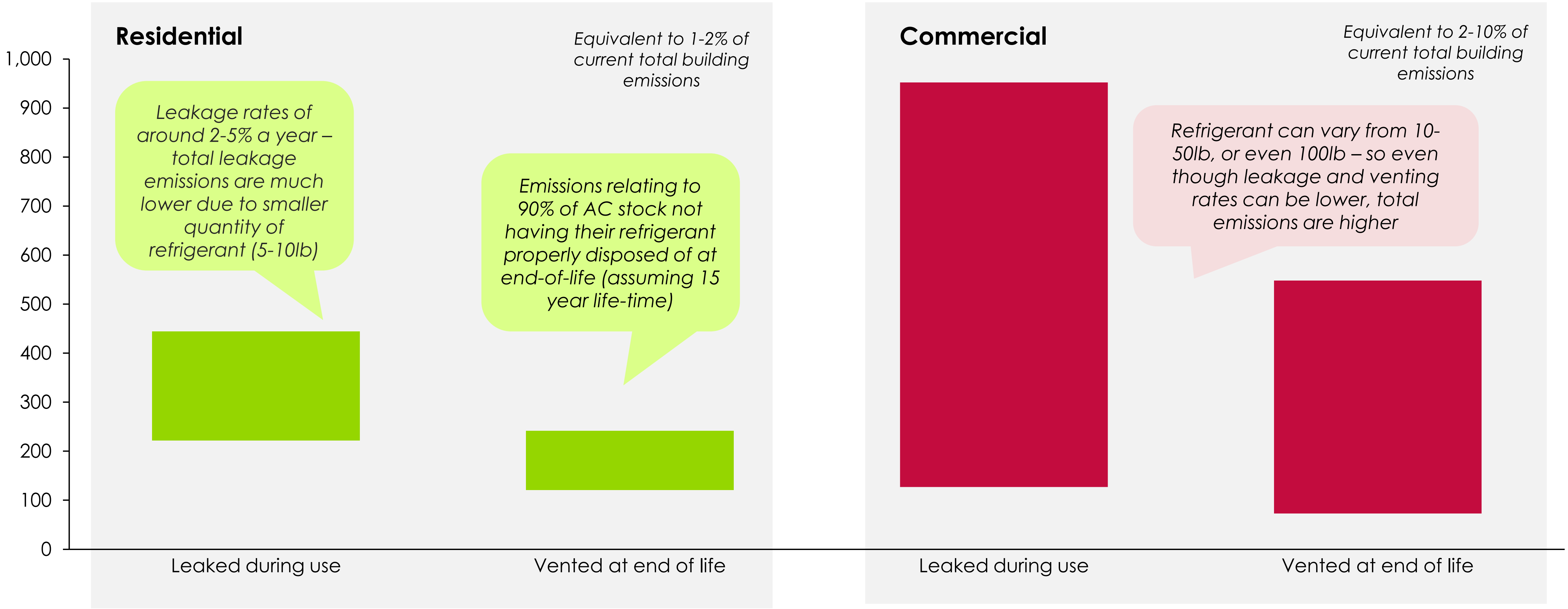
Note: GWP – global warming impact relative to the impact of the same quantity of carbon dioxide over a 100 year period

Sources: IEA (2023), *Energy Technology Perspectives*; BSRIA (2020), *BSRIA's view on refrigerant trends in AC and Heat Pump segments*; Net Zero Carbon Guide, *Refrigerants and their Contribution to Global Warming*; IEA (2018), *The Future of Cooling*; Carbon Containment Lab (2022), *Managing Refrigerants in a Warmer World*

Despite higher quality installation, maintenance and better end of life disposal, commercial AC systems can have over 10x as much refrigerant in them – making total emissions higher

Range of estimates of annual global emissions relating to leakage and venting of refrigerant from AC in 2030
MtCO2e

Range reflects different quantities of refrigerant

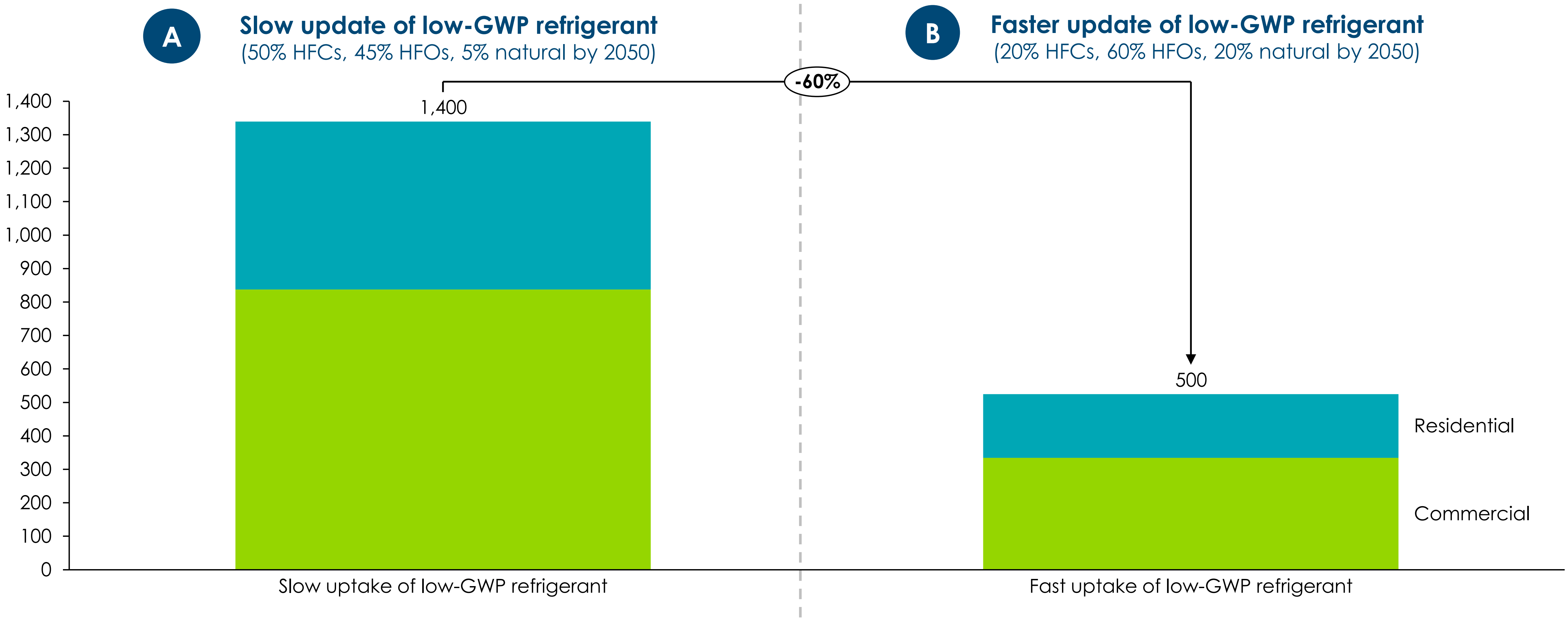


Source: Systemiq analysis for the ETC (2024), BSRIA (2020), *BSRIA's view on refrigerant trends in AC and Heat Pump segments*; Net Zero Carbon Guide, *Refrigerants and their Contribution to Global Warming*
Note: the figures are based on reasonable assumptions about refrigerant technology today and the IEA's AC projections.

Emissions from refrigerant leakage can be significantly reduced with a faster transition to low-GWP refrigerants; a 60% reduction is feasible

Scenarios of annual global emissions relating to leakage and venting of refrigerant from AC in 2050
MtCO2e

Median refrigerant charge assumed

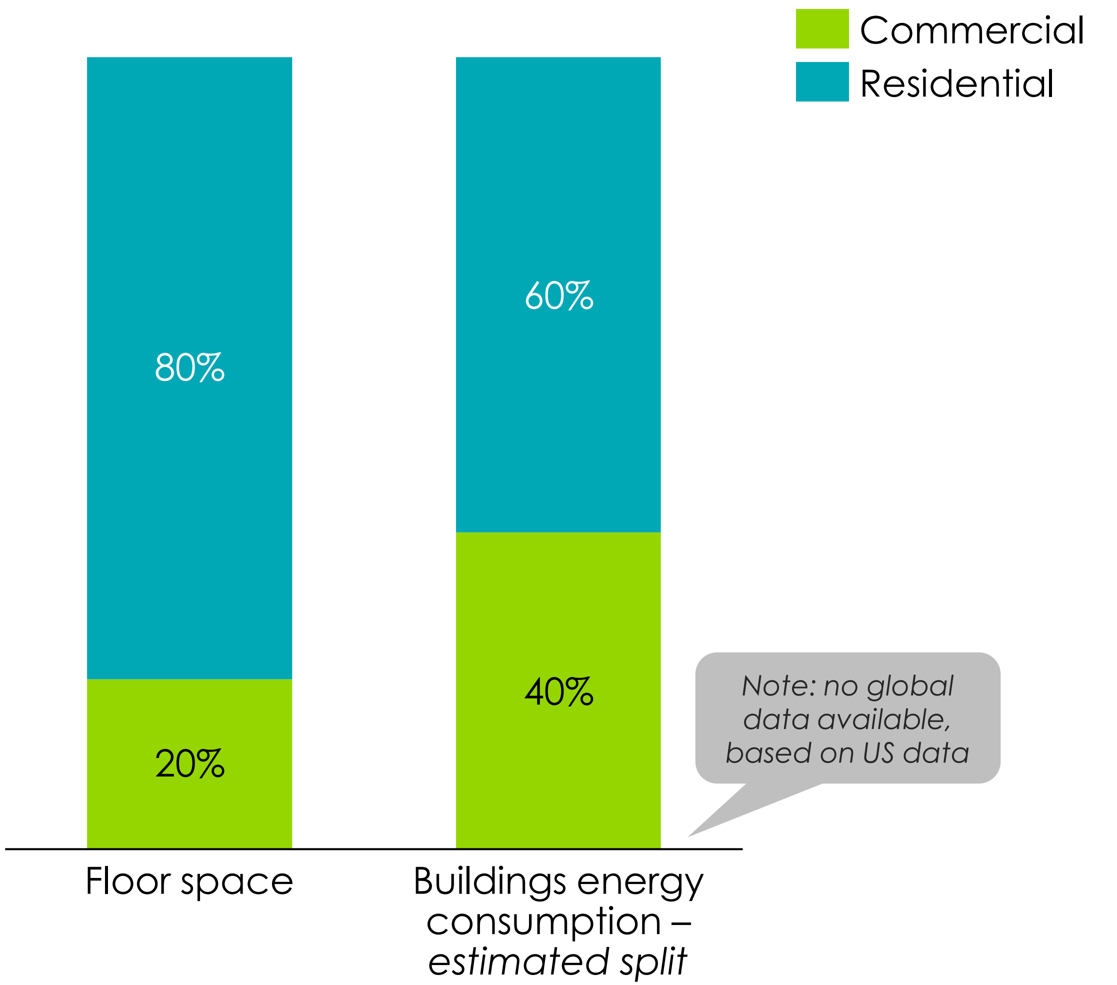


Source: Systemiq analysis for the ETC (2024), BSRIA (2020), *BSRIA's view on refrigerant trends in AC and Heat Pump segments*; Net Zero Carbon Guide, *Refrigerants and their Contribution to Global Warming*
Note: the figures are based on reasonable assumptions about refrigerant technology today

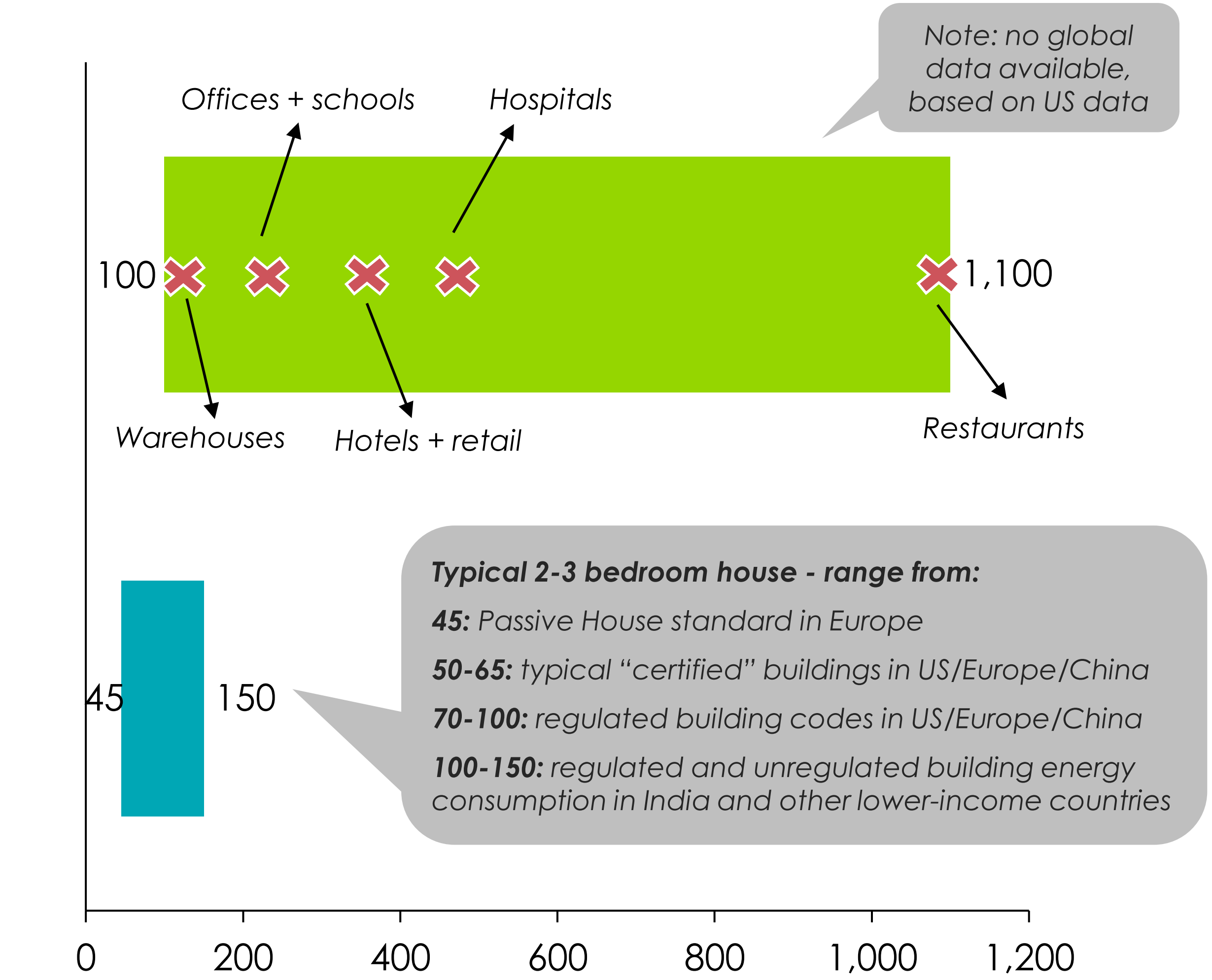
Emerging conclusions

It is clear there is a huge opportunity to improving the energy efficiency of commercial buildings, which have a far greater energy intensity than residential buildings

Global floor area and buildings energy consumption
% of total



Range of building energy consumption by type of building
kWh/m2/year



Source: Systemiq analysis for the ETC (2024); IEA (2023), *World Energy Outlook 2023; US* National Renewable Energy Laboratory.

However, understanding the current energy efficiency of buildings and the potential for improvement is incredibly challenging due to a lack of data

Lack of mandatory requirements for commercial buildings to collect and report data on energy performance

Lack of consistent data frameworks for measuring and reporting data (e.g., design based vs performance based) – incomparable across buildings/regions

Definitional differences across countries
- EPC certificates cannot be compared
- Differences in what counts as building sqm (e.g., including staircases or not)

Implications:

- Lack of transparency on building performance
- Lack of clarity on how on/off track a building is with net-zero alignment
- Lack of clarity on areas of investment / for improvement

- Challenge for policymakers to develop a clear roadmap and set targets
- Challenge for financial institutions to appropriately value energy efficient buildings and assess risk
- Challenge for tenants to create a strong demand signal

Emerging conclusions (1/2)

- Assessing pathways for commercial buildings is challenging
  - Incredibly **heterogenous** buildings and energy use – there is even less of a "one-size-fits-all" solution than in residential
  - **Lack of data** – both modelled (e.g., EPC certificates) and actual energy performance
- However, just as in residential, it is clear there is a **massive opportunity** to both build new commercial buildings to better standards, and to decarbonise and improve energy efficiency in existing stock
  - Commercial buildings have a greater energy use intensity than residential buildings

New commercial buildings

- For new commercial buildings, where floor area is set to grow 55% by 2050, there is a clear opportunity to **incorporate passive heating and cooling techniques** – although the impacts will vary hugely depending on the nature of the building
  - Passive heating, such as wall and roof insulation can reduce energy consumption by 15-25%, on average
  - Passive cooling, such as low-emissivity windows and white roofs, can reduce energy consumption by 25-40% on average
- As with residential, there is **no reason why regulation should not ban fossil fuel heating in new commercial buildings** from the mid-2025s, just like the EU has done
  - There is a **cost premium** to installing a heat pump compared to a gas boiler, but the **total impact on construction costs** of clean heating + better building design is expected to be **manageable** in most cases (e.g., ~5%), although it could be much higher in complex commercial buildings (e.g., hospitals)
  - However, if regulation requires this in high-income countries and China, the industry have many ways to manage to this
    - Cost premiums passed onto tenants, who will benefit from **significant operating cost savings**

Emerging conclusions (2/2)

Existing commercial buildings

- Installing heat pumps in existing commercial buildings is **more challenging**, due to dismantling existing systems especially with tenants in the building
  - The paybacks to installing heat pumps are challenging – but costs are expected to come down
  - This underpins the importance of **regulation** to drive this, combined with **access to low/zero cost finance** for smaller commercial buildings and a **rebalancing of gas/electricity prices**
- Building fabric improvements can be even **more challenging and costly**
  - However, case studies suggest that heat pumps can typically be installed **without substantial changes**, and with sufficient pipework / radiator upgrades
  - Just as with residential buildings, the **fabric first approach does not** need to be the default for the average building

Other technology choices and efficiency

- Installing a **building management system** is a **no-regrets solution** – helps to close the "performance" gap between modelled and actual energy consumption
  - **Sensors** which automatically turn off lights and appliances, combined with strategic use/design of space (e.g., hot desking and allocating hotel rooms close to each other so unused spaces can have lights/heating turned off)
  - **Sub-metering** of specific energy uses, to give tenants more information over their use
  - **AI systems** which can respond in real time to changes or predictions in the weather, occupancy and the grid
  - Systems can typically reduce energy consumption by 10-20%
- The paybacks to rooftop solar will ultimately depend on how much **roof space there is relative to floor space**
  - Stronger paybacks in warehouses; limited paybacks in offices

Barriers and implementation

In residential buildings, we concluded that regulation will be the most critical driver; for commercial buildings, there is potential for a much stronger market demand signal

Residential buildings

Most critical

1. **Regulation and building codes**
2. **Market and voluntary actions**
3. **Policy incentives**

Commercial buildings

1. **Regulation and building codes**

Most critical

2. **Market and voluntary actions**
3. **Policy incentives**

Potential for a much stronger demand signal in commercial buildings:

1. Cost savings and revenue streams associated with more efficient and flexible buildings
2. Asset de-risking against future carbon and energy regulation
3. In-house net zero and financed emissions commitments

A well-functioning low-carbon commercial building market needs strong demand signals from lenders, tenants, investors and fund managers; certifications can help create demand

Key demand signals needed:

Lenders – offering favourable rates

Tenants – paying a premium

Investors + fund managers – access to finance

Requires a clear correlation between efficiency/green buildings and value:

Demand signals rely on being able to **identify, price and provide incentives** for energy efficient and low-carbon buildings.

This requires:

- **Transparency** on building performance
- **Actual data** on energy and carbon
- **Clear targets** for energy intensity and 1.5C aligned carbon pathways

Building certifications can help build certainty around this correlation:

Building certifications help provide this transparency:

- Ratings for going above and beyond regulations
- Stronger energy performance
- Additional environmental criteria (e.g., water use, air quality)

Certifications can create a strong demand signal if they set clear and ambitious targets, use actual energy data, and publicly disclose performance against clear metrics

1 Cover all emissions

- Operational and embodied energy / carbon
- Whole building emissions

Done by many schemes, but not all

2 Clear minimum Requirements

- Requirements for energy use intensity
- Operational and embodied carbon

Done by many schemes, but not all

3 Ambitious goals

- 1.5C alignment for top performance bracket

Done by many schemes, but not all

4 Measure performance

- Performance based assessment
- Based on actual carbon and energy data

Done by many schemes, but not all

5 Provide transparency

- Publicly available targets and metrics
- Publicly available assessments and ratings

Most do not do this

Limited confidence in real estate owners to invest in decarbonisation + efficiency

Source: Systemiq analysis for LOTUF, Arup (2024), *Seeing is Believing: Unlocking the Low-Carbon Real Estate Market.*

Certification and rating tools today do not provide sufficient transparency or clarity

		New buildings					Existing buildings				
	Key assessment criteria of certifications	**BRREAM**	**LEED**	**ILFI**	**Green Star**	**LCBI**	**BRREAM**	**LEED**	**ILFI**	**Green Star**	**EPC**
	Primary geography	*Global*	*Global*	*US*	*Australia*	*Europe*	*Global*	*Global*	*US*	*Australia*	*Europe*
1	Cover operational and embodied energy/carbon										
2	Minimum requirements for energy use intensity										N/A
	Minimum requirements for operational carbon										N/A
3	1.5C alignment for top performance										
4	Require actual data for operational energy										
5	Clear and public targets, which reference 1.5C pathways										
	Performance is public and transparent										

Fully meets criteria	*Partially meets criteria*	*Doesn't meet criteria*

Source: Systemiq analysis for LOTUF, Arup (2024), *Seeing is Believing: Unlocking the Low-Carbon Real Estate Market.*

Net-zero commitments from some of the largest players depend upon well-functioning building certification; these commitments will also be key to driving improvements

Commitments required across the stakeholder landscape:

Real estate developers + construction

- Science-based targets to reduce emissions over time
  - ➢ Separate consideration of operational + embodied
- Heavy focus on operational emissions this decade
- Skills, training and knowledge sharing
- Data and assessment development to create demand signal

Businesses with large scope 1 and 2 emissions

- Commitments to reduce energy use intensity and emissions in their buildings from:
  - ➢ Major hotel chains
  - ➢ Large restaurant and retail chains
  - ➢ Large professional services
- Drive technology development and cost reductions

Cities and governments

- Commitments to decarbonise public buildings, creating early demand signals
- Policy incentives (e.g., fast tracked permitting)
- Education and awareness of best practice
- Data collection and tracking

Financial institutions

- Developing a clear understanding of how to price and assess value / risk
- Lenders – clear lending criteria tied to minimum EPC, favourable rates for better performance
- Investors and fund managers – clear plans to reduce financed emissions

Commitments by major hotel chains currently vary in terms of ambition and specificity

Company	Target	Target status	Interim target	Detailed plan	Reporting mechanism	Scope 3 coverage
Marriott HOTELS · RESORTS · SUITES	Net zero by 2050	In corporate strategy	2025			
Hilton	Emissions intensity reduction by 2030	In corporate strategy	2030			
HYATT®	Science-based target by 2030	In corporate strategy	2025			
ACCOR	Net zero by 2050	Declaration / pledge	2030			

Source: Net Zero Tracker

This must be underpinned by strong regulation which sets a clear minimum floor for building design, energy use and the efficiency of installed technology

What should regulation do?

- Set ambitious targets for energy use intensity reduction and carbon
    - Tailored to different building types and sizes
- Minimum energy efficiency standards for clean heating technologies, ACs, lighting, and appliances
- Mandate clear EPC certificates, data collection and monitoring
- In countries without established building codes, regulation needs to move gradually and begin with being prescriptive (e.g., specifying passive techniques) and move to performance based over time (e.g., kWh/m2)

This needs to be underpinned by:

- **Rapid power decarbonisation + appropriate power market design**
- **Carbon pricing which rebalances gas and electricity prices**

Regulating commercial building energy use is always going to be imperfect; but it is clear that there is a significant opportunity especially around new buildings

Challenges for regulation

- Huge heterogeneity in energy use across commercial building types, even within sectors
- Appropriate flexibility to different building types and uses
- Lack of data and transparency on actual building performance
    - No clear starting point
    - Unclear potential for improvement

For example, commercial building regulations tend to treat airport arrivals/departure lounges as "lobbies" – but frequent open doors and large spaces mean that maintaining regulated lobby temperatures requires a significant amount of energy.

A study found that **increasing HVAC set temperature from 25C to 27C reduced 25% of energy consumption** during the hot months.

Examples of recent commercial building regulation:

- **UK:** rented commercial properties must have a minimum EPC rating of C from 2028 (up from E today), and B by 2030
- **EU:**
    - **Existing buildings:** renovate 26% of the lowest-performing commercial properties by 2033
    - **New buildings:** Banning of on-site fossil fuel use in new buildings from 2028 for public and 2030 for all other buildings

Source: Sayed Hassan Abdallah, A. et al (2021), *Energy audit and evaluation of indoor environment conditions inside Assiut International Airport terminal building, Egypt.*

Next steps

- Continued refinements to analysis presented in workshops 1-3 based on your feedback
- Workshop 5 on Tuesday 16th July, 2-4.30 pm UK time to explore embodied carbon
- Final workshop in September to present the workstream’s key messages
- Draft report to members in early Autumn

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