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Tackling a legacy of high-energy, high-carbon urban design

Why we need to focus on buildings

Urban skylines around the world are dominated by the buildings in which people live, work and spend their leisure time. These buildings are responsible for 36 per cent of global energy consumption and 37 per cent of energy-related CO_2 emissions.

And yet, construction demand in cities continues on a steeply upward trajectory, with building stock in Africa and Asia expected to double by 2050. Radically new thinking about how we build will be needed if we are to achieve efficient and resilient buildings and meet zero emissions targets for the built environment of the future.

The built environment of our cities is the product of changing design processes over the centuries that reflect a mix of need, availability of materials and technologies, and aesthetics.

At different times there have been different priorities, and much of the built environment that survives in cities such as London or Beijing or Los Angeles has been designed to meet standards that were important then – but have since receded in the face of the multiple challenges facing the world's cities today.

In most cities, people live surrounded by a legacy of poor design because the buildings were designed at a time when resources and energy were taken for granted. One element of today's climate crisis arises from the fact that many legacy buildings are not designed appropriately for their climate – indeed, they have been designed to overcome their climate, requiring high energy consumption to power circulation systems, electrical appliances and air conditioning plants to heat and cool buildings.

When thinking about ways to reduce the energy consumption of buildings, there are two factors to consider as part of a 'whole-life' strategy: embodied energy and operational energy.

This series of city related policy and information briefs draws on lessons learned from cities and infrastructure work carried out by Triple Line over the past five years. It is intended to contribute to more sustainable, inclusive and climate-resilient cities that generate equitable economic growth opportunities for all by identifying market-driven solutions to urbanisation challenges and strengthening democracy and decentralisation processes through capacity building of government agencies at national, regional and city levels.

Embodied and operational energy

Embodied Energy

The energy required to create, maintain and eventually demolish the building. It includes the energy used for the extraction, processing and manufacture of the materials of the building as well as their transportation and assembly on site. The embodied carbon that results from these processes is among the environmental impacts of a building that are hidden and often overlooked.

Operational Energy

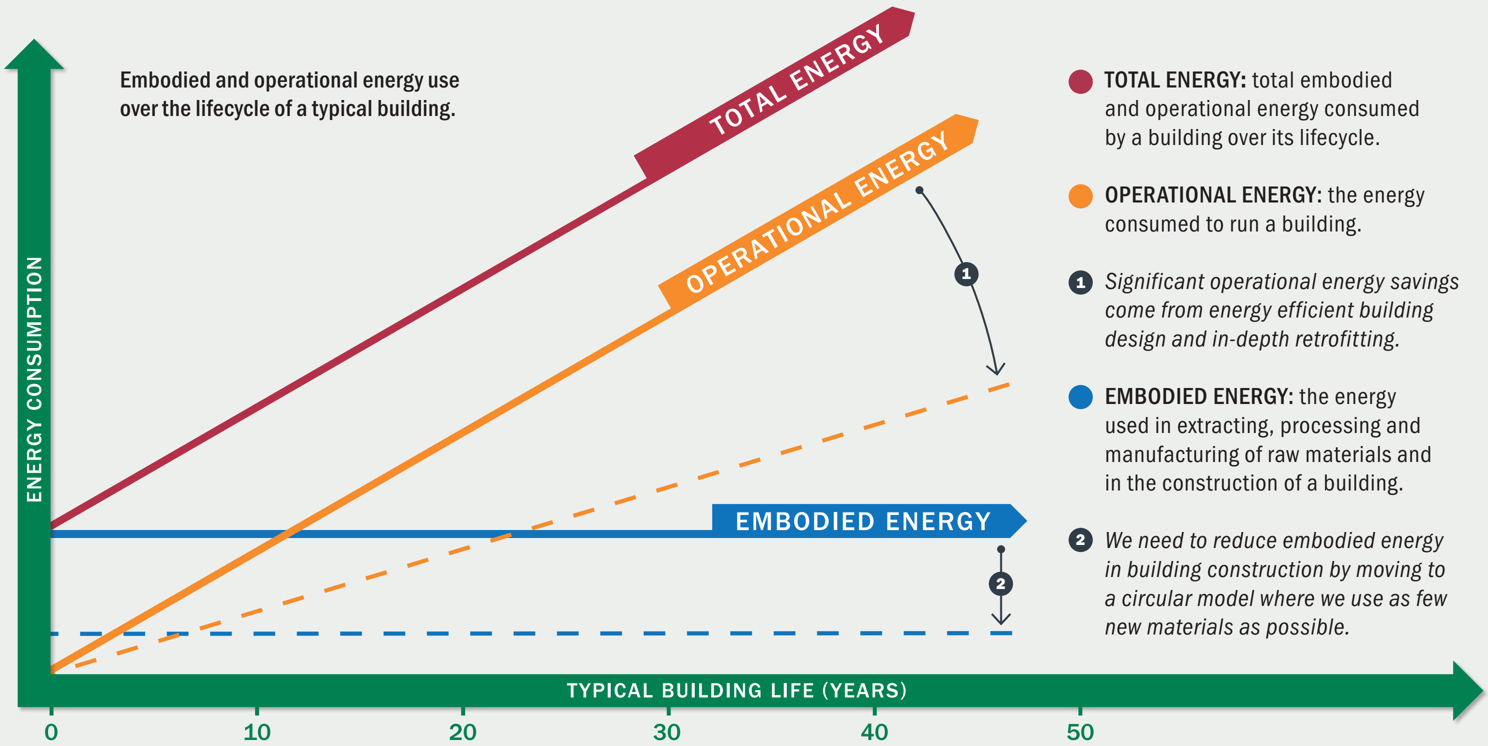
The energy needed to run a building across its lifecycle. This includes the energy needed for air conditioning, cooking, hot water, lighting and other appliances.

Operational energy is more visible and easier to measure than embodied energy, and operational carbon emissions are generally perceived to far exceed embodied carbon emissions. This is the case for much of our legacy stock, where a focus on operational energy is key to reducing the energy use and carbon footprint of buildings. With improving energy efficiency standards, however, the impact of embodied carbon becomes larger: in most buildings built today, embodied impacts will be nearly the same as the impacts of operational energy. In countries with high energy efficiency standards such as Denmark and France, embodied carbon emissions can be two to four times higher than operational emissions over the lifecycle of a building.

Retrofitting old buildings

Despite their design legacy, reusing old buildings instead of building new ones still represents a saving in terms of embodied carbon emissions.

There are many ways in which an existing building can be retrofitted to reduce energy consumption. Apart from upgrading heating, ventilation and air conditioning equipment, insulating the outer shell – including walls, windows and roofs – will reduce the amount of energy required for heating and cooling. Depending on the original construction of the building, cavity walls may be filled, or insulation can be added to the exterior; and options for using natural ventilation and fresh air should be considered to reduce heating and air conditioning. Windows can be double or treble glazed, and solar shading devices will help reduce energy consumption. Light fittings can be changed from fluorescent tubes and halogen bulbs to more efficient, longer-lasting LEDs. Smart meters and sub-meters should be used to track energy usage and patterns demand, and this information can help inform adjustments to lighting and air conditioning settings to optimise use based on occupancy.



Designing new buildings

The design of new buildings needs to focus on minimising both embodied and operational energy use.

- Embodied energy use can be minimised by carefully choosing materials to ensure that they are sustainable and low carbon in their manufacture. Most of the commonly used building materials – such as steel, cement, concrete, bricks, glass and aluminium – have significant embedded energy. Ways of reducing their impact include specifying low-carbon concrete mixes, lower carbon alternatives (e.g. wood instead of steel and concrete) and carbon sequestering materials (e.g. wood, straw, hemp) while limiting carbon-intensive materials such as aluminium, plastics, and foam insulation; reusing materials and using highly-recycled content materials.

- Operational energy use can be minimised using a passive building approach. Passive building principles focus on using the properties of building materials to insulate buildings from heat and cold – depending on the context – without creating additional demand for energy. They rely on minimising heat gain and stopping heat loss through high-quality insulation; robust and sophisticated window technology; airtight construction; heat recovery ventilation to flush stale air out and replace it with fresh, filtered and temperature-managed air; and elimination of 'thermal bridges' – areas of the building shell that conduct heat or cold more readily than the rest of the structure. Heat recovery ventilation can use natural methods – for instance, using prevailing winds and vents to control the flow of air through a building.

What should cities do?

- **ensure building regulations and other measures, such as tax incentives, set high environmental standards;**
- **ensure that regulations set strict energy efficiency requirements;**
- **work with the private sector to find ways to build greener;**
- **build a well-trained cadre of building inspectors;**
- **ensure building inspectors are well paid to reduce the prospect of bribery; and**
- **initiate a city-wide programme of retrofitting the most energy inefficient buildings.**

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