

BUILT ENVIRONMENT

Energy efficiency – improving ‘m’ to reduce ‘E’

As the world’s population, energy demand and emissions continue to rise, Sandy Jayaraj argues that focusing on the ‘mass’ of our structures is a key part of the solution – via a famous equation.

In 1905, Albert Einstein discussed the equivalence of energy and mass in his paper *Does the inertia of a body depend upon its energy-content?* The result was his famous equation: $E=mc^2$.

There is no doubt that the ‘E’ in the equation has become a dominant influence in modern life – the pursuit of it, the demand for it and the economic and environmental cost of it (we’ll discuss the latter in a moment).

The first industrial revolution, which took productivity to new levels, had a profound impact on both the economic and social aspects of life. The economies of scale of machinery-based production facilitated a cheaper supply of goods which has, in turn, enabled economic growth, population growth, and with it a seemingly insatiable growth in the demand for energy.

The downsides

The dominant input into energy production since before the industrial revolution has been carbon based and non-renewable. It is easy to see why. The main fossil fuels of coal (and originally peat) and oil have a high calorific value and were relatively easy to find and transport. Natural gas also has a high calorific value but is clearly harder to transport and store.

As they are non-renewable, incremental discoveries have become harder and more costly, with the shift from open-cast mining of coal to deep pits, and from onshore to offshore exploration along with fracking for oil and gas.

However, the key issue this century is the negative impact of the emissions from the combustion of fossil fuels on the lives of all species on the planet. The drive for economic growth, combined with the Jevons paradox phenomenon – whereby greater efficiency can lead to more consumption – has until

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A building’s mass is important alongside its energy running costs

Photo by Bernard Hermant/Unsplash

now driven a ‘plus one’ correlation with emissions growth.

There were hopeful signs in 2016 when the International Energy Agency (IEA) reported energy-related emissions growth in 2014 and 2015 had stagnated, leading to speculation emissions had in fact, finally, decoupled from economic growth. PwC’s Low Carbon Economy Index then reported global carbon intensity falling by 2.8% in 2016, even as global GDP continued to grow at 3.4%. However, this optimism was short-lived.

In PwC’s most recent Low Carbon Economy Index report, the decarbonisation rate had fallen to only 1.6% – or less than half that witnessed in 2015 (3.3%) following the commitment of 190 governments to the Paris Agreement. In fact, this slowdown means it will be harder to reach the Paris Agreement’s goals, as more substantial decarbonisation rates per year are now necessary compared with earlier recommendations.

PwC found that in 2018 global emissions actually grew by 2% as most energy demand growth was met by fossil fuels, despite generation from renewables increasing to record levels worldwide.

What’s perhaps most concerning is that the growth in energy consumption in 2018 was partly a result of extreme hot and cold weather events, which increased the demand for energy for cooling and heating. Extreme weather in the US in 2018 resulted in the country’s highest electricity demand in a decade. These weather events will become more frequent as climate change progresses, reinforcing this positive feedback loop.

A material difference to efficiency

The current world population is 7.7bn – 45% higher than 30 years ago – and the UN expects it to rise another 26% in the next 30 years

to 9.7bn. An increasing number of people surviving to reproductive age coupled with major changes to fertility rates, and accelerating migration into increasingly urbanised areas, have been the key drivers. That means an increasing number of people in buildings and structures wanting heat and cooling.

Individual behavioural change is hard. Simply asking those people to use less energy is unlikely to produce the desired results fast enough – particularly where income levels have recently risen, as in emerging markets. Technical solutions are needed and – along with better tools, better monitoring and alternative heating and cooling solutions – any successful attempt at efficiency has to fundamentally reassess the ‘mass’ in our built structures.

Consideration of embodied energy and the ‘upstream’ carbon costs related to materials like concrete and steel should help a move to lower embodied energy alternatives. Taking thermal mass into account, better insulated building fabrics will be key, and innovative construction materials, such as hydroceramics, can help to passively cool buildings while also controlling humidity.

Efficiency – of both building operations and construction materials – will be a key element in the ultimate panacea of a zero carbon economy, within which a rising population along with Jevons’ paradox would not result in additional unintended emissions.

In short, tackling ‘m’ has to be a key strategy to reduce the consumption of E. All things being equivalent, of course. ●

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