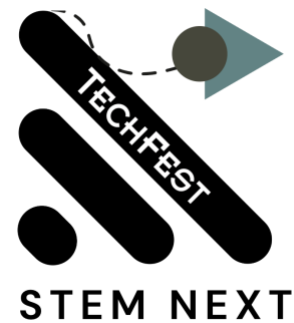


TECHFEST

ENERGY IN ACTION



Question 3 Beyond net zero buildings - it is now common for new buildings to achieve net zero carbon emissions, but could buildings be used to work harder for the environment? Could buildings produce energy, or reduce carbon in their surrounding environment, or provide other enhancements to people's life and work?

Shelter is a basic human need alongside air, food and water; our human needs, especially buildings for shelter, bring energy use and carbon emissions. For our species, such survival needs will not change, therefore, meeting net zero carbon requires change in how we design and use the buildings we live, work, relax, shop, eat, play and shelter inside. The word 'design' is not mentioned in the question yet my essay comes from a design perspective because following Papanek (1985), 'all that we do, almost all the time, is design, for design is basic to all human activity' (p.3). By threading design thinking through my essay, positions design in its rightful place in this environmental narrative. My aim is not about placing human needs above environmental needs but a discussion of a sustainable relationship to enhance human lives in the built environment with and through wider environmental gains on the way to net zero and beyond. I cannot propose any kind of answers to the questions this essay poses without first understanding the context where any discussions and answers are situated. I look for clear definitions of net zero buildings and the part they play in the drive to increase energy efficiency and reduce carbon emissions. My discussion then explores reuse as well as regenerative options for meeting climate goals including 'giving back' to the contexts and the environmental systems that buildings are part of. In doing so, I discuss Norman's (2003) linking of

emotion with design and Maslow's (1943) hierarchy of needs to get a social perspective when discussing the 'enhancement' question.

“science to policy to mainstream in less than a
decade”

(Lang, 2022)

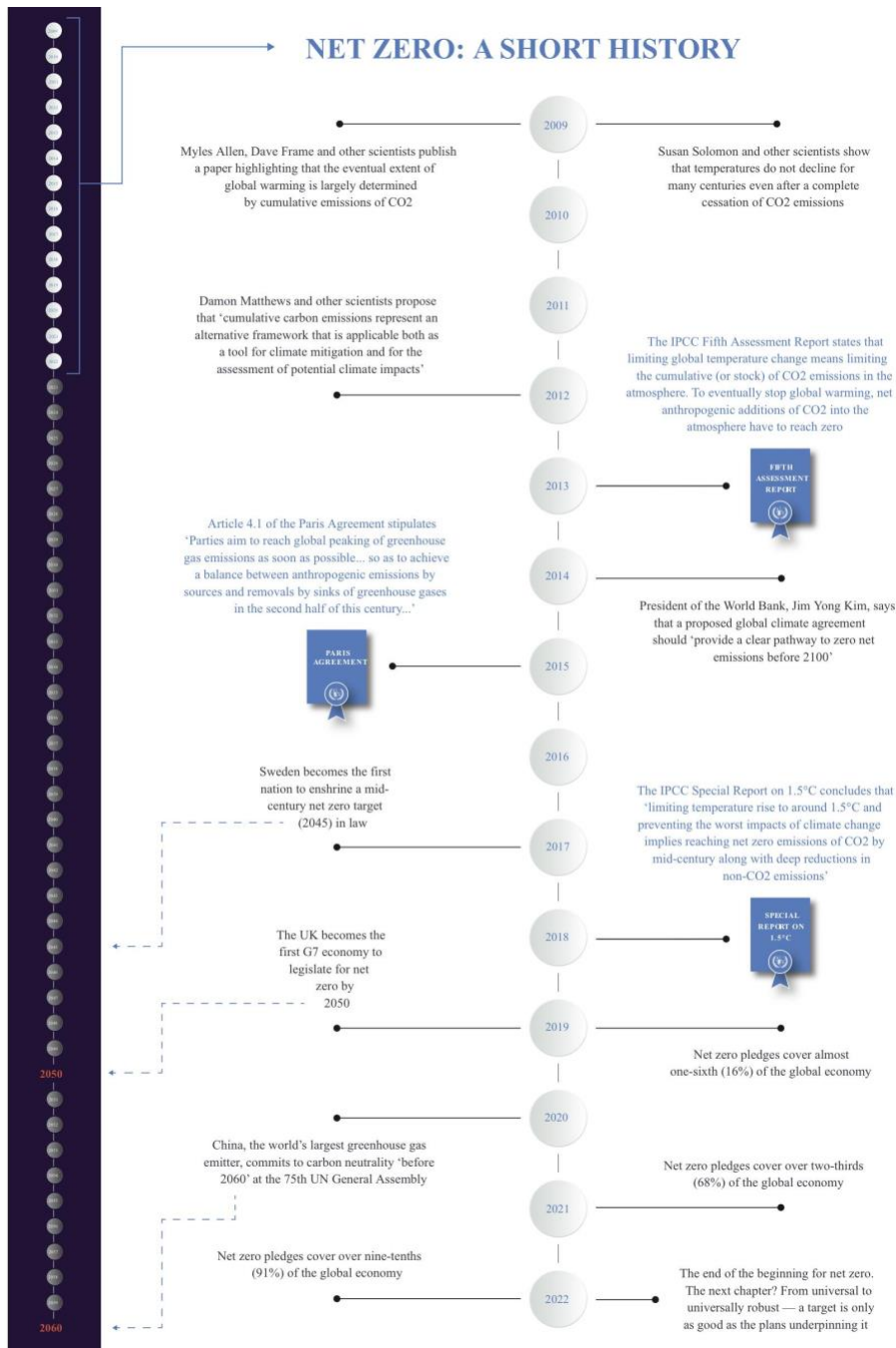


Figure 1

Figure 1 (Lang, 2022) illustrates how net zero has become a focus since 2009 when scientists and policy makers committed to a 100% reduction of greenhouse gas emissions by 2050 compared with 1990 levels and this is the derivation of the net zero target (UK Parliament, 2019). The Paris Agreement is a global framework to avoid dangerous climate change by limiting global warming to well below 2°C. This

United Nations treaty binds 196 parties to a drastic reduction of energy consumption and carbon emissions where the 'change' that I open with above, translates as 'economic and social transformation' (UN Climate Change, 2015). With depletion of fossil fuels, rising oil prices and concerns over energy use came the idea of energy independence (Lang, 2022). Coined around 1970 for domestic buildings, the sectors of the built environment used for commercial purposes followed. A recent literature review (Jaysawal et al, 2022) opens with a list of abbreviations that shows today's complexities and differences between countries of the concept of a 'net zero building' (NZB). The UK government stated that net zero means:

'any emissions would be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture'. (UK Parliament, 2019)

My first interview question (Higgins, 9.8.2023) asked about this issue of defining net zero buildings:

'I believe a net zero building would be one that provides its own energy source, enough to run the building and pay back the emissions created during construction.'

This advice suggests that this essay needs approaching from two directions: operational energy demanded when a building is used and embodied emissions from during construction, including material choices. Sometimes referred to as 'net zero energy buildings' (NZEB) (Kapsalaki & Leal, 2011) helps remind us that energy consumption is at the core of the concept. 'Net zero' refers to the difference between the amount of greenhouse gas produced and the amount removed from the atmosphere; the amount of energy used by a NZB equals the amount of renewable

energy it produces in a year. Globally, it is currently estimated that buildings account for 40% of energy consumption and carbon emissions (Gatupalli, 2023; Jaysawal, 2022) and 50% of extracted materials (UN Climate Change, 2015). New building projects generate half of their emissions from embodied sources, including concrete and steel, and half from the energy used in operation (UN Climate Change, 2015). In 2011 (Kapsalaki and Leal, 2011) note the newness of the concept of NZEBs and are right to call for a rapid take up by the construction industry because the Paris agreement requires all new buildings to reach net zero operational and 40% reduction in embodied carbon emissions from 2030. In a recent lecture, sculptor Sir Antony Gormley (2023) spoke of the dominance of glass, steel, concrete in today's built environment. Our familiarity with and need to change such materials that routinely surround and shelter us is already one starting point for a more environmentally friendly narrative.

The 'working harder' part of this net zero essay could be interpreted in two ways: first, via green architecture and sustainable design principles; or alternatively, using less energy and fewer carbon emissions via reuse rather than demolition. For example, One Angle Square in Manchester has:

'a double-skinned façade that minimises heating and cooling [...] underground concrete earth tubes [that] passively absorb heat and lower energy required [functioning] as a thermal sponge.' (Neuroproject, 2020)

This 'green pocket' (Neuroproject, 2020) of a building has been designed to work 'harder' by having less of an impact on the environment. In turn the content author notes how such buildings enhance lives by saving energy, reducing pollution and building habitats. Thinking about 'working harder' from another interpretation considers producing energy or 'pay back' (Higgins interview, 9.8.2023) perspective

and this led me to look at the reuse option for buildings. Reuse is a regenerative opportunity in the evolving net-positive era of building design. Regenerative suggests forward-thinking development or ‘the ability to renew, restore and grow’ (Gattupalli, 2023 p.2). When used in reference to buildings, however:

‘net-positive energy approaches open a host of new [...] issues and opportunities not currently evident with net-zero energy buildings.’ (Cole & Fedoruk, 2015)

For example, batteries that run some solar panels bring a “tax on home decarbonisation” (Simkins, 2023), heat pumps can have design issues in flats if there is insufficient outdoor space for the units or when outdoor temperatures falls, so does heat pump efficiency (Drury, 2023) due to condensation forming on internal fins. One design solution is one huge, networked unit for example in Helsinki, a heat pump of 500 megawatts is planned to provide 40% of the city’s heating needs by 2029 (The Times, 2023a).

While ‘a building lifespan is typically 60 years’ (UN Climate Change, 2015), reuse is an alternative to demolition. Near to where I live is the megastructure The Centre Cumbernauld - 300,000 sq ft of retail space and 1,000 space car park designed and built 1955-67 as part of Scotland’s new town plan for population overspill from cities including Glasgow (Watson, 2023). Now, council plans to demolish the remaining building—parts have already been demolished and new sections built on the brownfield space created—have brought a modernist, brutalist landmark or blight debate (Moore, 2022). I agree with the view that both demolition and building new bring emotional and environmental costs as not only are resources and a building’s story lost (The Design Museum, 2021), but also there’s a failure to reduce carbon in the buildings surrounding environment. I understand that some materials may be beyond reuse (Higgins 9.8.2023) so other solutions to be considered are design

optimisation and the use of technologies like photovoltaics (a non-mechanical cell that converts sun's energy into electricity), carbon capture from steel and cement-making industries as well as low-carbon material alternatives to glass, steel and concrete (Bramilla, 2018) as well as regulation and monitoring (Higgins interview) via for example energy management systems and Building Automation Systems.

“emotions are at the heart of how we interpret reality”

(Norman, 2003)

Meeting ambitious targets by 2050 places responsibility on humans as designers, occupiers, builders, policy makers and suppliers. For me, this responsibility looks like emotional and cognitive design because when we understand something, we can get passionate about it, which I see as the foundation of a symbiotic, sustainable relationship.

Emotional design is the concept of how products (including our built environment), systems and services evoke emotions in users. The diagram below (Figure 2) shows how Norman's theory covers three, cognitive levels—visceral, behavioural and reflective—through which users respond positively and negatively with things in their lived experiences - positive ones drive our curiosity and growth; negative ones help us learn from our mistakes. As defined by Norman (2003), the diagram illustrates how emotion and cognition are interwoven through the three elements so that all three are a part of any design (a building or anything), and relevant to meeting users' needs effectively and efficiently.

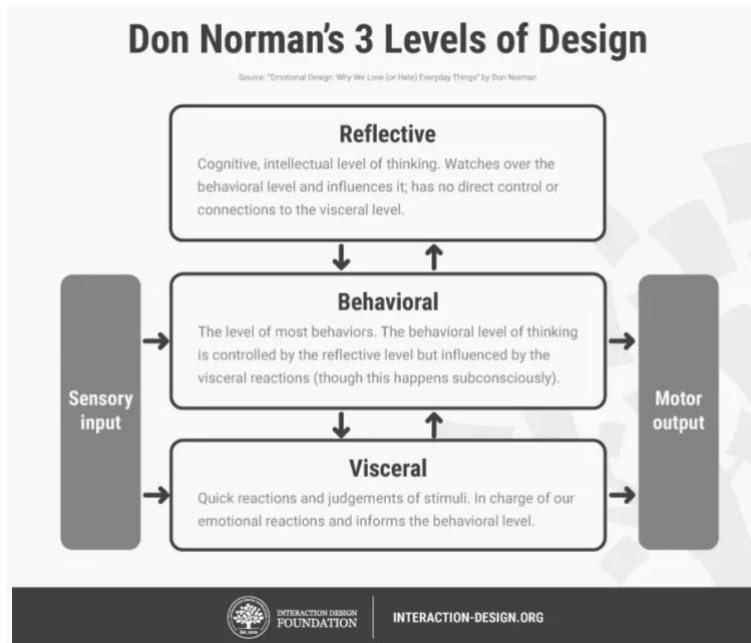


Figure 2

Norman (2003) states that emotional design affects the success or otherwise of a product or service. Similarly, Zhao, et al. (2015) writing about green buildings stated that the public's attitudes and understanding of eco strategies had an impact on success. A journalist (MacWhirter, 2023) takes a political view:

'There is no way that net zero can be achieved in a democracy without public support.'

Recognising that voters play a part in 'the fate of the planet' (MacWhirter, 2023) while believing in emotional design offers one route to moving beyond 'coercive policies' to impact climate change (MacWhirter, 2023), and change without the The Energy Performance Certificate (EPC) 'stick' (Drury, 2023). Bramilla (2018) notes housing as one of the most impactful sectors so in my interview I asked about products that make the most impact on reducing energy consumption and she said ground source heat pumps and solar panels. Applying Norman's (2003) concept to devices and

systems that can reduce our reliance on mainstream gas and electricity, requires designers to get involved by considering for example, ease of use that will make behavioural changes easier and more accessible. All people involved both in operational and embodied must actively 'buy in' and the goal is, if users love the products and continue to 'buy in' because they are happy and satisfied, that in turn forms emotional bonds that bring continued use and belief in the devices gains momentum. For example, by word-of-mouth and positive feedback there is a chance of meeting Lang's (2022) 'universally robust' (Figure 1). It must be better for humans to want to do something rather than being made to do it. For the construction industry, my interviewee thinks:

'Public attitudes towards net zero are definitely changing and therefore sustainability will now be a consideration when buying a property. This itself is an incentive for the construction industry as it could potentially open more lucrative revenues'. (Higgins)

Gormley (2023) sees his sculptures as neither architecture nor landscape but as the 'intersection between the two'. He explains how an object when it becomes a place and that place gains focus, then the experience of viewing is just as important as the object itself. His point made me think beyond basic, core human needs where my essay starts to further psychological needs that humans seek.

“man is a perpetually wanting animal.”

(Maslow 1943 p.370)

Psychologist Maslow's (1943) hierarchy includes elements of autonomy and self-reliance and the connection I am making between this and net zero buildings is if energy-efficiency goals are the object or objective, then getting where we need to be

could be the experience of living in more sustainable ways. In Maslow's hierarchy when one goal is realised, the next higher need emerges and later iterations relevant to the built environment (Zhao, 2015) can help us to understand human behaviours and how they might be applied to net zero buildings.

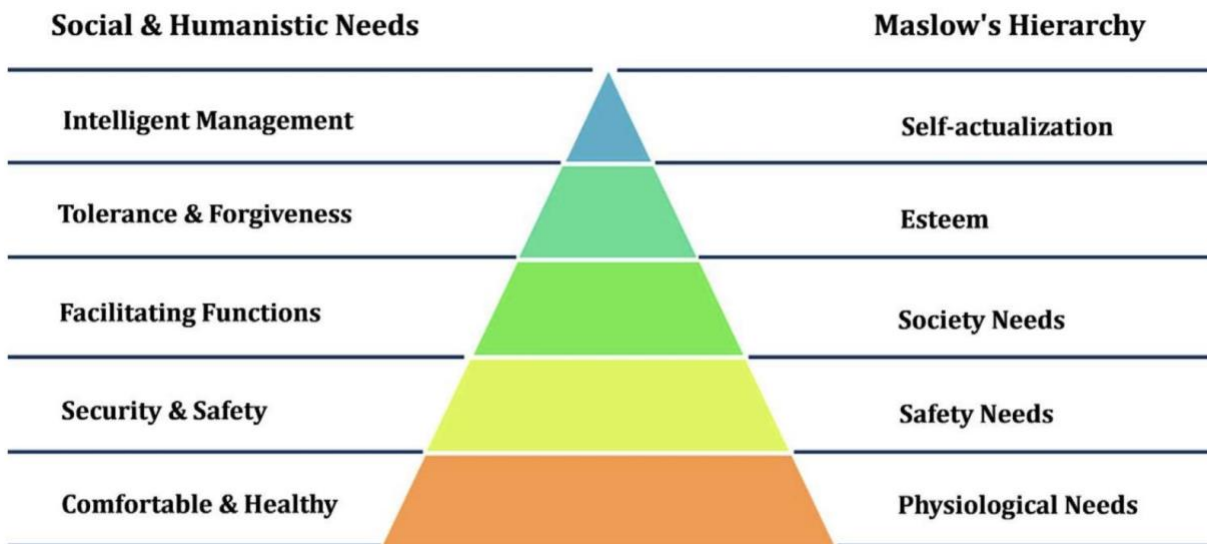


Figure 3

Figure 3 is from Zhao (2015) who talks about green buildings and uses Maslow's hierarchy to say that needs are a part of the architectural design process and that an important consideration is 'design intention':

'how humanistic concerns of buildings work to maximise users' subjective feelings'
(Zhao, He, Johnson & Mou, 2015 p. 1599)

This is relevant to net zero buildings because the view of the humans has an impact on how well the building works or 'facilitates function' but also higher order feelings like satisfaction, autonomy and control or even being reflective through say, judging day-to-day performance of a heat pump and enjoying benefits, including value for money that help us meet our growth needs.

When questioned if buildings can ‘provide other enhancements to people’s life and work’, I thought about ‘if’ but also how such ‘enhancement’ might manifest? First, households can save money through improved energy efficiency. Recent estimates show:

‘households can save an average of £385 a year by installing solar panels, £300 a year from having cavity wall insulation, £285 with loft insulation, and £140 by installing smart heating systems. Switching your old gas boiler for an air source heat pump could save £385 a year, and you will be £710 a year better off if you opt for a ground source heat pump’. (Energy Saving Trust, 2023)

Second, there is a “feel good factor” - doing right, doing what makes you happy by recognition of what you value; in other words, caring. Third, altruism—supporting each other for the betterment of our collective humanity—brings some of Maslow’s autonomy, self-reliance and control at the top of the triangle. For example, the satisfaction and ability to store energy captured through solar panels and choose to sell it back, for UK homes, to the National Grid.

This essay’s questions about net zero buildings are posed as problems. Yet, to return to Papanek (1985):

‘Design as a problem-solving activity can never, by definition, yield the one right answer [...]. The “rightness” of any solution will depend on the meaning with which we invest.’ (p.5-6).

I understand this to be saying that if the design of buildings is engrained and inherent in human’s psychology while also buildings, for shelter, are a basic need, then these same buildings have the potential to also meet our growth needs and thus enhance

lives by getting people—designers, occupiers, etc—to have meaningful, emotional, caring relationships for the ways we live in the built environment.

Concluding thoughts

Buildings are here to stay; humans need them for shelter for survival - this was my opening point. In my opinion the answers to the questions posed in this essay must be 'yes', again for our survival. There is no alternative for humans and the built environment that we live, work, relax, shop, eat and play in. If we seek enhancement, habitual behaviours need to change through our choices of building materials, devices in our buildings, naive energy use or monitoring emissions, as widely documented elsewhere and noted in this essay. A new human survival need is the need to question assumptions about ways that we live to help us realise we are responsible for building the future through our routine actions. A question also interrogated in my essay is 'how?' or 'in what ways can this be possible?' In Steinbeck's *The Grapes of Wrath*, Ma asks:

'How will we know it's us without our past?'

Writing about Centre Cumbernauld, this quote struck a cord - for the historical significance of knowing where we have come from like Lang's (2022) timeline. Two of my favourite design books (Norman, 2003; Papanek, 1985) have first editions that pre-date the Paris Agreement and definitions entering common parlance and technologies, such as solar panels, insulation and heat pumps touched upon in this essay. I find that what these "dated" texts give is an 'upstream' or 'rear view' (Lang, 2022) insight into history and buildings' lifecycles which helps us not only see where we have come from but also where we are going and how rapidly the planet is changing. One definition that I have saved until my conclusion is 'nearly zero energy

buildings' (nZEB); for me the word 'nearly' suggests progress over time and a journey. Energy efficiency is 'the first step' (Brambilla et al, 2018) towards meeting net zero goals by 2050. While it may now 'be common for buildings to achieve net zero carbon emissions' and the feasibility of net zero is being demonstrated, that does not mean human users should stop seeking further improvement. At school, I have learned design is iterative and looking at net zero buildings from a design perspective for this essay involved looking back and forward but also looking beyond the design discipline. To return to Lang's diagram (2022) he says the next decade is important because change will be about us all 'working together to enhance the credibility of net zero targets'. My interviewee specialised in offshore energy but helped with insights for how the building industry could learn from the decommissioning of offshore oil platforms. There is no easy answer to questions raised by this essay. For me, Steinbeck's writing always has a way of heightening realism to draw particular attention to real-life issues at a particular point in history. Researching and writing this essay in the summer of 2023, has been a very informative process and I have learned a great deal. This essay may be a prizewinner, it may not be. Either way, it achieves my better understanding of the buildings in my life (be they net, nearly or nowhere near zero!) and that makes me a changemaker and every step in the right direction is enhancement.

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Appendix 1: Interview

Monica Higgins monica.higgins@xodusgroup.com

Dear Ms Higgins,

I am an A-level student and am writing to you because your details were provided by TechFest as part of their Energy Matters essay competition. Your energy expertise caught my attention because I am completing the essay on net zero buildings and I hoped you may be able to offer answers to the following:

Q1: Could I start by asking about the complexities and subtleties of the concept of a 'net zero building' (NZB)? The academic articles I'm finding suggest some disparity (between definitions, sectors, countries) in measurements and parameters while newspapers seem to dramatise impractical targets and political conflicts. What does this mean to you?

I believe a net zero building would be one that provides its own energy source, enough to run the building and pay back the emissions created during construction. It should also be built using sustainable materials where possible.

For example; the actual construction of a building takes many months, involving lorries, cranes etc. All of these vehicles will have associated emissions due to their fuel consumption. In addition, the materials will have an embodied carbon associated with them. Therefore, before the building is even used it will have a sizable carbon footprint. In terms of net zero, it would not be good enough for the building to just be self-sustainable, it must pay back the generated emissions from construction. This is very similar to the considerations made for wind farms, as they too must generate enough useful energy to

payback their associated carbon emissions from construction, maintenance and decommissioning, along with providing electricity (their main function).

Q2: One strand of my essay comes from my designer/engineer viewpoint. Which designed or engineered devices/products/systems do you think could help users make the most difference in reducing energy consumption and decarbonising our domestic and commercial settings?

This is a very broad question and I am not sure if it relates to the construction of buildings or their habitation/use. I have no comment on the construction as that is not my industry. In terms of living, I would say things that will become more common in the UK are solar panels for electricity generation. This will allow users to not only reduce their grid electricity consumption, but also save money (in the long term – PV panels are a large investment). I would also research ground source heat pumps, as they are another way to reduce the reliance on grid electricity or gas. However they are very expensive to install and maintain, which could be a barrier to market. In addition, having a device such as a smart metre in the building will provide insight into the energy use, helping to minimise waste where possible.

Q3: The essay states it is now ‘common’ for new buildings to achieve net zero carbon emissions. What did you think the industry did to reach this ‘common’ position? How can we learn from this and apply to the notion of ‘work harder for the environment’, especially for older buildings? Are there lessons that the construction industry can learn from oil and gas industries eg. offshore decommissioning?

I think this is, in part, to do with the regulation that is now in place. Speaking from the oil & gas side of things, there is regulation in place to ensure that the environment is considered throughout the lifecycle. For older buildings it will be a case of trying to utilise

what is available, as there will be cases where it is simply not possible to use certain materials due to age/state of the building. I would imagine that poor insulation would be a factor for older buildings, which would result in inefficient heating systems and therefore increased energy usage.

Q4: In answering the 'work harder' or "give something back" element of the essay, I have talked about our built environment in terms of reuse (using Centre Cumbernauld as an example), and regenerative options. Could I ask your opinion on what you think the opportunities and challenges might be with these ways forward? What contribution do you think public attitudes towards net zero will have in reaching the target's success?

Public attitudes towards net zero are definitely changing and therefore sustainability will now be a consideration when buying a property. This itself is an incentive for the construction industry as it could potentially open more lucrative revenues.

Monica Higgins (she/her)

Senior Emissions Engineer

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www.xodusgroup.com



Professor Sukumar Natarajan S.Natarajan@bath.ac.uk - no reply

Dear Professor Natarajan,

I am an A-level student and am writing to you because while researching net-zero buildings for an essay competition (see link below) your Department caught my attention. As part of the competition, it is compulsory to interview academics and/or industry professionals and I hoped that you may be willing to help?

The essay that I have chosen to answer asks:

Beyond net zero buildings - it is now common for new buildings to achieve net zero carbon emissions, but could buildings be used to work harder for the environment? Could buildings produce energy, or reduce carbon in their surrounding environment, or provide other enhancements to people's life and work?

Your University website says you are interested in the extent that "the occupant of a building plays in the creation and maintenance of a building's low energy profile and how this could be optimised". This viewpoint is of particular interest to me because one strand I am following for my essay is how the "rightness" of any solution will depend on the meaning with which we invest" (Papanek, 1985, p.5-6). Buildings benefit humans by meeting one of our basic needs for survival - shelter, yet Maslow's (1943) hierarchy includes higher, psychological and social elements of autonomy and self-reliance. I am also thinking about Norman's (2003) emotional design and how its attachment of meaning can be used in a discussion of users' energy choices.

It would be very much appreciated if I could ask:

Q1: If the need for shelter (buildings) is inherent in human psychology, can these same buildings have the potential to meet higher growth needs and enhance people's lives?

Q2: What can be done to cultivate peoples' meaningful emotional connections to the ways we live in the built environment, enough to care and love it for future environmental benefit?

I will of course cite this communication and refer, with gratitude, to any answer you offer to my essay.

Thank you for your time,

Yours Sincerely,

Kit Nugent

<https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKewjP4o2l1LuAAxVDkFwKHbOOAuoQFnoECCQQAQ&url=https%3A%2F%2Ftechfest.org.uk%2Fnews-events%2Fupcoming-events-new%2Fevent%2F203-stem-next-essay-competition&usg=AOvVaw3Ch4tVMCbUz6pPNspalwh9&opi=89978449>