LOW & ZERO CARBON DESIGN

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Introduction

Today (18th of November 2020) the UK Prime Minister, Boris Johnson, set out what he calls “a 10-point plan for a green industrial revolution” to help the Government meet its target of “Net Zero by 2050”. We thought it would be helpful to give some guidance on the true meaning or definition of “net zero carbon”.

Sir David Attenborough has moved climate change to the forefront of public discussion encouraging governments across the globe to set ambitious goals and targets for reducing carbon emissions. In 2019 the UK has become the first country in the world to sign into law a target of zero carbon emissions by the year 2050.

This briefing document has been produced to explain the approved definitions of **Net Zero Carbon (NZC)** buildings and provide a general roadmap of the design and construction process to follow to achieve NZC Status.

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Defining Net Zero Carbon

To understand the scope of potential carbon reduction a project can achieve, it is first necessary to define what is meant by an NZC building. This note adopts the definitions provided by the UK Green Building Council (UKGBC) – a leading authority in defining the framework under which a building can be demonstrated to have achieved NZC status.

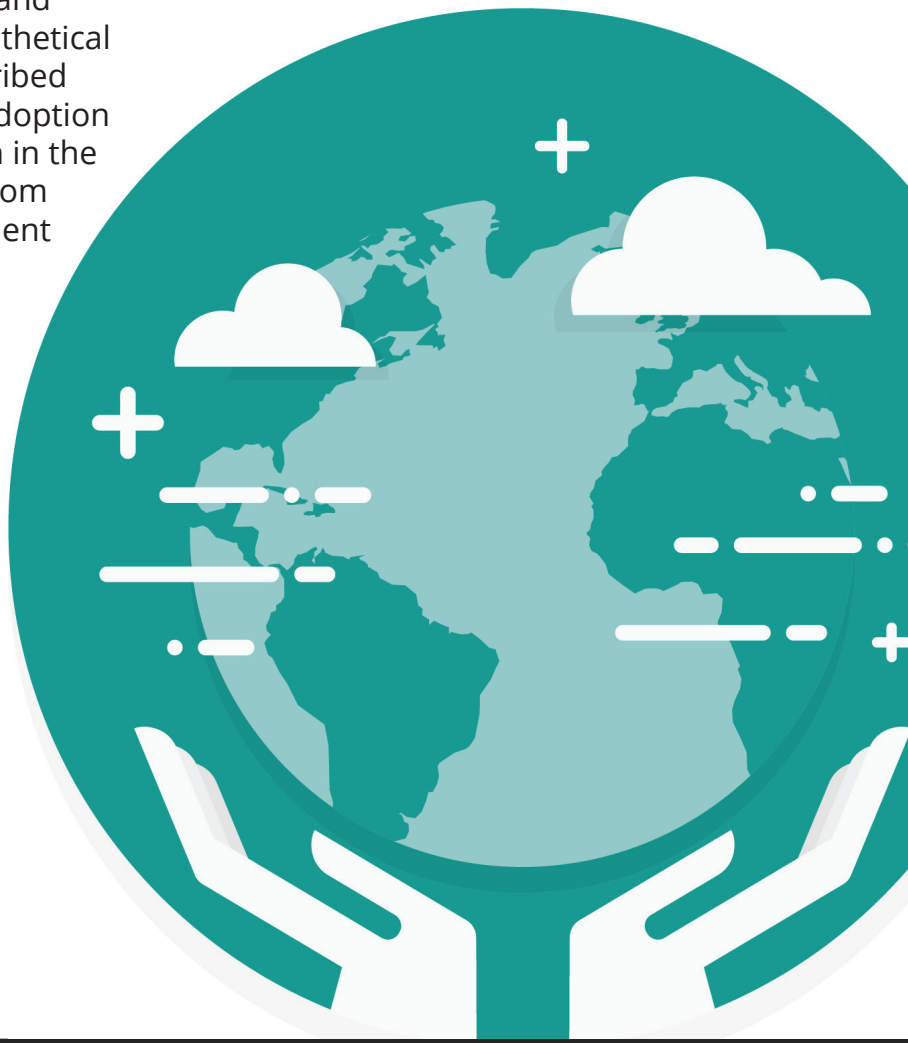
UKGBC Net Zero Carbon Buildings document defines two equally important approaches to NZC:

1. Net zero carbon – construction - "When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."

2. Net zero carbon – operational energy - "When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

The highest level of commitment to carbon reduction would be to adopt a Net Zero approach for both construction and operational energy. A third hypothetical whole life approach is also described but it is not recommended for adoption at this stage due to limitations in in the reporting of carbon emissions from maintenance, repair, refurbishment and end-of-life stages.

3. Net zero carbon – whole life - "When the amount of carbon emissions associated with a building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative."



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Achieving Net Zero Carbon (NZC)

After the NZC scope for the building has been established it is important to understand what processes will contribute to achieving set targets and what assessment procedures will demonstrate the NZC status.

Net Zero Carbon Construction

Buildings aiming to achieve net zero carbon for construction should attempt to minimise embodied carbon of the building's materials and construction works and offset all remaining embodied carbon through payments and generation. Assessing embodied carbon content should be done in line with the Royal Institution of Chartered Surveyors (RICS) Professional Statement "Whole life carbon assessment for the built environment". This includes tallying up the carbon emissions of building materials at production, transportation and installation stages. The whole life carbon assessment should be carried out in two phases:

1. The first assessment should take place as early as concept design (RIBA Stage 2 or equivalent) and as a minimum before the commencement of technical design (RIBA Stage 4 or equivalent). This ensures the assessment has the greatest potential to drive carbon reductions in all future stages of the project's delivery.

2. A further assessment should be undertaken at practical completion (end of RIBA stage 5) which should measure the as-built outcome, in place of modelled assumptions. This final as-built assessment should be used to determine the extent of carbon impacts needing to be offset to achieve net zero carbon for construction.

The carbon to be offset should be determined through the whole life carbon assessment undertaken at the point of completion.
The carbon can be offset using two routes:

A. One-off payment made at the point of completion; and/or
B. Net export of on-site renewable energy on an annual basis.

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Net Zero Carbon Operation

Investing in high performance building envelopes, energy efficiency and low carbon energy generation together with demand reduction is the most effective way to minimise a building's direct impact on the environment and achieve net zero operational carbon. The building should target reductions in energy demand and consumption to reduce the amount of total energy supplied, both from the grid and from renewable energy sources. Below is a list of suggested considerations for achieving NZC Operation:

1. Orientation Optimisation – The first step in reducing the overall energy demand required to operate the building is to undertake a dynamic assessment of the orientation to determine the optimum orientation. This balances good levels of daylight and potential for photovoltaic electrical generation (south facing) with those of limiting over-heating and reducing cooling demand (North facing). This is a service that we are experts in and would be happy to offer for any new build development.

2. Building fabric and passive design – Reducing the overall energy demand required to operate the building. Improvements include efficient fabric and shading design to reduce heating and cooling demand, natural daylighting to reduce artificial lighting demand, natural ventilation to reduce HVAC demand, appropriate sizing of building systems to limit over-engineering.

3. Systems efficiency – Increasing the energy efficiency of the building systems. Improvements include highly energy efficient building systems – HVAC, lighting, vertical transport etc.

4. Energy management – Implementing smart energy/building management systems. Improvements include conducting an energy audit, managing occupant behaviour, managing 'peak loads', adjusting HVAC temperature set points, achieving ISO 50001 accreditation.

5. On-site renewables - Implementing, where feasible, renewable energy generation on-site. Renewable energy sources include wind, solar, heat pumps, biomass, PPO and biomass or PPO CHP.

6. Off-site renewables - Adding purchase of renewable energy generated off-site will also offset carbon emissions in operation. Power Purchase Agreements (PPAs) for electricity, certified low-carbon district heating/cooling and certified green gas (e.g. biogas from sustainable sources) will all achieve this aim and provide the most credible additionality.

7. Off Setting - The final element of carbon reduction, after all the above steps have been taken, may only be possible by a process known as "off-setting". This involves purchasing certified carbon credits from companies that invest in rainforests. This not only achieves a net zero carbon building but actively helps to protect existing and create new biodiverse habitats for future generations.

8. Further considerations – The physical wellbeing of building occupants should not be compromised as a result of energy use reductions. These include considerations around indoor air quality, daylight and over-heating.

While creating a building's energy model pre-construction is essential in developing a solution that would achieve NZC Operation, a building model is not proof of NZC Operation status. The actual building's in-use energy should be measured and reported against the amount of renewable energy generated or purchased annually. Reporting on an annual basis considers seasonal variations and provides a standard comparative measure between buildings. The building's annual energy use should be reported as a total (kWh) and in terms of intensity (kWh/m2).

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Conculsion

Analysing the two approaches to achieving Net Zero Carbon it can be seen that it is no small feat. Construction and operation approaches are often at odds with each other as efficient fabric, systems and renewable generation technologies often involve materials with high embodied carbon content. It is therefore recommended to consider implementing the NZC Operation approach first alongside attempting to minimise embodied carbon of materials and construction process.

Should NZC Operation approach be adopted in the context of a new built project it is important to begin modelling and design works as early as possible. The final design solution is likely to involve the implementation of some or all of the following:

1. **Super-insulated fabric** – Pushing fabric U-values as low as technically and economically feasible to reduce heat losses space heating requirements.

2. **Passive solar control** – Integrated façade solution with window specifications, fins and overhangs designed to control solar incidence, reduce the need for active cooling and the risk of overheating.

3. **Hybrid ventilation solution** – Mechanical ventilation with heat recovery to reduce space heating requirement in winter and openable windows to allow passive cooling in summer.

4. **Low temperature heating & Heat Pumps** – Ground source heat pumps coupled with underfloor heating loop exhibit the highest efficiencies of all heating systems currently available on the market. Some combination of heat pump (air/ground/water source) and a low temperature heating solution is likeliest to minimize operational carbon emissions.

5. **Solar PV and Battery storage** – The site allows a solar array that would generate a considerable amount of energy to be installed. Taking full advantage of the generated power will require energy storage. Implementing energy storage would also benefit from purchasing off-site renewable energy.

6. **Carbon offsetting & Purchase of renewable energy** – The measures listed above may prove to be insufficient to achieve NZC Operation. Carbon offsetting by off-site sources may be required.

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