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PERSPECTIVE

Net zero adaptation—a review of built environment sustainability assessment tools*

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Abstract

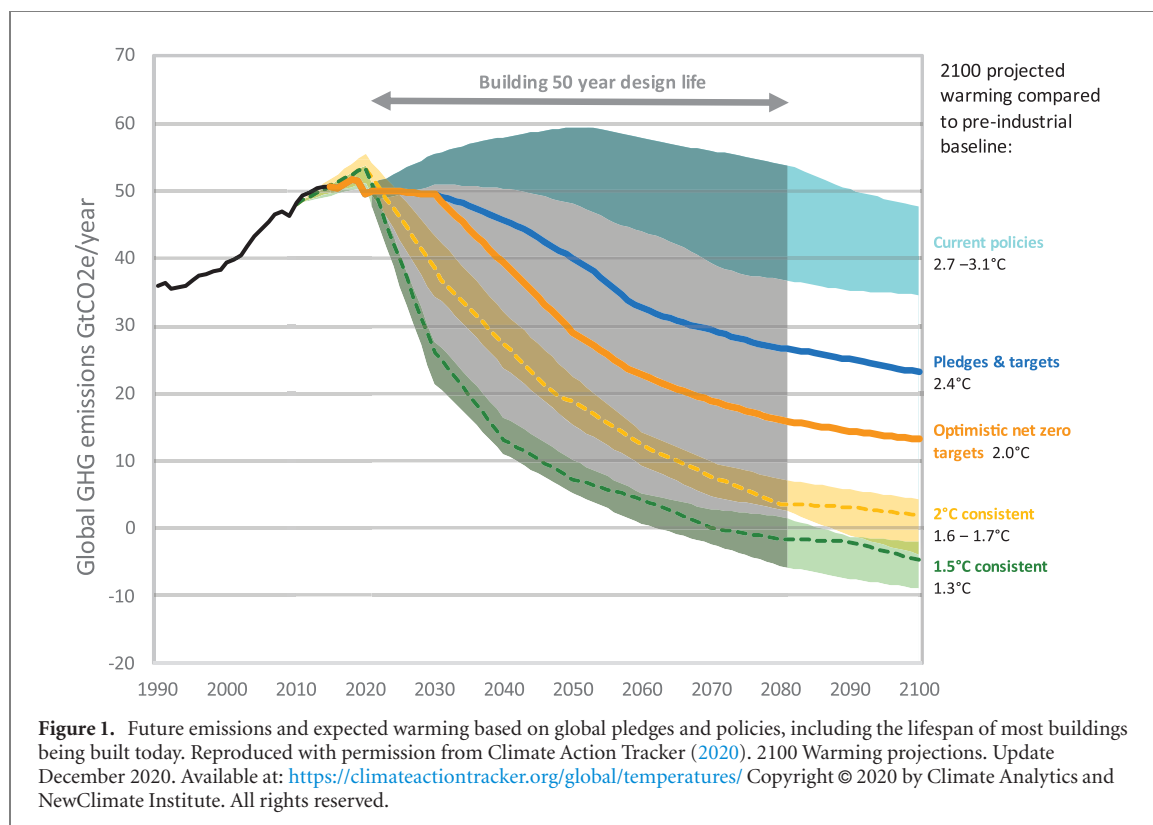
In the context of the built environment there has been a greater focus of research and policy on climate mitigation efforts, compared with adaptation. Buildings designed today will likely need upgrades within their lifetime if adaptation is not adequately considered. There is currently no widely adopted system for assessing building adaptation in design and clearer guidance is needed. By way of example, a review of three established, geographically diverse building sustainability assessment tools (BREEAM, Green Star and LEED) demonstrates the extent that adaptation to climate change and mitigation of greenhouse gas emissions have been integrated. Despite recent assessment updates, emphasis on action pertaining to climate issues is heavily weighted towards mitigation; the integration of adaptation considerations is limited and in most cases not mandatory. This state of play in assessment tools is reflective of wider shortfalls in meaningfully addressing climate change risk in asset design. To ensure that asset investment considers climate-related impacts in a holistic manner, better mechanisms for achieving an integrated perspective of mitigation and adaptation are required.

1. We need to adapt, even if we meet our net zero greenhouse gas emissions target

Since 2019 ‘extreme weather’ and ‘climate action’ have featured as the two most likely risks in the World Economic Forum Global Risks Report, reflecting an increase in attention towards these issues in the business market (World Economic Forum 2019, 2020, 2021). At the Davos Agenda 2021, achieving ‘net-zero’ was clearly profiled under the ‘how to save the planet’ theme. Much like wider policy sentiment, climate adaptation was largely missing from the discussion. Yet, climate mitigation and adaptation are clearly related concerns. Indeed, as figure 1 shows, current projections indicate that the climate is likely to continue to warm above 2 degrees Celsius even if all current national pledges and targets are met. This means buildings designed today will likely need upgrades within their lifetime given building codes and sustainability assessment tools are typically based on historical data, not current or future weather patterns (Mauree *et al* 2019 and Stagrum *et al* 2020). While net zero carbon policies will have a role in mitigating some impacts of climate change, this does not justify the relative absence of adaptation considerations.

In the context of the built environment there has been a greater focus in research and policy on mitigation, compared with adaptation (Grinnell *et al* 2011, Champagne and Aktas 2016, Hu and Pavao-Zuckerman 2019, Mirhosseini *et al* 2019, Palmer 2020 and Royal Academy of Engineering and National Infrastructure Commission 2020). From an industry perspective, within the last five years there has been a proliferation of

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commitments and frameworks for ‘net zero carbon’¹ led by the likes of the World Green Building Council, with none pertaining to adaptation.

Why is this the case when climate change is already happening, and negatively impacting the built environment? It could be that climate mitigation targets (for example, net zero by 2050 in the UK) are clearer to understand, whereas adaptation is a less tangible goal—therefore receiving less attention (Royal Academy of Engineering and National Infrastructure Commission 2020). Others argue it is because no comprehensive tool has been developed for the assessment of buildings for adaptation (Sharifi and Yamagata 2015) which is necessary in order for it to be operationalised into design (Mirhosseini *et al* 2019), which is the underlying principle of why assessment tools were developed for sustainability considerations.

2. The impacts of ignoring future climate change for the industry

There are a range of ramifications if net zero carbon buildings are not designed in a way that accounts for future climate change. This includes locking future retrofit costs into the current building stock as assets will not be able to operate efficiently to provide user comfort, and presents risks of breaching safe operating thresholds throughout the anticipated life span. For example, wind damage and flooding associated with increasing intensity of tropical cyclones and maintaining thermal comfort are two impacts of climate change on the future performance of buildings, which could deem them unsafe. Only a limited number of studies cover both net zero carbon and future climate change in the built environment, (such as Gething 2010, Jankovic and Huws 2012, Ascione *et al* 2017, Hu and Pavao-Zuckerman 2019 and Mancini and Lo Basso 2020). The key findings of these studies are that:

- Climate change needs to be considered when designing net zero carbon buildings since efficiency and effectiveness of energy reduction measures are highly dependent on future temperatures.
- In order to mitigate against climatic and economic vulnerabilities, retrofitting the existing building stock to be energy efficient, resilient to climate change as well as cost optimal needs to be a priority.
- There can be conflicts in mitigation and adaptation design measures, for instance increased natural light (to reduce electricity) can increase issues with overheating in the long term. It is therefore important to be explicit about mitigation actions that may be working against adaptation in the medium to long term. Many of these design issues can be solved with informed optimisation decisions.

¹ The construction industry tends to adopt the term ‘carbon’ as a proxy for greenhouse gas emissions.

3. What solutions are there to achieve net zero adaptation for buildings?

The need for large-scale net zero adaptation without interruption to users is a challenge for practitioners and policymakers alike. Accordingly, the response needs to be ‘two pronged’, with agendas converging and not diverging. If we look to the codification of sustainability metrics into assessment tools for buildings, they have facilitated the integration of sustainability into the way that designers operate (Hu 2018 and Hu and Pavao-Zuckerman 2019). Whilst there has been some debate over the extent to which these tools achieve truly sustainable outcomes (e.g. Lützkendorf and Lorenz 2006 and Kajikawa *et al* 2011), they have provided a means to set baselines and promote improved industry practice.

In recent years, there has been a concerted effort by many sustainability assessments tools to ensure that they are holistic, expanding upon operational carbon mitigation to include aspects such as health and wellbeing, responsible procurement as well as climate change *adaptation*. However, it is not obvious from a building rating how well both mitigation and adaptation to climate change is covered. If an asset achieves a high rating via one of these assessment tools, how does it reflect the achievement of net zero targets, or adaptability to climate change? This is important for investors and property developers to understand if they are seeking both a net zero carbon portfolio, whilst also minimising their exposure to risks associated with changing weather patterns. They could use a sustainability assessment tool to quickly understand already constructed assets and as a requirement for future investments to ensure it meets these requirements. Such tools are already being stipulated through green bonds as demonstration of a sustainable property investment, as there are few alternatives (Climate Bonds Initiative, Climate Resilience Consulting and World Resources Institute 2019).

4. Building scale sustainability assessment tools—a review

To understand how net zero carbon and adaptation is currently addressed in the design and operation of buildings, it is worth briefly examining three established, geographically diverse and recently updated building sustainability assessment tools: BREEAM (UK), Green Star (Australia) and LEED (USA). Understanding how well adaptation to climate change and mitigation of greenhouse gas emissions have been integrated into these tools can provide us with a proxy of wider ‘best practice’ in industry, as there are no other common stand-alone standards. In this review of the three tools’ assessment manuals, the identification of a relevant credit or point for climate mitigation was based on a simple criterion that the explanation and/or guidelines identified greenhouse gas reduction/mitigation as part of the requirements. This included all aspects of the building’s life cycle (both embodied as well as operational emissions). Similarly, the review for climate change adaptation sought explicit reference to future climate or weather patterns. Table 1 provides the outcome of the assessment.

The results demonstrate that although these assessment methods were updated recently, emphasis on action pertaining to climate issues are heavily weighted towards mitigation; the integration of adaptation considerations is much lower and in most cases are not mandatory. This makes it challenging for investors to know whether climate risks have been assessed and acted upon within the development, even if the highest ‘sustainability’ rating is awarded.

BREEAM has the most obvious integration of both mitigation and adaptation considerations. Although there is little mention of adaptation within BREEAM’s purpose, the assessment integrates future climate change into a number of key credits such as thermal comfort and water use, as well as having a standalone credit, recognising the multifaceted impact climate change has on the core design process. However, there remains limitations in application:

- There are inconsistencies in which future climate change scenarios are applied within the assessment, with a different scenario stipulated for thermal comfort than for peak rainfall for example.
- There is no mandatory requirement to include climate change adaptation to achieve a rating, meaning that a building could be awarded an ‘excellent’ rating, but not have completed a future climate change risk assessment.
- Climate considerations are not integrated into ‘management’ section, meaning that the team do not have to set out and agree a future climate change scenario on which to base the project brief and design.
- Future climate change is not stipulated to be included as part of ‘reduction of energy use and carbon emissions’ credit. As discussed previously, this is an important aspect to consider when designing a net zero carbon building, particularly as temperature increases will impact the performance of the passive and mechanical systems in place.

In October 2020 Green Star released a substantial revision in the issue of a new version of the tool, with a new definition of a sustainable building—including ‘giving owners, occupiers and investors’ confidence that theirs is a high quality future proofed asset’ and for ‘all buildings to be net zero carbon’. This last statement will be mandatory from the 1st of January 2030 for any project that registers with the scheme. There are additionally

Table 1. Assessment of credits/points relating to climate change mitigation and adaptation for the assessment tools. There is a clear weighting towards mitigation rather than adaptation within all assessments.^a

	BREEAM SD5078 2018 3.0 (BRE 2019)	Green Star buildings 2020 V1 (Green Building Council Australia 2020)	LEED 2019 V4 design and construction (USGBC 2019)
Intent	<i>Mitigating the life cycle impacts of new buildings on the environment</i>	<i>Lead the sustainable transformation of the built environment</i>	<i>A framework for healthy, highly efficient, and cost-saving green building</i>
Credits/points where mitigating greenhouse gas emissions are integrated into the requirements	Reduction of energy use and carbon emissions Energy monitoring External lighting Low carbon design Energy efficient cold storage Energy efficient transportation systems Energy efficient laboratory systems Sustainable transport measures Environmental impacts from construction products (LCA) Impact of refrigerants	Grid resilience Upfront carbon emissions Energy use Energy source Other carbon emissions Life cycle impacts Movement and place Green power and carbon offsets	Bicycle facilities Reduced parking footprint Green vehicles Commissioning & enhanced commissioning Minimise & optimise energy performance Building level & advanced energy monitoring Demand response Renewable energy production Fundamental & enhanced refrigerant management Green power and carbon offsets
% of assessment - mitigation	33.8%	25.0%	29.5%
Credits/points where adaptation to future climate change is integrated into the requirements	Thermal comfort Low carbon design Flood and surface water management Design for disassembly and adaptability Designing for durability and resilience Water monitoring Water consumption Ecological risks and opportunities Adaptation to climate change Impact of refrigerants Land use	Climate change resilience Community resilience Heat resilience	Sensitive land protection Innovation—3 pilot credits available for resilience
% of assessment—adaptation	17.0%	3.0%	4.3%

^aFull data analysis available in ‘supplementary information’ link (<https://stacks.iop.org/ERIS/1/023002/mmedia>).

now 10 minimum expectations to ensure all Green Star rated buildings meet a basic definition of a sustainable building, including that it must ‘*Be built with climate change in mind*’ and ‘*emit less carbon in construction and during operations*’. This in turn means that as a *minimum* a project seeking certification needs to have a pre-screening assessment to identify climate-related risks facing the building. This push on adaptation to form part of the minimum requirements for a building to be determined ‘sustainable’, alongside mitigation of emissions, is an important step forward for the industry. However, as table 1 identifies, there is little explicit integration in other aspects of the assessment; although it is mandatory to conduct a climate change impact review, this does not mean it will *necessarily* be integrated into the design (as the developer can choose not to act on the results of the risk assessment). This is something that BREEAM more prescriptively requires throughout.

LEED was also recently updated (2019), however upon review the only aspect that directly relates to climate adaptation is if the development is in an area at high risk of flooding. Other credits where one might expect future climate change to be included (for example, in calculations for drainage) are prescriptive and based on past climate conditions using the last five years of rainfall. In comparison, 29.5% of available points are directly related to mitigating future climate change. LEED has included pilot credits for the last six years on climate adaptation and resilience; these credits have not yet been integrated into the tool. The USGBC recently took over the administration of another standalone tool called RELi—specifically developed to assess building resilience and adaptation (USGBC 2018). RELi includes aspects such as hazard preparedness, community cohesion and material effectiveness. It is the first built environment assessment tool that has emerged with ‘resilience’ as the focus, however it is not integrated into LEED. A developer or investor would have to commission two assessments to ensure it is both sustainable and adapted to future climate change.

5. The way forward?

Although net zero carbon has dominated the academic, political and industry rhetoric in recent years, there is an increasing understanding that we must concurrently adapt to existing and future climate impacts. If we look to the real estate and finance sector, we can see that there are going to be more requirements of developers and designers. The taskforce on climate related financial disclosures and the Climate Bonds Initiative, Climate Resilience Consulting and World Resources Institute (2019) recognise the importance of mitigation *and* adaptation within built assets because of the different risks they both pose (regulatory, transitional and physical). However, if integrating adaptation criteria into existing sustainability assessment methods is required for adaptation considerations to be operationalised within the engineering and construction industry—as more strongly evidenced by the net zero carbon agenda—this perspective paper has demonstrated there is still some way to go. Updating these assessments would provide a signal for best practice and help to address the current shortfalls in meaningfully addressing climate risk (*both* mitigation and adaptation) within building design.

Where there are claims that climate change is considered, but it is not transparent how, this will not help achieve the ultimate desired outcome to ensure buildings are both net zero carbon and adaptable to a changing climate. To ensure that asset investment is driven in a direction that considers climate-related impacts in a holistic manner, better mechanisms for achieving an integrated perspective of mitigation and adaptation is required. This will require further development in standards (moving from voluntary to mandatory). COP26 later this year could be an ideal platform for ensuring that adaptation considerations increasingly become part of the climate change action agenda.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary information files).

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