Government Property Agency

Net Zero and Sustainability

Design Guide – Net Zero Annex

August 2020

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Contents

Introduction

a. Aims

To identify the standards for Net Zero (NZ) and Sustainability for the Government Workplace Design Guide to support and add to the content in the main body of the Guide. To have those Standards practically applied to all Government Estates buildings. This document outlines how to pilot the NZ model and targets on an existing GPA building to define the technical requirements and guidance to support the delivery of Net Zero carbon buildings.

b. Approach

Sustainability Annex is underpinned by empirical evidence and data from a detailed desktop study of existing guidance and standards documents:

- LETI Climate Emergency Design Guide
- BREEAM 2018
- CIBSE Guides
- RICS - Whole Life Carbon Assessment for the Built Environment
- RIBA 2020 Plan of Work
- RIBA 2030 Climate Challenge
- Better Buildings Partnership documents and standards
- Government Soft Landings
- Green Construction Board – Buildings Mission 2030
- The London Plan
- UKGBC Net Zero Carbon Buildings – A Framework Definition

Recommendations for targets and benchmarks have only been proposed where a solid body of evidence exist to support them, backed by published data and case studies.

In addition, analysis of existing buildings has also been undertaken to ensure that the targets align with best practice industry standards and examples. Exemplar buildings, in terms of building performance and energy consumption, have been highlighted to provide additional guidance to developers and project teams regarding how they adopt these standards to enable a NZ building to be realised.

c. Outline of Annex

The Annex largely aligns with the UK Green Building Council Net Zero Buildings Framework to identify the steps and process that a project team should undertake to enable the delivery of a NZ Building. The Annex takes a standardised approach whereby the targets and guidelines must be adopted by the whole portfolio of buildings within the Government Office Estate and not only a single building. There are 6 defined sections in the Annex as follows:

1 – Net Zero Definition

- Using the UKGBC Net Zero Carbon Buildings definitions for construction, operational energy and whole life emissions.

2 – Net Zero Model – Steps to achieving a NZ Building

- Defining the NZ Model using the UKGBC 5 step framework for construction and operational energy.
- Identifying the key processes and building elements which will support the delivery of a carbon neutral building e.g. using low carbon heat, incorporating renewables, accurate data disclosure and designing for disassembly to reduce embodied carbon in construction and end of life.

3 – Net Zero Targets

- Identifying the key and supporting targets a GPA Estates building must meet to achieve NZ for construction and operational energy
- Identifying guidance and recommendations to enable a developer to achieve the NZ targets and improve the performance of an existing building.

4 – Tools and Assurance

- Identifying industry tools and certification schemes which are of relevance to the sustainability annex.

5 – Methodology

- The methodology section of the report further clarifies the process each building must go through to achieve the stated standards and targets aligning with the RIBA 2020 Plan of Work for both new build and refurbishment projects
- The methodology also explains the outcomes expected at each stage which must be met or an evidence-based explanation of why the targets cannot be achieved prior to any derogations or offsetting purchases.

6 – Case Studies

- The case studies identify buildings which have implemented high efficiency systems including plant and lighting to reduce energy consumption to enable a high performing building.

Case studies also include new and refurbished buildings which have achieved a DEC top quartile rating aligning with the GPA Design Guide targets.

1. Net Zero Definition

The UKGBC Net Zero Carbon Buildings: A framework Definition, sets out two approaches for Net Zero with definitions and principles which are of equal importance:

1 - Construction

For new buildings and major renovations - *"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 - Operational Energy

For all buildings in operation - *"When the amount of carbon emissions associated with the building's operational energy*[1] *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 Energy Use Intensity target defined includes all of the energy consumed in the building (regulated and unregulated).

In addition, the **Whole Life Asset Management** (WLAM) emissions of the building should be considered - *"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".*

However, whole life carbon is not proposed as an approach at present due to current limitations in the reporting of carbon from the maintenance, repair, refurbishment and end-of-life stages of a building's lifecycle. Instead buildings should aim for net zero carbon in construction and operational energy until greater familiarity with whole life carbon impacts has been achieved.

In all instances, the building developer, owner or occupier seeking to achieve NZ should do so over the greatest amount of building area they have control over. The boundary and related floor area should be clearly disclosed to allow the market to appreciate the extent to which the developer, owner or occupier has achieved net zero. The boundary options for construction and operational energy are as follows:

[1] For the purpose of the Design Guide NZ model "energy" refers to both regulated and unregulated.

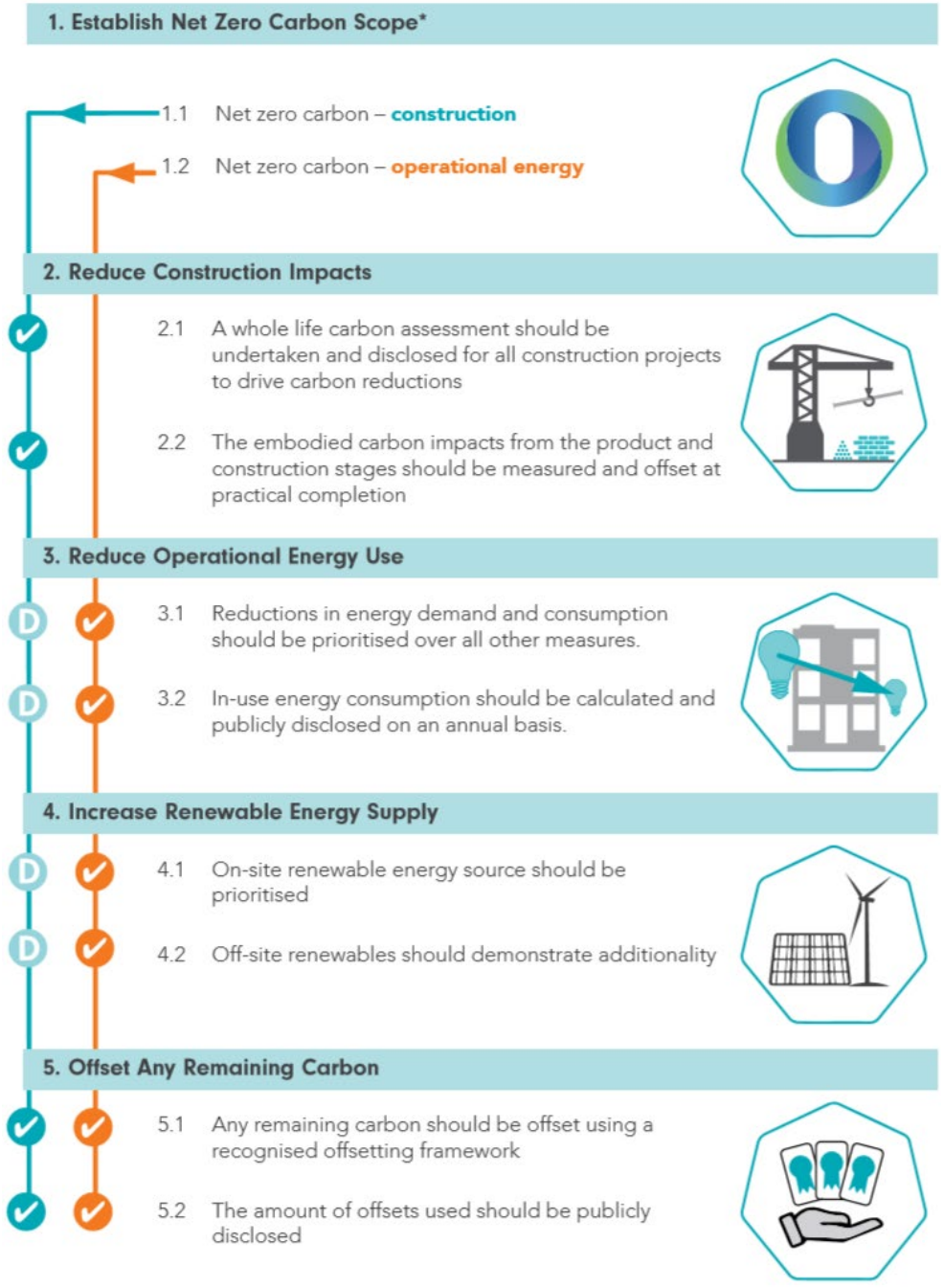
Boundary Options[2]

Construction	Tenancy (fitout or refurbishment)
	Single building (new or refurbishment)
	Multi-building development (new or/and refurbishment) (programme)
Operational Energy	Individual dwelling/tenant area in multi-unit building
	Base building
	Whole building
	Multi-building development (programme)
	Portfolio (base or whole building)

[2] Considerations when setting the scope of NZ modelling for compliance with the Design Guide.

2. Net Zero Model

The UKGBC Framework has also been adopted to develop the NZ Model for the Design Guide Sustainability Annex. The framework lays out a 5-step approach that a building should undertake to achieve NZ.



The Sustainability Annex identifies the process each building within the GPA Portfolio should follow aligning with the UKGBC Framework as follows:

1. Establish NZC Scope

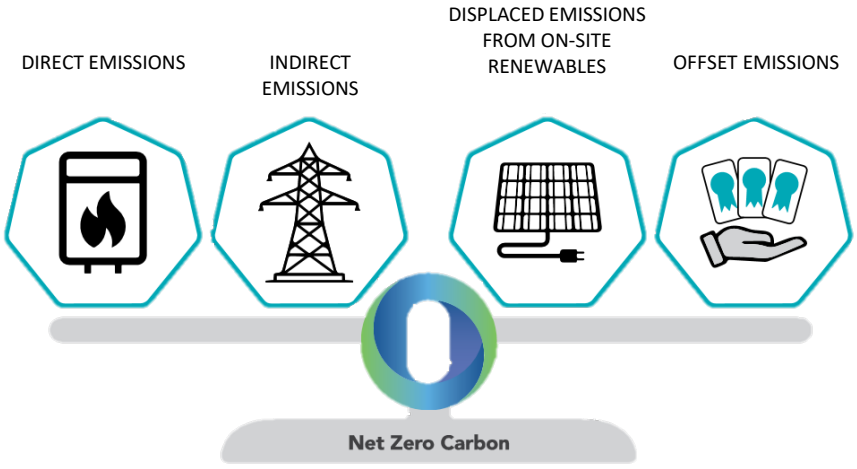
a) All buildings must disclose the NZ targets the building will achieve as per the targets defined in the Annex for both construction and operational energy.

b) Scope for construction:

- WLAM carbon assessment must be undertaken to determine the building's carbon impact. The assessment should be audited by a third party and should be in line with RICS Professional Statement.
- Related offsetting of carbon either through the net export of on-site renewable energy or the purchase of offsets should be audited by a third-party.

c) Scope for operational energy:

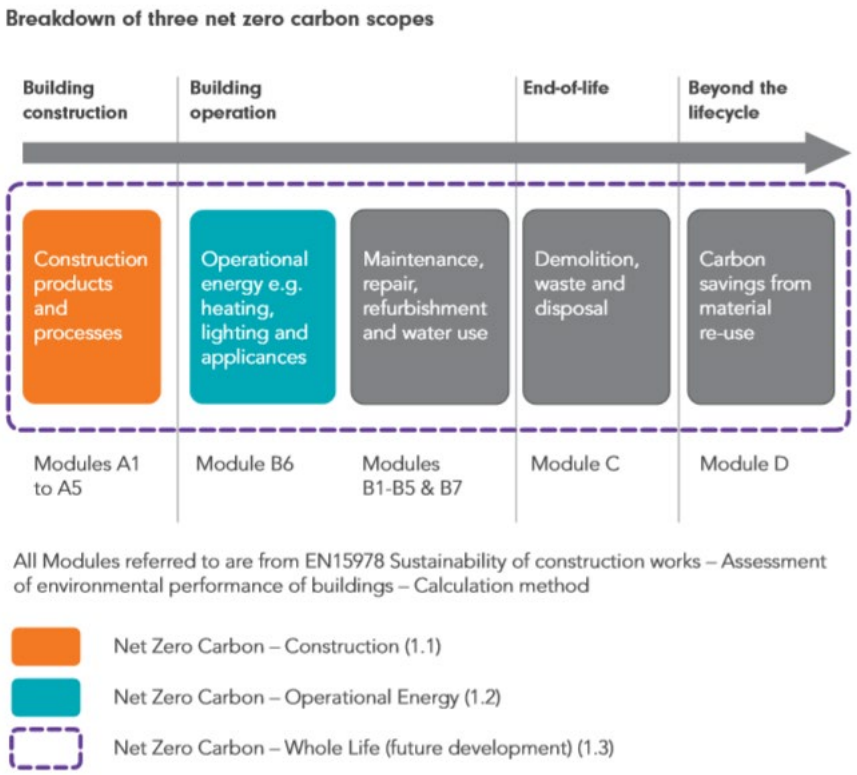
- Defined as all areas under operational control that have been used to demonstrate a NZ. The energy scope and related gross internal area (GIA) should be disclosed to allow the market to appreciate the extent to which the owner/occupier has demonstrated an annual NZ performance for operational energy.
- The operational energy of a building must be reported annually for carbon impacts as a total emissions (tCO_2e) and intensity ($kgCO_2e/m^2$).
- NZ for operational energy is achieved when the Building's total annual net CO_2 emissions = 0. i.e. all carbon impacts are balanced by all carbon credits as seen in the figure below.



- Where the annual net emissions equal zero, as audited through a third-party, the building is NZ for operational energy

d) Scope for WLAM carbon:

- Will be developed and added to the Design Guide within 5 years to take account of all building lifecycle stages. This will address construction impacts at practical completion and operational energy in-use.



2. Reduce Construction Impacts

a) WLAM carbon assessment must be carried out in two phases. First assessment should take place at RIBA Stage 1 to ensure the assessment has the greatest potential to drive carbon reductions in all future stages of the project's delivery. A further assessment should be undertaken at practical completion which will measure the as-built outcome. This should be used to determine the extent of the embodied carbon to be offset to achieve NZ for construction.

b) A building's product and construction stages are defined as modules A1-A5 of the **RICS Professional Statement.** RICS Guidance must be followed.

c) Best practice design guidance and recommendations must be followed to reduce construction impacts for example reducing the use of carbon intensive materials in the design.

d) The UKGBCs circular economy guidance for construction clients should also be reviewed to ensure that the building is designed to maximise circular outcomes.

3. Reduce Operational Energy Use

a) In-use energy consumption should be calculated and publicly disclosed on an annual basis. In-use energy consumption calculations and modelling must be undertaken. **PHPP** driven compliance-based modelling will be undertaken but supplemented and guaranteed by **DfP** & **TM54** modelling.

b) Reductions in energy demand and consumption should be prioritised over all other measures. To reduce energy demand and consumption, the development should

- Seek to optimise building fabric and passive design.
- Maximise systems efficiency.
- Implement smart energy/building management systems.
- Prioritise physical wellbeing of occupants.

4. Increase Renewable Energy Supply

a) On-site renewable energy should be prioritised. The amount of renewable energy generated on-site (minus any storage losses) should be measured and reported annually.

b) Off-site renewable energy should demonstrate additionality. Any renewable electricity purchased should demonstrate additionality in line with RE100 guidance documents '*Making credible renewable electricity usage claims*' and '*Technical note on renewable electricity options*.'

c) LZC Carbon modelling to identify on and off-site options to reduce energy consumption

d) Where on-site renewable energy is used as an offset, the achievement of NZ for operational energy should take precedence. When net NZ for operational energy has been achieved, any surplus carbon credits from exporting on-site renewable energy can be used to offset embodied impacts.[3]

5. Offset Any Remaining Carbon

a) Any remaining carbon should be offset using a recognised framework of accredited carbon credits. Offsets should only be considered as a last measure if steps 1-4 have not enabled net zero for construction and operational energy to be achieved.

b) Offsets should demonstrate additionality, avoid double-counting and provide a clear process for verification of carbon savings. For construction – offsets should be commensurate with the carbon impacts determined at practical completion. Exported on-site renewable energy can also be used as an offsetting route on an annual basis.

[3] Care should be taken to avoid double-counting renewable energy used to achieve NZ construction.

For operational energy – offsets should be commensurate with the carbon impacts determined annually.

c) All offsets must be publicly disclosed. The use of offsets must be accompanied by a plan to eliminate their use by reducing carbon emissions through design improvement and optimisation.

    - For construction – offsets should be disclosed at practical completion, in line with the reporting requirements. Where on-site renewable energy is used as an offsetting route, this should be reported annually as a cumulative figure alongside a statement of the outstanding carbon balance.

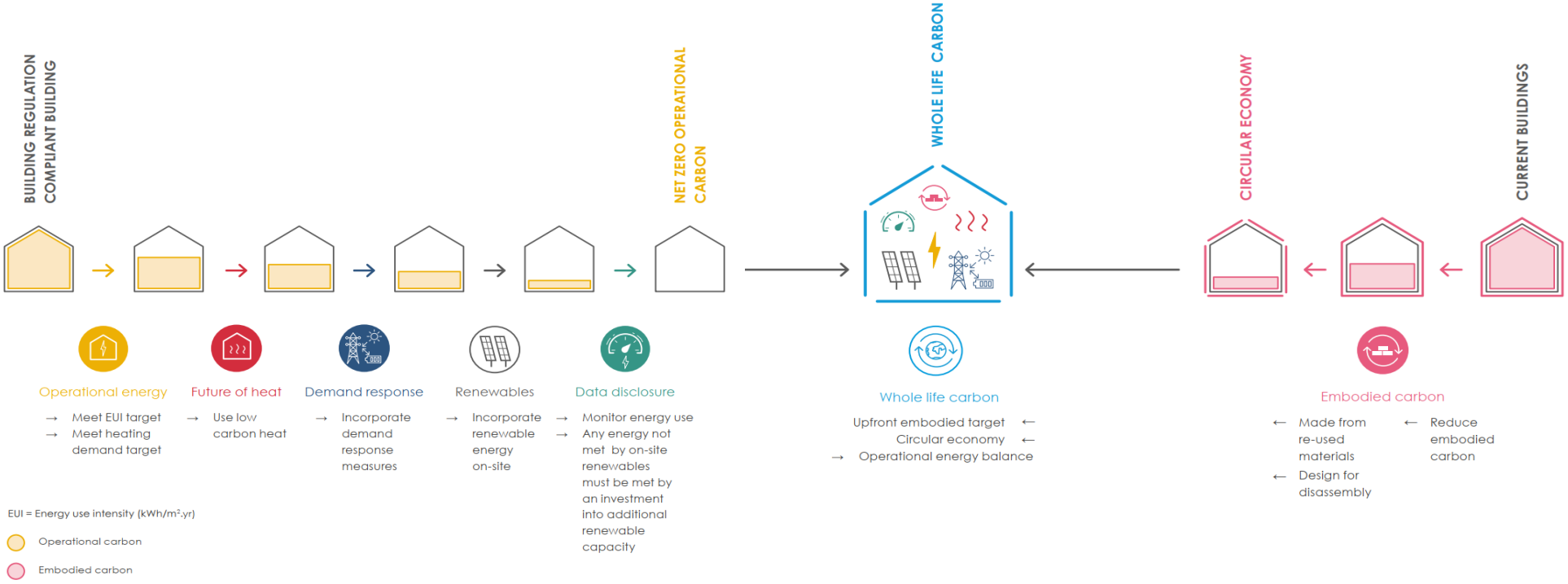
    - For operational energy – offsets should be procured and disclosed annually in line with the reporting for energy consumption.

d) Offsetting of embodied carbon impacts is suggested for up to practical completion rather than the WLAM of the building.

WLAM carbon explained

For all projects (new building & major refurbishment/ fit-out and refurbishment) in the first instance, the building construction and performance should be optimised through low carbon materials, fabric and system efficiency improvements as well as through the implementation of passive strategies to reduce energy consumption and associated carbon emissions to enable NZ construction and NZ operational energy to be achieved.

To enable NZ to be achieved for both construction and operational energy, the LETI Climate Emergency Design Guide seeks to explain WLAM carbon. The figure below shows the operational carbon reduction stages on the left and the embodied carbon reduction stages on the right.

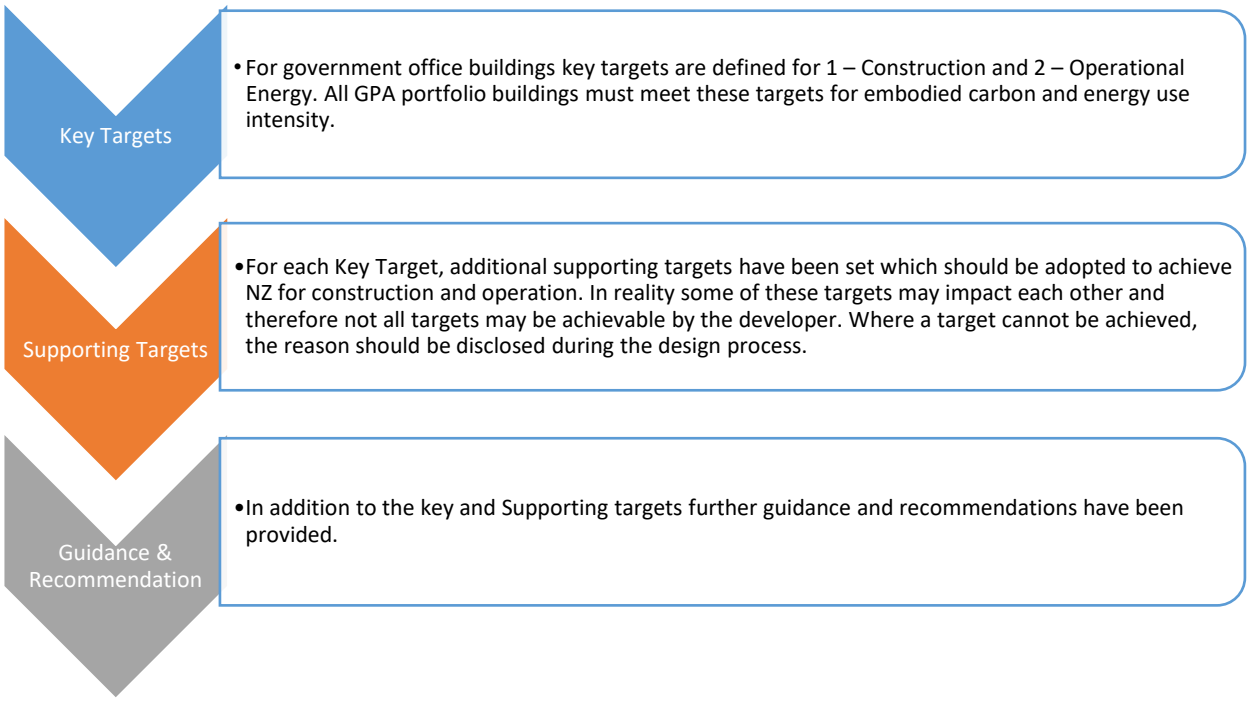


The methodology section of this sustainability annex will identify how all developments can achieve net zero carbon for construction and operational energy aligning with the UKGBC Framework.

3. Net Zero Targets

Through the desktop study of existing standards and guidelines regarding sustainability and the NZ Transition, a number of best practice targets and recommendations have been developed to enable a NZ Building for both construction and operational energy to be achieved. These targets are identified to provide guidance to all developers regarding the design standards they should be aiming to achieve.

It is understood that in practice several of these targets impact each other and therefore not all may be achievable when implemented in tandem. However, the developer, owner and occupier should seek to meet as many of the NZ targets during the design process as possible and where the targets cannot be achieved the developer must disclose proof regarding why the targets cannot be achieved. The key targets should otherwise be considered mandatory for all buildings.



The following section identifies the Key and Supporting targets as well as additional guidance and recommendations that should be followed by all Government Estates buildings for:

1 – Construction, and

2 – Operational Energy.

These targets should be achieved in addition to meeting other sustainability requirements, such as minimum BREEAM standards.

1 – Construction

Embodied carbon impacts from the product and construction stages should be measured and offset at practical completion

Key targets to achieve NZ for construction for all office buildings within the GPA Portfolio:

	Key 2030 Target
Embodied Carbon	<350 $kgCO_2/m^2$

For the Key Targets to be achieved, specific building elements must be optimised as follows:

	Supporting Targets
% of materials that are reused	50%
% of materials designed for reuse	80%
Embodied carbon including sequestration	<250 $kgCO_2/m^2$

To achieve the key and supporting targets within Construction, the following guidance and recommendations should be followed:

	Guidance and Recommendations
Materials	• Ensure longevity of material and systems specifications • Consider natural and renewable materials • Reduce the use of high embodied carbon materials
Design	• Simplify the design to use less materials (Tonnes of material per m^2) • Reduce the weight of dead loads where possible • Restrict long structural frame spans • Consider regular structural grid and future-proofed risers and central plant space • Avoid over-provision of MEP plant and reduce duct runs where possible • Structural members should be designed for 100% utilisation rate • Minimise structural weight, using lightweight materials to reduce foundation load and size

Transportation	• Reduce transportation to site and onsite construction through off-site modular construction, manufacture, consolidation centres and distribution hubs • Use existing materials on or near the site where possible
Manufacture & Assembly	• Explore design for manufacture and assembly (DfMA) solutions to reduce waste and site works • Mechanically fix systems so that they can be demounted and reused/replaced in the future to support a circular economy • Consider end-of-life use of structure, including ease of demolition and reuse of structural elements and materials

2 – Operational Energy

Key targets to achieve Net Zero Carbon for operational energy all office buildings within the GPA Portfolio:

	Target
Operational Energy Use (EUI)	70 kWh/m²/yr (NLA), 55 kWh/m²/yr (GIA)
Space Heating Demand	15 kWh/m²/yr
DEC Rating	In the top quartile of performance
EPC Rating	A
Renewable Energy (RE) Supply	Local Plan requirement for minimum % on-site RE achieved

For the Key Targets to be achieved, specific building elements must be optimised as follows:

	Supporting Targets
Form Factor	1-2
Window areas guide (% of wall area)	25-40% per wall
Fabric U-Values W/m^2.K	Achieve minimum U-Values (W/m^2.K) for wall (≤0.15), floor (≤0.12), roof (≤0.12)
U-Value: Windows	1 (triple glazing)
U-Value: Doors	1.2

Air Tightness	<1 (m^3/h. m^2@50Pa)
Thermal Bridging	0.04 W/m.K (y-value)
G-Value of glass	0.3-0.4
Low carbon concrete	min % GGBS or another substitute
CO2 Levels	<900 ppm with sensors for ventilation
Total VOCs	<0.3 mg/m^3
Daylighting	>2% av. Daylight factor, 0.4 uniformity
Daylight	Use of Climate Based Daylight Modelling (CBDM) as part of design process, both for CAT A and fit out
Lighting Power Density	4.5 (W/m^2 peak NIA)
Lighting out of hours	0.5 (W/m^2 peak NIA) Install lighting sensors/controls with daylight dimming
Tenant power density	8 (W/m^2 peak NIA)
ICT Loads	0.5 (W/m^2 peak NIA)
Small power out of hours	2 (W/m^2 peak NIA)
Automation	Common sensors for lighting and HVAC to reduce components and enable capital and maintenance cost savings
Free-cooling/Night cooling	Reduce LTHW to 55-60 °C. Increase CHW temperature to 8 °C flow
Comfort set points	20-26°C
Overheating	25-28 °C (for 1% occupied hours)
Heat Recovery	90% (efficiency)
Heat pump SCoP	≥ 2.8
Chiller SEER	≥ 5.5
Low SFP	FCU 0.35 W/l/s, Central AHU 1.2 – 1.5 W/l/s

To achieve the key and additional targets within 2 – Operational Energy, the following guidance and recommendations should be followed:

	Guidance and Recommendations
Design	• Design for a form factor of 1-2 to reduce fabric exposure to outdoor conditions • Reduce glazing area and improve U-Values of the building fabric • Include openable windows and cross ventilation where possible • Balance daylight and overheating and include external shading • All rooms but be designed in-line with SLL guidance • Reduce internal gains and relax setpoints • Install heating and cooling set point controls • Local heaters at point-of-use to meet DHW demands • Demand controlled and use of CO_2 sensors and linked to occupation • Use VSD for pumping and fans with demand and load controlled speed operation
Renewables	• Maximise use of renewables to generate the annual energy requirement for at least two floors of development including the use of heat pumps • Consider battery storage • Ensure heating and hot water generation is fossil fuel free • Implement high efficiency services systems and onsite renewables where possible
Energy consumption	• Reduce regulated energy consumption from controlled, fixed building services • Reduce unregulated energy consumption through occupant's incentive schemes • Reduce lighting, ventilation and small power energy consumption • Lighting design should be implemented to effectively light the spaces • Use LENI calculation method to understand true lighting system consumption ($W/m^2/100lux$)

In addition to the operational energy targets, the following monitoring and metering recommendations should be adopted through the design process:

Guidance and Recommendations – Monitoring and Metering

- Implement a sustainability and efficiency energy management plan in line with ISO 50001 that includes provisions for carrying out a DEC assessment, reporting on the DEC assessment outcome on an annual basis and incentivise incremental performance improvement
- Implement a metering management scheme to ensure that meters are and remain calibrated throughout the operational life of the building
- Metering should also provide a breakdown of major energy uses in line with Soft Landings and TM39 requirements to provide accurate, useful information and should be designed in collaboration with building operators
- Install an automated metering system (AMR) with half hourly data logging separate from the BMS with data storage and interoperability to access CSV data and interface with energy management systems
- The Building Management System (BMS) should be integrated between Cat A and Cat B and will enable 100% point commissioning

4. Tools and Assurance

The tools and schemes identified in this section aim at providing guidance and assurance. However, it needs to be noted that their implementation does not suffice to achieve the NZ target which was defined in section 1 of this document.

4.1 BREEAM Credits

All buildings are expected to achieve high levels of energy performance. To ensure performance against fundamental environmental issues is not overlooked in pursuit of a particular rating, BREEAM NC 2018 sets minimum standards of performance in key areas, for example: energy, water, waste etc.

The minimum acceptable levels of performance to achieve Excellent and Outstanding BREEAM ratings can be seen in the table below. In addition to these requirements, the minimum overall percentage score must also be achieved: Excellent 70%, Outstanding 85%.

Mandatory Requirements		**Excellent**	**Outstanding**
Man 03	**Responsible construction practices**	1 Credit: Responsible construction management	2 Credits: Responsible construction management
Man 03	**Responsible construction practices**	1 Credit: Responsible construction management	2 Credits: Responsible construction management
Man 04	**Commissioning and handover**	**1 Credit: Commissioning - test schedule and responsibilities and Criterion 11 (Building User Guide)**	**1 Credit: Commissioning - test schedule and responsibilities and Criterion 11 (Building User Guide)**
Man 05	**Aftercare**	1 Credit: Commissioning - implementation	1 Credit: Commissioning - implementation
Ene 01	**Reduction of energy use and carbon emissions**	4 Credits: Energy performance or Predication of operational energy consumption*	6 Credits: Energy performance and 4 Credits: Predication of operational energy consumption*
Ene 02	**Energy monitoring**	1 Credit: First sub-metering credit	1 Credit: First sub-metering credit
Wat 01	**Water consumption**	1 Credit	2 Credits
Wat 02	**Water monitoring**	Criterion 1 only	Criterion 1 only

Mat 03	**Responsible sourcing of construction products**	Criterion 1 only	Criterion 1 only
Wst 01	**Construction waste management**	None	1 Credit
Wst 03	**Operational waste**	1 Credit	1 Credit

*It must be demonstrated that the operational energy performance has been significantly improved

In addition to the mandatory requirements identified in the previous section, and in line with the RIBA Sustainable Outcomes Guide, the maximum number of credits should be targeted for the following BREEAM assessment issues.

Man 03	Responsible construction practices
Ene 01	Reduction of energy use and carbon emissions
Ene 02	Energy monitoring
Ene 03	External Lighting
Ene 04	Low carbon design
Ene 05	Energy efficient cold storage
Ene 06	Energy efficient transportation systems
Ene 07	Energy efficient laboratory systems
Ene 08	Energy efficient equipment
Mat 01	Environmental impact from products - Building life cycle assessment (LCA)
Mat 02	Environmental impact from products - Environmental product declarations
Mat 03	Responsible sourcing of materials
Mat 04	Insulation
Mat 05	Designing for durability and resilience
Mat 06	Material efficiency
Wst 01	Construction waste management
Wst 02	Recycled aggregates

Wst 03	Operational waste
Wst 04	Speculative floor and ceiling finishes
Wst 05	Adaptation to climate change
Wst 06	Design for disassembly and adaptability

4.2 Design for Performance

The GPA has made the important first step in referencing the DfP model, but to use their full market power this needs to be mandated with an ambitious minimum rating to actively drive the market and develop the supply chain. This was the key success factor in Australia where first of all the New South Wales government and then the national government mandated NABERS rating for all their building transactions in commercial buildings which has contributed to the improved performance of buildings since its start and led to improved performance in the private commercial office market.

The key elements needed are:

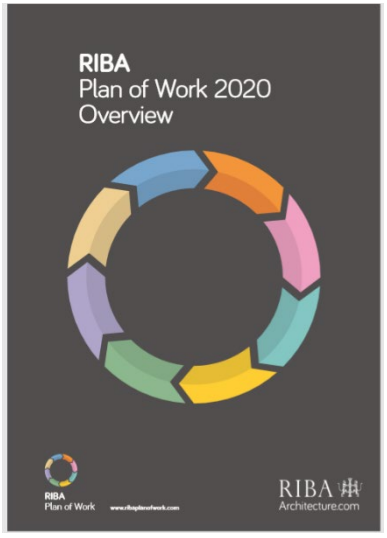
- Minimum DfP rating of 5.5* - base-build, tenant and whole building
- Contractual commitment
- Commitment to independent design review
- Commitment to 5-year reporting (aligns to GLA Be Seen guidance)

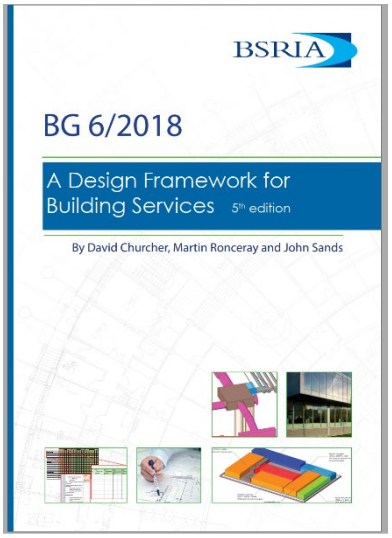
The DfP model in the UK is based on a base build rating which will drive improvements in the core landlord services, and it is intended that a DEC rating will cover the whole building element. However, with the nature of UK fitouts and Cat A/B split this may just end up reporting a performance gap. As such the GSL approach is needed to ensure that the positive change-driving elements of DfP are continued through the whole building approach. This will need the operational modelling, commitments, design reviews and governance to continue right through the project to operation.

5. Methodology

To design a NZ Building, sustainability principles should be applied at each stage of the project lifecycle. The methodology identifies a high-level process that should be adopted across all GPA portfolio buildings to ensure that the Net Zero Targets outlined in this annex are achieved. The guidance has been developed in collaboration with and upon review of:

- Better Buildings Partnership
- UKGBC Net Zero Carbon Buildings Framework
- CIBSE Guides
- London Energy Transformation Initiative – Climate Emergency Design Guide
- RIBA Plan of Work 2020 - including the Sustainability Strategy Chapter
- BSRIA BG6 2018
- Design for Performance



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UKGBC Framework	RIBA 2020 Stages	0 – Strategic Definition	1 – Preparation & Brief	2 – Concept Design	3 – Spatial Coordination
1 – Establish NZC Scope 		• Identify Net Zero (NZ) Champion for the project • Identify NZ targets that the development will seek to achieve as per Section 4 of this sustainability annex document • Consider contractual incentives for achievement of performance targets	• Set clear intent for NZ targets and define what this includes, document boundaries and targets i.e. base building or whole building, single development or portfolio	• Establish clear energy use and embodied carbon targets, document the targets and strategies to achieve them and share with all project stakeholders • Highlight the roles and opportunities for overcoming the performance gap for example through the adoption of the BSRIA soft landings framework • Identify soft landings champion to overcome performance gap	• Submit building regulations applications and interim certification applications e.g. BREEAM
2 – Reduce construction Impacts 		**For new build**: • Undertake site appraisal to assess opportunities and constraints • Identify and review the options for formal assessment/modelling which will be undertaken to achieve embodied carbon targets **For refurbishment** • Review opportunity for retention of existing structure and building fabric and how the quantum of materials of the refurb/new build can be reduced • Undertake study of existing structure to identify current embodied carbon and disclose performance	• Set an embodied carbon target for the development (2030 target for embodied carbon previously defined within this report) and embed within the brief. • Appoint an LCA specialist to be responsible for the whole life carbon assessment • Review circular economy statement to ensure that whole life impact is considered at this design stage. • Specify in the brief that the development will have low embodied carbon, adopting the principle of reuse and refurbishment	• Develop the concept design in accordance with the critical design parameter recommendations and targets as defined in this annex including % reused materials, opportunities for offsite manufacture • Analyze carbon reduction options for building elements following the guidance and recommendations presented in this annex and use numerical analysis and initial modelling to quantify results • Specify low carbon material and product specification as per the targets and recommendations to reduce construction impacts and minimize waste • Identify recommendations for a carbon reduction strategy over the in-use stage	• Discuss whole life carbon targets and A1-A5 embodied carbon targets with potential contractor • Advance modelling and numerical analysis to optimize material specification and design • Undertake in depth analysis of the elemental and component parts of the building including identifying specific materials, products and lifespans to generate a baseline model. Optimize the baseline model using low carbon alternatives and establish the carbon reduction target. • Develop a whole life carbon budget representing the total carbon emitted over the lifetime of the building • Ensure proposed construction details are robust to support low energy and airtightness performance characteristics • Disclose where NZ targets for construction cannot be practically achieved and state reasons why. Challenge these statements during the technical design phase
3 – Reduce Operational Energy Use		• Identify project team responsibilities to achieve operational energy use targets including calculations, documenting assumptions, risk	• Set an energy use intensity target for the development (2030 target for operational energy previously defined in this report) and embed within the brief	• Develop the concept design in accordance with the critical design parameter recommendations and targets as defined in this annex including: form factor, glazing ratio,	• Refine a full operational energy model for evaluation of produced energy demand and EUI against the NZ targets. Ensure this simulation goes beyond regulated energy and considers unregulated energy as well

	management and validating in-use performance • Identify and review the options for formal assessment/modelling which will be undertaken to achieve operational targets • Identify a project team member who can advise on demand response **For refurbishment:** • Identify current energy performance of building for metering systems, DEC/EPC ratings and previous years data disclosure	• Identify demand response programmes that are suitable and eligible for project implementation • Incorporation of data disclosure into BIM requirements. • Discuss localized energy constraints issues with the DNO	operating scenarios, technical systems integration and efficiency • Develop preliminary operational energy model aligned to the predefined energy use intensity targets and incorporating the building element targets defined in this annex • Reduce the reliance on fossil fuels by following the LETI Heat Decision tree when making decisions on heating and hot water systems • Implement the most significant carbon/energy reduction measures in design including demand response and energy storage opportunities.	• Test proposed design improvements as per the NZ targets using the energy model • Update and document strategies to achieve the target. Include design measures and assumptions of likely occupancy patterns as well as strategies for long term adaptability • Undertake overheating assessment to ensure the risk can be mitigated through design changes • Develop demand response strategy and simulate impact • Develop sub-metering strategy. Heating and cooling energy consumption should be metered separately to enable fabric performance to be assessed. • Establish a secure remote source for metered data to be transmitted over a communications network • Disclose where NZ targets for operational energy cannot be practically achieved and state reasons why. Challenge these statements during the technical design phase
4 – Increase Renewable Energy Supply 	**For new build:** • Undertake desktop study of surrounding context to identify potential renewable energy sources including rooftop PV and district heat network connections • Identify the local plan requirement for onsite renewable energy generation % **For refurbishment:** • Review performance of current on and off-site generation		• Highlight the on-site energy storage opportunities and design in on-site renewable energy generation and supply in accordance with the local plan minimum requirements • Maximize the on-site renewable energy generation through baseline modelling	• Develop on and off-site renewable design strategies to minimize carbon offsetting requirement • Develop a more accurate renewable energy generation model to quantify the offset available from low carbon sources
5 – Offset Remaining Carbon 	**For refurbishment:** • Identify current offsetting schemes and carbon price for offsets annually			

UKGBC Framework	RIBA 2020 Stages	4 – Technical Design	5 – Manufacturing & Construction	6 - Handover	7 - Use
1 – Establish NZC Scope 		• Finalize requirements and targets for whole life carbon for construction and operational energy in specifications and tender documentation at the start of procurement	• Ensure appointment of a clerk of works is responsible for quality checks throughout the construction process • Engage with supply chain regarding the design targets and provide toolbox talks to help upskill contractors and to communicate the importance of quality construction to achieve the targets for both construction and operational energy	• Undertake light touch post occupancy evaluation • Provide induction and training of building users and facilities managers • Review seasonal performance and update the building manual to reflect changes. Issue the building manual to managers and building users	• Comply with in use planning conditions • Undertake more detailed post occupancy evaluation and use the data to evaluate the building elements and performance against original NZ carbon scope
2 – Reduce construction Impacts 		• Finalize requirements with potential contractors and subcontractors around whole life carbon targets. Identify options for improvements and include carbon questions on tender return forms. • Undertake further modelling and analysis to optimize the material specification. • Update carbon budget to include design development and finalize the carbon reduction options list to define the final specifications in line with the embodied carbon targets • Send pre-procurement RFI forms to suppliers to collect carbon data to provide information's for supplier selection. • Assess the design against the previously defined NZ targets. Ensure specifications include embodied carbon of the materials	• Engage with contractors to reduce waste • Review alternative products and materials proposed by contract against NZ targets, technical and performance standards and whole life carbon requirements. • Prepare for post-completion analysis by collecting data through the construction phase • Send RFIs to suppliers to receive carbon data and validate the environmental credentials • Undertake building site monitoring through monthly site logs and construction progress reporting. Undertake gap analysis frequently to identify gap between targets and actual construction data	• Undertake post completion analysis using as-built information to assess upfront the embodied carbon • At the end of site works the contractor should confirm the final carbon data to the LCA specialist who will develop the practical completion carbon report. • Align the design stage NZ for construction targets with what was achieved at the end of construction • Carbon report to be issued to the client	• The carbon reduction strategy for the in-use stage should be followed through the building lifecycle including at the end of life stage • In-use report disclosed to the client
3 – Reduce Operational Energy Use 		• Update building energy model with design amendments and ensure NZ operational energy targets are still being achieved. Document strategies to achieve the targets by creating a Building Performance Register • Confirm envelope specification and complete detailed design ensuring targets are achieved e.g. thermal bridging and air tightness	• Update energy model to account for design changes and reject substitutions or omissions if they compromise the NZ targets being achieved • Ensure contractors understand the commissioning requirements including metering and validation of manual vs half hourly readings • Ensure the contractors has quality monitoring processes in place to ensure	• Review final construction including rectification work for quality including in-situ thermal performance tests, thermographic and air tightness testing • Finalize the as-built energy model to account for changes in the design or assumptions behind it • Ensure commissioning and testing is fully completed and witnessed and the and that the 'as installed' controls strategies,	• For the first year of occupation both the building and the targets should be tuned to actual building usage patterns. Ensure a dual focus of improving accuracy of targets as well as improving building operation • Ensure hourly energy consumption trends match the operating hours

	• Check suitability of heating and hot water system and confirm HVAC system type and performance specification aligning with NZ targets and Design Guide MEP criteria. • Iterate design response model with exact data to gain accurate prediction of carbon savings and monetary gains • Ensure specified metering and sub-metering is incorporated • Include operational energy in construction tender package e.g. using DfP type of target and feedback loop • Incorporate in contractors' prelims with guarantees to recalculate energy model if items are value engineered. Confirm that the as built project still metes the net zero targets for operational energy • Create risk register and confirm responsibility for management during construction and commissioning	proper installation of insulation, air tightness and mechanical equipment for whole construction period • Carry out benchmark inspections to clarify quality expectations as per the targets and continue to monitor construction quality including thermal performance tests, thermographic and air tightness testing	setpoints, commissioned flow rates, metering etc. are in line with the energy model. • Ensure the building user is trained and understands use of the building systems • Ensure that planned demand response activities occur correctly as part of the commissioning process and that the initial setup parameters are recorded • Ensure a suitably qualified individual understands the energy management and measurement systems. For further information refer to the BBP better metering toolkit • Ensure that performance data from sensors and meters are reconciled with main meter, spot meter and BMS readings and that logs are set up in BMS to facilitate long term monitoring of building performance.	• Ensure the metering system is operating correctly and is regularly validated against utility meters • Identify and track key efficiency metrics. Aim to track the fewest but most useful metrics • Assign an annual budget for monitoring energy use and tuning controls in response. Aim for monthly review and quarterly 'deep dive' analysis • Line up energy efficiency assessments with post occupancy evaluation assessment to ensure occupant satisfaction with conditions in the building • Upload total energy and heating energy consumption data to a public data platform for first 5 years post-completion. • Carry out annual DEC report to maintain top quartile rating
4 – Increase Renewable Energy Supply 	• Maximize on-site and offsite renewable energy generation to offset carbon emissions of the development • Identify the opportunities to export renewable energy to offset emissions • Prioritize offsetting the operational energy prior to embodied carbon	• Update renewable energy generation model to account for design changes and ensure correct capacity and number of modules are installed • Ensure contractors understand monitoring and metering requirements	• Measure actual output of on-site and offsite renewable energy generation and benchmark against initial targets and modelling • Ensure regular testing and commissioning of all installations to ensure efficiency is maintained throughout the lifecycle • Training FM team and building management on proper maintenance of low carbon installations	• Regular maintenance and testing of renewable energy capacity and output • Regular cleaning of installations for example solar PV to ensure efficiency is maintained • Annual reporting of renewable energy generation to offset carbon emissions from the development
5 – Offset Remaining Carbon 				• Where net zero carbon targets have not been achieved through fabric and system optimisation for both net zero construction and operational energy, carbon offsets should be purchased through certified schemes • Annual disclosure of offsets purchased must be reports publicly

6. Case Studies

The GPA Design Guide states that all Government buildings will have a DEC rating in the top quartile and will achieve the Net Zero targets defined in the Sustainability Annex. To provide insights into best practice design a number of case studies will be provided as extra guidance for developers to follow to achieve the required DEC rating and to achieve the defined targets. Some of the case studies will provide overall exemplar buildings while others will be for specific building elements e.g. lighting.

The Enterprise Centre, University of East Anglia, NR4 7TJ - https://www.architype.co.uk/project/the-enterprise-centre-uea/

WWF-UK, Living Planet Centre - https://www.ukgbc.org/ukgbc-work/case-study-wwf-uk-living-planet-centre/

Mirvac's one Darling Island, Australia - https://www.architectureanddesign.com.au/news/mirvac-s-one-darling-island-achieves-6-star-energy#

Sirius House, 23 Furzer Street, Woden, Australia - https://www.architectureanddesign.com.au/news/mirvac-s-sirius-house-setting-sustainability-stand

Sky Believe in Better Building - https://woodawards.com/portfolio/bskyb-believe-in-better-building/

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