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Environmental Impact Assessment Guide to:

Assessing Greenhouse Gas Emissions and Evaluating their Significance

Acknowledgements

Working Group

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Contents

ACKNOWLEDGEMENTS

1. INTRODUCTION 1
   - 1.1 The aim of this guidance 1
   - 1.2 EIA and project linkage 2

2. SCREENING 4

3. SCOPING 5
   - 3.1 Introduction 5
   - 3.2 Stakeholder engagement 5
   - 3.3 Benefits and challenges of raising GHG emissions as part of project scoping 6

4. BASELINE 7
   - 4.1 Definition and aim 7
   - 4.2 Boundary setting 7

5. GHG EMISSIONS ASSESSMENT METHODOLOGY 9
   - 5.1 Introduction 9
   - 5.2 GHG assessment and proportionality 9
   - 5.3 Steps of GHG emissions assessment 10
   - 5.4 Define goal and scope 10
   - 5.5 Study boundaries 11
   - 5.6 Calculation data 12
   - 5.7 GHG emissions calculation method 13
   - 5.8 Study uncertainty 13

6. SIGNIFICANCE AND MITIGATION 14
   - 6.1 All GHG emissions are significant 14
   - 6.2 Contextualising a project's carbon footprint 16
   - 6.3 Mitigating GHG emissions 17

7. COMMUNICATION / REPORTING 18

APPENDICES

- APPENDIX A Stakeholder list and data sources 20
- APPENDIX B Methods for GHG emissions assessment 22
- APPENDIX C Significance of GHG emissions 23

LIST OF ABBREVIATIONS / GLOSSARY 23

1 Introduction

1.1 The aim of this guidance

The aim of this guidance is to assist practitioners with addressing greenhouse gas (GHG) emissions assessment and mitigation in statutory and non-statutory Environmental Impact Assessment (EIA). It complements IEMA's earlier guide on Climate Change Resilience and Adaptation and builds on the Climate Change Mitigation and EIA overarching principles (see Box 1). The requirement to consider this topic has resulted from the 2014 amendment to the EIA Directive.

Through a working group facilitated by Arup on behalf of IEMA, this guidance has been prepared to assist EIA practitioners to take an informed approach to the treatment of GHG emissions within an EIA. It sets out areas for consideration at all stages of the assessment and offers options that can be explored. It highlights some of the challenges to the assessment such as establishing study boundaries and what constitutes significance. Nevertheless, this guidance is not a prescriptive 'how to' guide and will be updated once the process of incorporating GHG assessment in EIA matures.

Box 1: IEMA's overarching principles on Climate Change Mitigation & EIA

The GHG emissions from all projects will contribute to climate change; the largest inter-related cumulative environmental effect;

The consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive – e.g. population, fauna, soil etc.;

The UK has legally binding GHG reduction targets – EIA must therefore give due consideration to how a project will contribute to the achievement of these targets;

GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant; and

The EIA process should, at an early stage, influence the location and design of projects to optimise GHG performance and limit likely contribution to GHG emissions;

As one of the most challenging environmental issues, the effects of GHG emissions are integral to the understanding of a project's impact and need to be factored into the decision making process accordingly. At the same time **a focus on proportionate assessment is also important in avoiding undue burden** to developers and regulators. It is widely recognised that EIA should focus on a project's significant impacts and this guide is predicated on all assessments being proportional to the scientific evidence available. **A 'good practice' approach is therefore advocated where GHG emissions are always considered and reported but at varying degrees of detail depending on the EIA project.** This is important to build up sufficient knowledge and understanding of how to effectively assess GHG emissions.

The sections which follow cover in two to three pages scoping, baseline, methodology, significance and mitigation for an assessment of greenhouse gas emissions. Finally, section 7 looks at how best to communicate the assessment within an Environmental Statement / EIA Report.

The scope of this guide is presented graphically in Figure 1.

1.2 EIA and project linkage

EIA should not be undertaken in a silo to avoid an accounting exercise rather than realising the full potential of GHG emissions reduction opportunity. This can be addressed by delivering EIA in close cooperation with the project design team.

Early stakeholder engagement is key to maximising the mitigation measures that can be implemented to offset the GHG emissions of a proposed project (as shown in Figure 1). Carbon savings are likely to be greater if mitigation is considered from project inception because the potential GHG emissions impact can be investigated at all aspects of the planning, construction and operation stages; enabling mitigation measures to be identified and implemented throughout the life cycle of the project.

The interaction between the design process and EIA process is underpinned by four key principles:

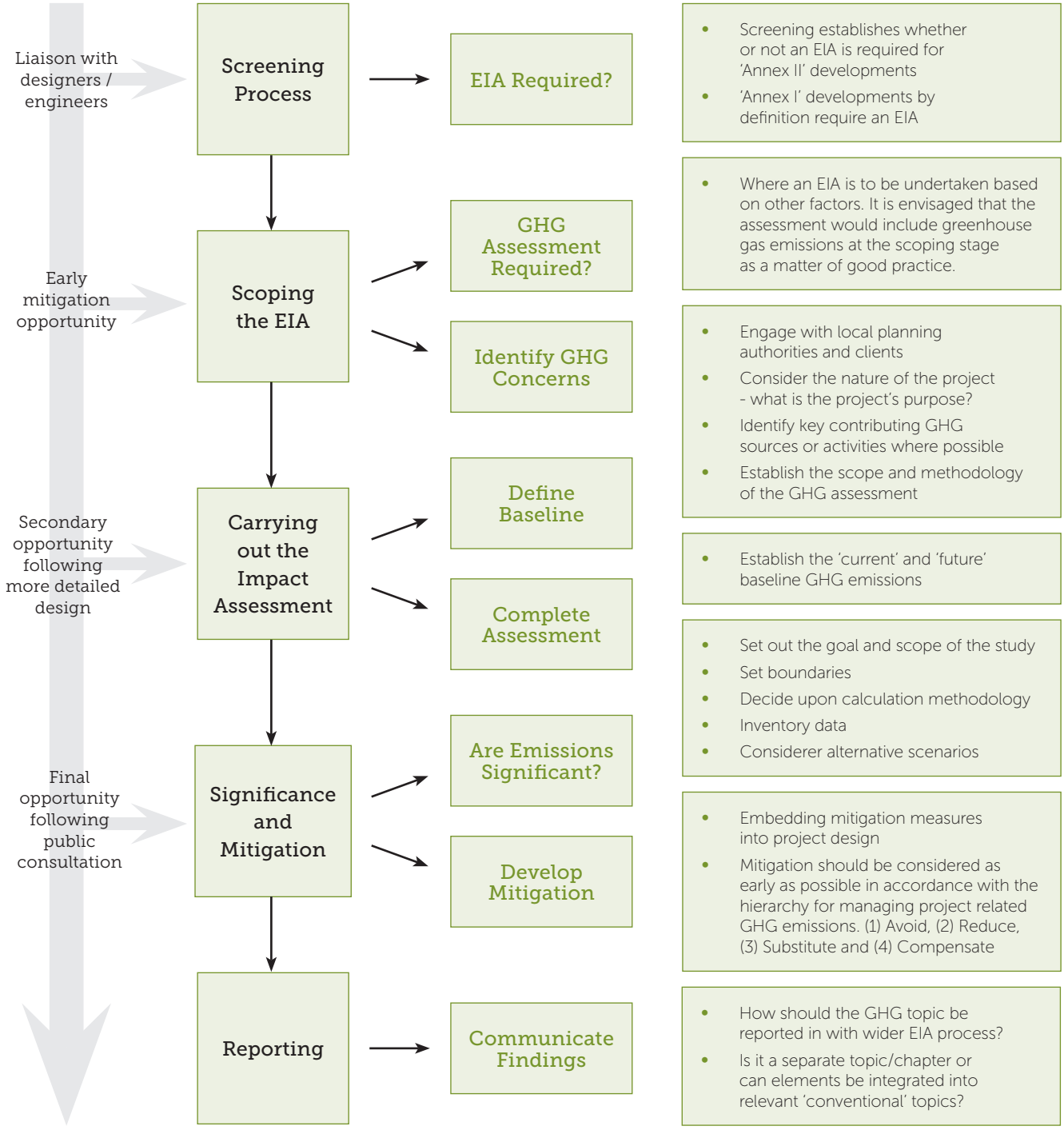
1. Early, effective and ongoing interaction;
2. Appropriate stakeholder engagement;
3. Consenting risk is managed; and
4. A clear narrative.

For further detail on these principles and ensuring that carbon mitigation measures are 'built in' rather than 'bolted on' at a later stage, refer to IEMA's EIA guide on Shaping Quality Development[1].

The need to ensure that carbon mitigation measures are implemented does not end at the pre-application EIA stage, and extends to once consent has been granted for a project. In order to ensure that carbon mitigation measures are carried forward the development of an Environmental Management Plans (EMP) should be seen as the primary mechanism. For further information refer to IEMA's EIA guide to Delivering Quality Development[2].

1. IEMA (2015), Environmental Impact Assessment Guide to Shaping Quality Development.
2. IEMA (2016), Environmental Impact Assessment Guide to Delivering Quality Development.

FIGURE 1: Scope of this guide



2 Screening

The purpose of screening is to establish whether or not an EIA is required for 'Annex II' developments (Annex I development by definition requires an EIA). The 2014 amendments to the EIA Directive (2011/92/EU as amended by 2014/52/EU) require specific information such as a description of likely significant effects of the project at the screening stage.

Applying screening criteria (Schedule 3) and taking account of existing environmental conditions and the nature of a proposed project will allow a judgement to be made on whether there is potential for likely significant environmental effects to arise which may trigger the need for an EIA. Occasionally, this may apply to only a very limited number of topics, for example in a sensitive location for a relatively small scale project. Generally however, where an EIA is required it is customary for there to be several topics that require assessment. As the assessment of most topic areas is well established (ecology, water, heritage etc.), it is usually clear cut which topics trigger the need for EIA.

This contrasts with GHG emissions. This is a developing area of impact assessment with limited project examples and experience to draw from. For the purposes of screening it is therefore considered good practice to always consider whether the impact of GHG emissions is likely to be significantly enough to trigger EIA, and to also highlight any proposed mitigation measures that the developer has agreed to.

3 Scoping

3.1 Introduction

A good practice approach to EIA will see GHG emissions scoped into the assessment and thus estimated, reported and mitigated as part of the project's undertakings. This approach should follow for all projects regardless of whether there is a net increase or decrease in GHG emissions relating to the works.

During scoping it is also important to set out in principle the methodological approach that will be taken to addressing project GHG emissions. This means documenting in outline aspects such as baseline setting, assessment approach, how significance will be determined and strategies for mitigation. These are commonly recorded in a project scoping report and this can form a useful first record of the approach to delivering the GHG emissions assessment. Each of these steps for the EIA are addressed in the following Sections and should be consulted for further detail.

In selecting or developing an approach for project EIA GHG emissions assessment, the aim should be to deliver a robust, appropriate and consistent assessment. Good practice to this starts with a framework of five basic steps that a GHG emissions assessment should always incorporate:

1. Define goal and scope of GHG emissions assessment;
2. Set study boundaries;
3. Decide upon assessment methodology;
4. Collect the necessary calculation data; and
5. Calculate/determine the GHG emission inventory.

Section 5 explores these steps in more detail.

3.2 Stakeholder engagement

Stakeholder engagement is an important part of undertaking an EIA, especially during scoping. It will provide useful information and support the goals the GHG emissions assessment.

Stakeholder engagement will provide the practitioner better contextual understanding of the project including on key issues, opportunities, constraints and information pertinent to the assessment. Stakeholders will include clients and statutory consultees[3] who all have an interest and influence on the project.

Box 2 lists a series of questions the practitioner should be seeking to answer during stakeholder engagement as part of project scoping.

3. The UK's Government website includes a sections on Planning practice guidance including a list of statutory consultees: https://goo.gl/9ZvAI3

Box 2 Questions to consider during stakeholder engagement to support GHG emissions assessment and mitigation

- Is the client and their delivery team considering GHG emissions as part of the design?
- Has GHG emissions mitigation formed part of the project brief?
- Has a GHG emissions assessment already been done?
- Will the project deliver a net benefit in terms of GHG emissions?
- What project alternatives have been considered to measure against?
- Where are the majority of GHG emissions most likely to arise (site preparation, construction, operating the asset, using the asset, or decommissioning etc.)?
- What is the scale of construction, the size of the supply chain, the energy and GHG emissions profile of the materials that will be used?
- What operational and use profile will the project have regarding materials and energy demand and waste generation?
- What are the international, national and sectorial level legislation, policy or good practice on climate change and GHG emissions relevant to the project?
- Are there relevant sector-specific GHG strategies and targets that should be recognised by the EIA in addressing GHG emissions?

Depending on the project, GHG emissions may be a key topic to be discussed during public consultation. Initial consultation with the project team and wider EIA topic specialists may also reveal parallel activities where input from the GHG assessment would be beneficial. For example, clients may wish to report on the sustainability performance of their projects through the use of assessment schemes such as CEEQUAL or BREEAM. Being able to report on the project's GHG performance will help with such assessments.

Other project management decisions may include the desire to manage the project in an integrated manner, combining 3D models with performance data (including environmental data) such as BIM models.

3.3 Benefits and challenges of raising GHG emissions as part of project scoping

By going through the scoping process the GHG practitioner gains an early and informed understanding of the project's impact and potential sources of GHG emissions. This provides an opportunity to influence and even mitigate GHG emissions early in the design process as well as consider emissions from alterative options.

The challenge at scoping is that there is often limited information available from the design team at this early stage resulting in a qualitative-based decision and professional judgment from the practitioner. Nevertheless, the practitioner, by engaging with key stakeholders, should be able to define the boundaries of the GHG assessment (see Section 5.4) as well as start to form a view of where the majority of emissions are likely to arise from and appropriate mitigation strategies.

Where the competent authority (e.g. LPA) provides a scoping opinion, the subsequent Environmental Statement must be 'based on' the expectations set out in the opinion, including any reference to GHG assessment.

4 Baseline

4.2 Definition and aim

Baseline is the reference point against which the impact of a new project can be compared against, and is sometimes referred to as business as usual (BaU) where assumptions are made on current and future GHG emissions. Baseline can be in the form of:

A. GHG emissions within the agreed physical and temporal boundary of a project but without the proposed project; or

B. GHG emissions arising from an alternative project design and assumptions.

The ultimate goal from establishing a baseline is being able to assess and report the net GHG impact of the proposed project.

4.2 Boundary setting

All existing sources and removals of GHG emission prior to project construction and operation (i.e. without development) should be identified and clearly described. The boundary of baseline GHG emissions should consider the physical boundary (e.g. the project boundary line around a site), its geographical location (local, regional or national scale project), and temporal boundary (future baselines associated with operational emissions over an agreed period).

Some projects may lead directly or indirectly to avoided GHG emissions outside the project EIA boundary. In this instance care should be taken to describe the nature of the avoided emissions and potential reliance on any external factors to come to fruition.

For further detail on boundary setting see Section 5.5 in the Assessment Methodology chapter.

4.2.1 Current baseline

Current baseline represents existing GHG emissions from the project boundary site prior to construction and operation of the project under consideration. This may include emissions from existing projects (e.g. energy consumption from a building which is scheduled for refurbishment, demolition or replacement) and infrastructure (e.g. current operational and use emissions of a road due to be upgraded).

It may not always be possible to report on current baseline emissions, particularly with projects situated in areas with no physical development or activity. In this instance there would be zero GHG emissions to report, although particular attention should be paid where changes in land use are expected. For example, woodland areas or peat bogs sequester carbon over their lifetime and therefore make a contribution to CC mitigation. Their disturbance or removal through construction will release previously sequestered GHG emissions.

Other approaches to developing the current baseline are emerging that follow a baseline scenario, which is a projection that the project's GHG emissions are compared to. Further information on this approach can be found in the GHG protocol for Projects (see Chapter 6: Selecting a Baseline Procedure - http://ghgprotocol.org/project-protocol). An example of such a GHG baseline can also be found here - https://www.forestry.gov.uk/forestry/infd-8jes7v#what

4.2.2 Future baseline

Future baseline should capture both operational and use GHG emissions irrespective of their source (i.e. direct and indirect emissions). The distinction between operation and use GHG emissions is important. For example, an existing motorway will have operational emissions (i.e. lighting, maintenance, upgrades) as well as in-use emissions associated with vehicles travelling along the route. Current baseline travel patterns would have to be assessed as well as how these might change in the near future (changes in mode share, increased efficiency in vehicles and trip numbers for example). With regards to energy supply and demand (e.g. electricity use in a commercial building), future baseline should report on operational GHG emissions and how these may change over time (based on occupancy changes, UK grid decarbonisation projection scenarios or the adoption of renewables for example).

Box 3 lists potential sources of information which can be considered when establishing future baseline emissions.

4.2.3 Alternative baselines

Alternative baselines may be based on a different location, design, layout, operation or even size of the proposed project. A detailed GHG assessment of alternative baselines is not an EIA requirement, and in many instances alternatives may not have been considered by the developer. Ideally, alternatives would have been considered earlier in the project life cycle, and the EIA is viewed as the platform for improving the preferred design. Nevertheless, where alternative baselines were considered, even a qualitative assessment of their GHG impact would be acceptable as part of the overall assessment.

Box 3 Potential sources of information on GHG and energy projections (see Appendix A for further details)

- Committee on Climate Change (CCC) – The Fifth Carbon Budget[4]
- The Department for Business, Energy & Industrial Strategy (previously DECC)[5/6]
- UK greenhouse gas emissions statistics
- The Department for Transport (DfT) WebTAG (the Transport Analysis Guidance) – Data Book[7]
- The Green Construction Board – Infrastructure Carbon Review, Technical Report[8]

4. https://goo.gl/79MYvQ
5. https://goo.gl/6aNsnv | https://goo.gl/zgQx0D
6. https://goo.gl/jsQKZz
7. https://goo.gl/R1ypT9
8. https://goo.gl/icZxRQ

5 GHG emissions assessment methodology

5.1 Introduction

There are many different assessment methods available for measuring and quantifying the GHG emissions associated with the built environment. These range from general guidance to formal standards and many will be appropriate for use in EIA depending on the goals and scope of the assessment required. A list of relevant methods can be found in Appendix B. Two key examples particularly suited to EIA include:

- PAS 2080:2016 Carbon management in infrastructure[9] which has been developed to enable a consistent approach to the managed reduction of GHG emissions associated with economic infrastructure by construction industry stakeholders including clients, designers, constructors and material suppliers.
- BS EN 15978:2011 Sustainability of construction works, Assessment of environmental performance of buildings, Calculation method[10] which has been developed by CEN to enable a consistent approach to the environmental assessment of buildings including GHG emissions.

Given the wide variation of working situations and the particular aims and objectives of the EIA process this guidance does not recommend a particular approach, rather it sets out advice for the key common components necessary for undertaking a GHG emissions assessment.

5.2 GHG assessment and proportionality

GHG emissions should be assessed and reported as part of a good practice approach to EIA. This aligns with IEMA's overarching-principles[11]; that all GHG emissions will contribute to climate change and thus might be considered significant, irrespective of whether this is an increase or decrease in emissions.

Projects will vary by type and size, and so will GHG emissions. An effective scoping exercise ensures that a balance is struck between the amount of GHG emissions emitted by the project and the effort committed to the actual GHG assessment. For example, if the majority of impacts occur during a project's construction phase and that operational impacts are negligible, then the GHG assessment can reflect this. A high-level or qualitative GHG assessment for certain project elements or activities can be carried out as long as it is justified and agreed during the scoping stage with stakeholders. This will help contribute towards delivering proportional EIAs.

It should also be recognised that qualitative assessments are acceptable, for example: where data is unavailable or where mitigation measures are agreed early on in the design phase with design and engineering teams.

9. PAS 2080:2016, Carbon management in infrastructure, BSI
10. BS EN 15978:2011, Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method, BSI
11. IEMA (2010), IEMA Principles Series: Climate Change Mitigation & EIA.

5.3 Steps of GHG emissions assessment

In selecting or developing an approach for project EIA GHG emissions assessment, the aim should be to deliver a robust, appropriate and consistent assessment. Good practice to this starts with a framework of five basic steps that a GHG emissions assessment should always incorporate:

1. Define goal and scope of GHG emissions assessment;
2. Set study boundaries;
3. Decide upon assessment methodology;
4. Collect the necessary calculation data; and
5. Calculate/determine the GHG emission inventory.

The following sections explore these aspects in more detail.

5.4 Define goal and scope

In the first instance an EIA GHG emissions assessment should set out a study goal and scope. This will normally incorporate a range of different aspects including:

- The goal of the GHG emissions calculation;
- Description of the system (i.e. built environment asset/development etc.) that is the subject of the assessment;
- The function of the system (i.e. its performance characteristics);
- The system boundary to be applied;
- Allocation procedures (where used) for apportioning GHG emissions;
- The calculation methodology to be applied;

How GHG emissions information will be interpreted and used in decision-making including how it should be used to inform;

- Mitigation response;
- Significance of impact of emissions;
- Communicating and reporting GHG emission impact within EIA;
- Data quality requirements;
- Assumptions, limitations and constraints; and
- The study review process, ensuring it is appropriate and proportionate to the intended use of the study.

5.4.1 Scoping the boundaries of the GHG emissions assessment

It should be understood that scoping in the context of undertaking a GHG emissions assessment is the task of identifying what is included and excluded from the study. It is separate and different from the scoping stage of an EIA where the environmental topics are included or excluded from the EIA.

The scoping exercise of the GHG emissions assessment will consider aspects like which life cycle stages to include, whether there should be a focus on asset construction or operation, if there are specific elements of the supply chain that must be included, and what an appropriate boundary condition or cut off point might be to excluding aspects from the assessment.

5.5 Study boundaries

EIAs should apply system boundaries, use data that is consistent with, and report, using the modular approach (Figure 3). A detailed and complete GHG emissions assessment typically covers all life cycle modules including A, B and C with module D seen as optional. As described under Section 5.2, projects will vary in size and hence so will the scale of GHG assessments in the spirit of delivering proportionate EIAs. Certain life cycle modules (or stages) can be excluded as long as these exclusions are justified by the practitioner using professional judgement. One would expect that direct GHG emissions from a project's use and/or operation would be reported at a minimum.

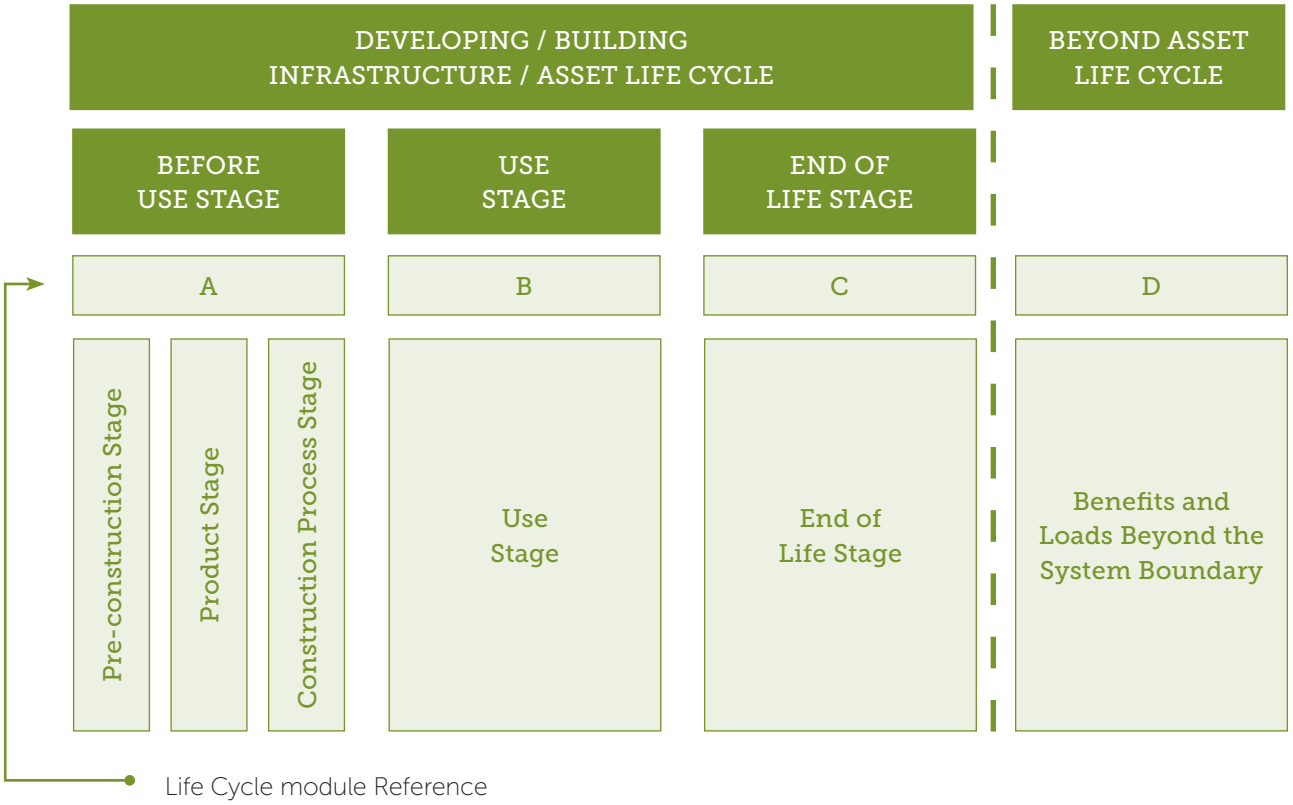


FIGURE 3: Modular approach of life cycle stages and modules for EIA GHG emissions assessment; the module references are widely used in construction GHG emissions assessment and reduction activities.

The figure provides a simplified presentation of the modular approach that can be used for boundary definition and the gathering and reporting of information associated with the assessment. A more detailed presentation of this structure can be found in PAS 2080 and BS EN 15978.

5.5.1 Inclusions

The study system boundary should reflect the system under study including its physical scope and life cycle stages relevant to the goal and scope of the assessment.

5.5.2 Cut off rules (exclusions)

Activities that do not significantly change the result of the quantification can be excluded however the total excluded input or output flows per module would generally be expected to be a maximum of 5% of energy usage and mass. All inputs and outputs to a process for which data are available should be included.

5.5.3 Study period (the life cycle period that should be studied)

A reference study period shall be chosen as the basis for the GHG emissions assessment and this should be based on the expected service life of the construction asset. Guidance is available in ISO 15686-1.

5.6 Calculation data

To undertake a calculated GHG emissions assessment for an EIA it will be necessary to gather data on the activities occurring and the GHG emissions factors for these activities, for the system under study. It is important that data for both these aspects, and particularly the activity data, is specific to the system under study.

5.6.1 Study system activity data

Activity data consists of information that defines and describes the size, magnitude and physical nature of the system under study. It will take many different forms and can consist of information covering materials quantity, energy and water demand, waste generation, transportation distances and modes, works techniques/technologies, etc.

5.6.2 GHG emission factors

GHG emission factors are a value for 'GHG emissions per unit of activity'. Examples of this are:

- HGV: 0.13 kg CO_2e / t.km
- UK electricity grid: 0.41 kg CO_2e / kWh
- Concrete: X kg CO_2e / tonne

GHG emission factors vary in their scope and coverage and will be representative of a single process/activity or multiple of these, sometimes incorporating multiple life cycle stages. Care should be taken to select the right factors for the system under study.

When undertaking a study it is often necessary to apply multiple GHG factors for the same activity particularly when the assessment is studying a life cycle with a long time period. This may be appropriate when future GHG emissions for that activity are expected to change; this might occur for example when accounting for a reduction in GHG emissions associated with a national electricity grid and the benefit this brings to demand side GHG emissions of using electric trains.

For examples of sources of GHG factors refer to Appendix A.

5.6.3 Data quality

Data of appropriate quality to satisfy the goal and scope of the EIA should be used and this means defining expectations in terms of:

- Age;
- Geography;
- Technology mix represented by data;
- Methodology applied to gather or calculate the data; and
- Competency of entity that developed the data.

5.6.4 Types of data

The type of data used by the GHG practitioner will vary depending on how detailed the project design is. Most EIAs are based on design-stage information, hence activity data specific to the project should in theory be available from the engineering and design teams. If this is not the case, an alternative approach would be to fall back on generic or publically available information that best represents the project and its activities.

5.7 GHG emissions calculation method

Quantification of the GHG emissions for an EIA may be associated with either a measured or calculated approach or a combination of both for the emissions associated with the project. It is expected that in almost all cases a calculated approach for quantifying GHG emissions will be taken because an EIA is completed in advance of supply chain mobilisation and associated construction works.

When undertaking a quantification calculation the formula for determining a GHG emission (or removal value), associated with the construction works, should have the following structure:

GHG emission factor × Activity data
= GHG emission or removal

Calculations may be taken at different scales reflecting specific activities, components or elements of construction. Therefore individual calculations should be summed to form a GHG emissions inventory for the quantification as a whole.

5.8 Study uncertainty

Uncertainty can arise from quality of data, study boundaries and period of assessment etc. and can never be eliminated from a study. Uncertainty should be considered and if it significantly affects the outcome of the study, additional steps should be taken to reduce it and provide confidence in results.

Uncertainty can be considered by:

- Testing upper and lower limits;
- Testing for different inclusions and exclusions; and
- Modify study period.

If the scale of uncertainty provides findings that are likely to change any decision based on the data then it should be appropriately reduced.

6 Significance and Mitigation

6.1 All GHG emissions are significant

IEMA principles on climate change mitigation and EIA identify climate change as one of the defining environmental policy drivers of the future and that action to address GHG emissions is essential. Specifically three over-arching principles are particularly relevant to considering the aspect of significance[12]:

"The GHG emissions from all projects will contribute to climate change; the largest inter-related cumulative environmental effect."

"The consequences of a changing climate have the potential to lead to significant environmental effects on all topics in the EIA Directive – e.g. Population, Fauna, Soil, etc."

"GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant."[13]

The thread through these principles is that 1) all projects create GHG emissions that contribute to climate change; 2) climate change has the potential to lead to significant environmental effects; and 3) there is a GHG emission budget[14] that defines a level of dangerous climate change whereby any GHG emission within that budget can be considered as significant.

Therefore in the absence of any significance criteria or a defined threshold, it might be considered that all GHG emissions are significant and an EIA should ensure the project addresses their occurrence by taking mitigating action[15].

Whilst there is no single preferred method to evaluate significance, extensive research is being undertaken to explore significance, thresholds for GHG emission assessments, and science-based targets. Box 4 provides further information on recent findings.

12. IEMA (2010) Climate Change Mitigation & EIA
13. The third principle is related to the IPCC carbon budget definition which states that to remain below a 2oC threshold (the level defined as dangerous climate change impacts), global GHG emissions must remain within 1000 billion tonnes.
14. IPCC 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
15. Notwithstanding this EIA traditionally works on the principle of significance and Appendix C provides guidance on considering the significance of GHG emissions.

Box 4: Targets based on scientific projections

Science-based targets are defined as GHG reduction targets which have been created based on scientific projections and global carbon budgets. These targets aim to mitigate the greatest effects of climate change by limiting GHG emissions within a certain cumulative threshold. This threshold has been defined by the IPCC, as a carbon budget equivalent to a maximum increase in global temperature of 2°C from pre-industrial levels.

There is currently little evidence of these science-based targets being used in the UK's development consent system, or related EIA process, to assess a project's significance. However, this quantitative approach provides a good indicator of significance and could be used in EIA to calculate a project's carbon budget. This budget can then be compared against an existing carbon budget (global, national, sectoral, regional, or local - as available), to identify the percentage impact the project will contribute to climate change. Consequently, the greater the project's carbon budget, the greater its significance.

A review of the literature has identified a number of different methods which can be used to allocate a project's carbon budget; a list of some of these is provided below:

- Grandfathering;
- Carbon Space;
- Contraction and Convergence;
- Blended sharing; and
- Common but Differentiated Convergence.

Due to the inconsistencies between the different methods and their assumptions for assessment; there is not one single agreed method by which to assess a project's carbon budget. Therefore a review of these methods should be undertaken, to identify which method can best represent a project's potential carbon footprint. The applicability of the method will be dependent on the type and scale of the project. For further detail on significance and project examples refer to Appendix C.

6.2 Contextualising a project's carbon footprint

Under the principle that all GHG emissions might be considered significant, and the ongoing research of how to actually measure significance, it is down to the practitioner's professional judgement on how best to contextualise a project's GHG impact.

Generating a project's carbon contribution, will enable the impact of your project, to be contextualised against sectoral, local or national carbon budgets. This will provide the practitioner and the LPA with a sense of scale. For example the Green Construction Board[16] has calculated carbon budgets for each of the UK built environment sectors (non-domestic buildings, domestic buildings, construction and operation). Similarly the Committee on Climate Change[17] (CCC) has determined a UK wide carbon budget broken down by the following key sectors: power generation, industrial production/ manufacturing, buildings, transport, agriculture and land use change.

The good practice approach included in Figure 4 below provides an example of how to contextualise your project's carbon footprint against pre-determined carbon budgets. This guidance does not include an exhaustive list of existing carbon budgets and therefore research should be undertaken to identify the best budget to compare with your project.

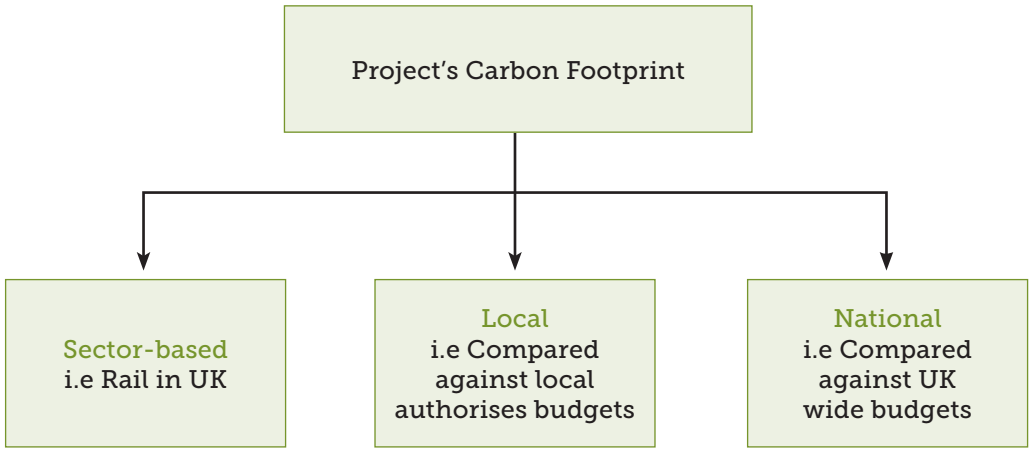


FIGURE 4: Good practice approach for contextualising a project's carbon budget

16. The Green Construction Board – the Low Carbon Routemap for the Built Environment: https://goo.gl/g3lOM6
17. Committee on Climate Change (2015) The Fifth Carbon Budget – The next step towards a low-carbon economy.

6.3 Mitigating GHG emissions

Carbon mitigation can best be achieved by taking a planned and focused approach following the principles of a carbon management hierarchy. There are many different variations on this theme covered in literature with the commonality that they set out a graded structure of interventions with more favourable options presented over others. Such structures typically start with first avoiding or reducing emissions where practical, before suggesting offset or sequester strategies beyond this. Depending on the project and contextual setting, the practical outcomes of this can be many and diverse. Although not set out in a hierarchy BS EN 14064: 2012[18] on GHG quantification and reporting provides an example list of carbon mitigation interventions such as;

- Energy demand and use management;
- Energy efficiency;
- Technology or process improvements;
- GHG capture and storage in, typically, a GHG reservoir;
- Management of transport and travel demands;
- Fuel switching or substation; and
- Afforestation.

For EIA GHG emissions mitigation, PAS 2080 also provides a useful structure for working through and identifying potential opportunities and interventions. The IEMA GHG hierarchy[19] provides a similar structure set out as avoid, reduce, substitute and compensate. A variation of these steps is set out below and can be followed by the GHG emissions practitioner in the EIA to identify opportunities that direct GHG mitigation action for a project.

1. **Do not build:** evaluate the basic need for the project and explore alternative approaches to achieve the desired outcome/s.
2. **Build less:** realise potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required.
3. **Design clever:** apply low carbon solutions (including technologies, materials and products) to minimise resource consumption during the construction, operation, user's use of the project, and at end-of-life.
4. **Construct efficiently:** use techniques (e.g. during construction and operation) that reduce resource consumption over the life cycle of the project.
5. **Offset and sequester:** as a complimentary strategy to the above, adopt off-site or on-site means to offset and/or sequester GHG emissions to compensate for GHG emissions arising from the project.

18. BS EN ISO 14061-1: 2012 Greenhouse gases – Part 1: specification with guidance at the organizational level for quantification and reporting of greenhouse gas emissions and removals.
19. IEMA (2014) Position Statement on Climate Change and Energy https://goo.gl/P9F14p

7 Communication/ Reporting

When reporting on GHG emissions assessment in EIA the text should conform to Schedule 4: Information for inclusion in environmental statements, of the EIA regulations[20] document. The GHG emissions assessment should form part of an integrated assessment on climate change impacts and can be presented as a standalone climate change chapter within an EIA or supporting technical appendix. GHG emissions should not be treated as a sub-category of an EIA's consideration of other environmental effects of climate change if it is to be considered and assessed through the EIA process.

The effects of potential future climate change based on the net GHG impact from a proposed project are likely to be interrelated to other key EIA topics. To ensure consistency is provided throughout the Environmental Statement / EIA Report the GHG team will need to liaise with other key EIA topics including (but not limited to):

- Logistics/Transport (based on TA);
- Waste management (cover construction and demolition);
- Noise/vibration (construction/hours of work/ fuel uses, list of plant/energy use); and
- Air quality (Carbon capture).

Consistent reporting of GHG emissions in EIA will highlight the importance of accounting for carbon emissions from project inception. It will encourage both clients and engineers to consider the impacts of GHG emissions during early design stage. At the same time it is suggested that a brief introduction to climate change and the role of GHG emissions as a contributing factor is included in the GHG assessment EIA chapter. This will help explain the interrelationship between GHG emissions and climate change with other relevant topics to the readers. This may further be supported with relevant links to documents and information on the topic.

When reporting on GHG emissions and mitigation in EIA the following steps should be presented where available:

- Baseline emissions: the existing emissions from the project boundary site prior to construction and operation of the project;
- Alternative emissions: including the future baseline emissions should the project not be developed;
- Net emissions (Year 1 and lifetime): the direct and indirect emissions of the project during the first year of operation and for the full lifetime of the project; and
- Mitigation savings: the amount of carbon saved during all stages of the project.

20. The Town and Country Planning (Environmental Impact Assessment) Regulations (2017) Schedule 4: Information for inclusion in environmental statements.

There are a number of challenges and difficulties when integrating GHG assessment into EIA practice. These challenges and ways to overcome them are presented below.

- The possible effects identified from a GHG emissions assessment can be interlinked with other key EIA topic chapters. There are a number of different ways to report these effects including;
    - Reporting on GHG emissions assessment in a standalone chapter that does not overlap with any of the other EIA chapters; or
    - Providing a GHG emissions assessment in a standalone chapter but also discussing the relevant likely climate change effects in the other EIA chapters.
- Reporting of a GHG emissions assessment, should endeavour to conform to the existing EIA template. However if there is data or information that needs to be included that doesn't fit into the existing EIA template then additional sub-sections should be added in order to present all the data from the GHG emissions assessment; to inform the EIA and account for the possible effects on future climate change.
- There are a lack of thresholds on which to identify the significance of a proposed project with regard to the net change in GHG emissions. The GHG assessment should therefore present assumptions, data collection and methodology to clarify how the significance has been quantified.
- Where GHG assessment is used to inform early design stages it is vital to get stakeholders to understand the importance of minimising the GHG contribution of a project and designing a project that will limit the net change in future GHG emissions.

Appendix A

Stakeholder list and data sources

Source	Description
Committee on Climate Change (CCC) – The Fifth Carbon Budget[21]	The CCC reports on UK carbon budgets, by sector, and reductions that need to be achieved of the UK is to meet its carbon reduction target of 80% by 2050. This includes historical and projected (up until 2035) GHG emissions by UK industrial sector: power, industry, buildings, transport, agriculture, land use and waste. Decarbonisation projections of the UK's electricity and gas network are also reported.
The Department for Business, Energy & Industrial Strategy (previously DECC)[22]	The UK Government regularly reports on UK energy and emissions projections by source: agriculture, business, energy supply, industrial processes, land use change, public, residential, transport and waste management. Currently, GHG emissions reach back to 1990 and project in to the future up until 2035.
The Department for Business, Energy & Industrial Strategy (previously DECC)[23] UK greenhouse gas emissions statistics	The UK Government also reports on GHG emissions from a geographical perspective, by UK local authority. Current and historical emissions are available which may be used to establish current baseline emissions.
The Department for Transport (DfT) WebTAG (the Transport Analysis Guidance) – Data Book[24]	WebTAG provides UK transport modelling values and information including projections on how the UK's modal mix (diesel, petrol, electric) is expected for change over time, current and future fuel efficiency projections (litres or kWh per kilometre travelled) up to 2035. Also reported are carbon dioxide emissions per litre of fuel burnt or kWh used for: petrol, diesel, gas oil and electricity used on road and rail travel.

21. https://goo.gl/Nvlmbs
22. https://goo.gl/XqmqW1 | https://goo.gl/9s8v6U
23. https://goo.gl/yEGl9t
24. https://goo.gl/4tklQZ.

Source	Description
The Green Construction Board (GCB) – Infrastructure Carbon Review, Technical Report[25]	The GCB has developed a tool that allows stakeholder to model policy changes associated with the built environment and visualise what this means in terms of GHG emissions. Also available is the Low Carbon Routemap report which explores various GHG emissions projections for both building and infrastructure at the UK level.
Inventory of Carbon and Energy (ICE) – University of Bath: Sustainable Energy Research Team[26]	The Inventory of Carbon and Energy (also known as the ICE database) is a leading embodied energy and carbon database for building materials.
The Department for Business, Energy & Industrial Strategy (previously DECC)[27] - Government emission conversion factors for greenhouse gas company reporting	The Government conversion factors for greenhouse gas reporting are suitable for use by UK based organisations of all sizes, and for international organisations reporting on UK operations.
Examples of publicly available carbon assessment tools. The list of carbon tools is non- exhaustive and constantly changing. It is up to the GHG practitioner's professional judgement to decide which tool is most appropriate for the project at hand. Of course it is perfectly appropriate to develop bespoke assessment sheets which may provide more flexibility and transparency.	• Scottish Government Windfarm Carbon Assessment tool • Environment Agency Carbon Planning Tool • RSSB / Network Rail Carbon Tool • Transport Scotland: Carbon Management System (CMS) • asPECT – asphalt pavement embodied carbon tool • Highways Agency DBFO (design, build, finance and operate) carbon calculation sheets
National Atmospheric Emissions Inventory [28]	• The UK Inventory contains summaries of information about air quality pollutants and GHGs. There is also access to a wide range of more detailed information about the levels and trends in emissions of these pollutants, and their sources.

25. https://goo.gl/lNyAru
26. https://goo.gl/ud4lHU
27. https://goo.gl/8B095W
28. http://naei.defra.gov.uk/

Appendix B

Methods for GHG emissions assessment

B1 List of standards

- WRI GHG Protocol - the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) partnered to develop internationally recognised guidance and standards on GHG accounting and reporting, and includes advice on:
    - Corporate Standards;
    - Corporate Value Chain (Scope 3);
    - Product Life Cycle assessments;
    - GHG Protocol for Cities; and
    - Agricultural Guidance.
- PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.
- PAS 2060 - a standard for declarations of carbon neutrality
- PAS 2070 - a standard for assessing city-wide GHG emissions.
- PAS 2080 - is the world's first standard for managing infrastructure GHG emissions.
- BS EN ISO 14064-1 - guidance on reporting GHG emissions at an organisational level.
- BS EN ISO 14064-2 - guidance on reporting GHG emissions at the project level.
- BS EN 15686-1: 2011 Buildings and construction assets – service life planning, general principles and framework.
- BS EN 15978:2011 Sustainability of construction works, Assessment of environmental performance of buildings, Calculation method
- BS EN 15804: Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.
- PD CEN ISO/TS 14067: Greenhouse gases. Carbon footprint of products. Requirements and guidelines for quantification and communication.
- BS EN ISO 14044: Environmental management. Life cycle assessment. Requirements and guidelines
- ENCORD: the European Network for Construction Companies for Research and Development – a network for active members from the construction industry have published a 'Construction CO_2e Measurement Protocol'.

Notes

1. IEMA Members can enjoy a 15% discounts when buying copies of BSi products (ISO / BS EN standards). Simply:
    - - Login to www.iema.net
    - - Visit the myIEMA section
    - - Follow the link to my BSi Shop.
2. PAS2050 and PAS2080 are freely available documents, which can be accessed on-line.

Appendix C
Significance of GHG emissions

C1 Considering the significance of GHG emissions

GENERIC PROCESSES

1. **Sacramento Metropolitan Air Quality Management District[29]**

   Established a significance threshold of 1,100 metric tonnes ($MTCO_2e$ per year). This is based on capturing 90% of the development projects across the state, ensuring that small projects, which generally have low emission levels, would not be considered significant. The small projects will still be required to reduce their GHG emissions because they must comply with state and local regulations that require energy efficiency and transport infrastructure improvements.

2. **California Air Pollution Control Officers Association[30]**

- GHG impacts are considered to be exclusively cumulative impacts because no single project makes a significant contribution to global climate change;
- Assessment of significance is based on whether a project's GHG emissions cumulatively represent a considerable contribution to the global atmosphere.

3. **California Environmental Quality Act (CEQA) guidelines**

According to Appendix G of the CEQA Guidelines, a project would have a significant effect associated with GHGs if it would:

- Generate GHG emissions, either directly or indirectly, that may have a significant and/or cumulative impact on the environment; or
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHG.

4. **IEMA principles on climate change mitigation and EIA**

The IEMA principles document provides a section on how to assess GHG emissions in EIA and states:

- "When evaluating significance, all new GHG emissions contribute to a significant negative environmental effect; however; some projects will replace existing development that have higher GHG profiles. The significance of a project's emissions should therefore be based on its net impact, which may be positive or negative."
- "Where GHG emissions cannot be avoided, the EIA should aim to reduce the residual significance of a project's emissions at all stages."
- "Where GHG emissions remain significant, but cannot be farther reduced... approaches to compensate the project's remaining emissions should be considered."

29. Sacramento Metropolitan Air Quality Management District, 2014. Justification for Greenhouse Gas Emissions Thresholds of Significance.
30. CAPCOA 2008 CEQA and Climate Change: Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act.

CASE STUDIES

5. The Park at Granite Bay[31], California, USA

Assessment included quantitative and qualitative methods of GHGs;

- Quantitative: construction and operational emissions were lower than the Sacramento significance threshold;
- Qualitative: project complied with a number of mitigation measures at local and district level including; increased diversity (incorporating recreational use into project design will reduce mobile source emissions), improve destination accessibility, improve pedestrian network, provide traffic calming measures and comply with energy efficiency standards; and
- The project would not substantially contribute to GHG cumulative impacts and therefore impacts would be considered less than significant.

6. Wind Energy Ordnance[32]

Guidelines for determination of significance

"For the purpose of the EIR, the County's Interim Approach to Addressing Climate Change on CEQA Documents (County of San Diego 2010) guidelines for determining significance apply the direct and indirect impact analysis, as well as the cumulative impact analysis. A significant impact would result if:

- The project would conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs"
- The impacts from the proposed project (Wind turbine) related to generation of GHG emissions on a cumulative level would be less than significant as they will contribute to emissions reductions targets set out in the Climate Change Action Plan/Goals in AB 32 (for San Diego) and will contribute to the state's goals by facilitating the development if renewable sources of energy in place of fossil fuel based electrical generation.
- Implementation of the proposed project would not result in significant impacts associated with GHG emissions and global climate change. By facilitating the development of a local renewable energy supply, the proposed project could help to reduce impacts related to global climate change in two ways: (1) decrease GHG emissions, and (2) reduce the potential for energy shortages and outages in the inland areas. Therefore, the proposed project would not result in any significant impacts related to GHGs

31. The Park at Granite Bay (December 2015) Draft Environmental Impact Report.
32. Wind Energy Ordnance (2012) Draft Environmental Impact Report

7. HS2 Phase One[33]

- GHG emissions associated with the construction of the proposed project are significant. Mostly a result of the construction of tunnels, earthworks, bridges, viaducts and underpasses that have been included to mitigate other significant environmental noise and visual amenity.
- Multiple mitigation measures have been identified, with two described below;
- Secondary carbon benefits: proposed project will increase total carrying capacity of the rail transport system therefore freeing up capacity of existing rail networks which can be used to transfer freight or passenger traffic from higher carbon modes.
- Opportunities will be identified to avoid carbon in the project design; and reduce embedded carbon in construction materials and carbon emissions from construction works.

The following two project example are based in New York City. Although they don't specifically focus on significance, both provide mitigation measures based on the following statement:

"Although the contribution of any single project's emissions to climate change is infinitesimal, the combined GHG emissions from all human activity have been found to be significantly impacting global climate... there are no established thresholds for assessing the significance of a project's contribution to climate change. Nonetheless, prudent planning dictates that all sectors address GHG emissions by identifying GHG sources and practicable means to reduce them."

8. Vanderbilt Corridor and One Vanderbilt, New York, USA

- Focus on mitigation measures. Don't compare against threshold instead they look at savings between baseline conditions and mitigated conditions example below:
- The proposed One Vanderbilt development is estimated to require 28.5 gigawatt-hours per year (GWh/yr) of electricity for general building use and a total of 17,487 million British thermal units per year (MMBtu/yr) of natural gas for heat and hot water. An option including on-site electricity and heat cogeneration is under consideration, which would provide approximately half of the electricity demand using a natural gas-fired system, requiring 148,268 MMBtu/yr of natural gas.
- Proposed project will include a number of sustainable design features that would reduce GHG emissions (based on LEED certification rather than standard building code), these include;
- Efficient building design;
- Use clean power;
- Transit-oriented development and sustainable transportation;
- Reduce construction operation emissions; and
- Use building materials with low carbon density (i.e. recycled steel).

33. HS2 (2013) London – West Midlands Environmental Statement Volume 3 Route-wide effects https://goo.gl/QkUCtc

9. **Billie Jean King National Tennis Centre (NTC), New York, USA**

- As the proposed project would result in more than 350,000 square feet of development, the sources of GHG emissions and measures that would be implemented to limit those emissions are discussed in this chapter, along with an assessment of the proposed project's consistency with the citywide GHG reduction goal
- The assessment concludes that the project's design includes features aimed at reducing energy consumption and GHG emissions, which is consistent with NYC citywide GHG reduction goal.
- Focus on minimising energy use and GHG emissions during the non-event season. Also aim to improve options for sustainable transport;

The majority of emissions from the proposed project would be associated with its construction rather than the two weeks per year the US Open operates. Therefore, many of the emission reduction measures that would be implemented as part of the proposed project would focus on construction activities

Notes

List of abbreviations / glossary

BaU – Business as Usual

BIM – Building Information Modelling

BREEAM – Building Research Establishment Environmental Assessment Method

CEEQUAL – Civil Engineering Environmental Quality assessment scheme

CEMP – Construction Environmental Plan

CEN – European Committee for Standardization

Climate change – changes in general weather conditions over an extended period of time (seasonal averages and extremes)

Climate Change Adaptation – the process that a receptor or project has to go through to ensure it maintains its resilience to climate change

Climate Change Mitigation – This consists primarily of approaches that seek to avoid, reduce or limit the release of GHG emissions that contribute to anthropogenic climate change. It can also include actions that will increase the removal of GHG atmospheric emissions (e.g. carbon sequestration through woodland creation, conservation and wider land management practices). The ideal is to pursue a strategic approach whereby overall emissions are quantified and reduced, assisting a transition towards a low or zero carbon footprint.

Climate Change Resilience – a measure of ability to respond to changes that something experiences. If a receptor or project has a good climate change resilience, it is able to withstand the changes in climate in a way that ensures it retains much of its original function and norm

CCC – Committee on Climate Change

DBEIS – Department for Business, Energy & Industry Strategy

DEFRA – Department for Environment, Food & Rural Affairs

DfT – Department for Transport

EMP – Environmental Management Plan

EPD – Environmental Product Declaration

EIA – Environmental Impact Assessment

ES – Environmental Statement

GHG – Greenhouse Gases

IEMA – The Institute of Environmental Management and Assessment

IA – Impact Assessment

LICR – Large Infrastructure Carbon Rating

LCA – Life Cycle Assessment

LPA – Local Planning Authority

PAS – Publically Available Specification

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