iLCCT Data User Handbook

Sustainable Healthcare Coalition

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iLCCT Data User Handbook

Considerations for the use and reporting of data in estimating the environmental footprint of clinical trials

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Acronyms and Abbreviations

Abbreviation	Full name
ERM	Environmental Resources Management
GHG	Greenhouse gas(es)
iLCCT	Industry Low Carbon Clinical Trials group
IMP	Investigational medicinal product
LCA	Life cycle assessment
PCF	Product carbon footprint
SHC	Sustainable Healthcare Coalition
SMI	Sustainable Markets Initiative
SOP	Standard operating procedure

1. INTRODUCTION

This handbook has been developed to provide structured, practical guidance in the use of data for practitioners involved in the environmental footprinting of clinical trials, in particular those following the method and guidance documents published by the Sustainable Healthcare Coalition (SHC) and the associated carbon calculator that operationalises this approach.

The main objective of the handbook is to provide clear and consistent support on the interpretation, use and integration of all relevant data, whether primary or secondary activity data, emission factors or data in the form of results, in life cycle-based assessments of the footprint of a clinical trial. It aims to promote methodological rigour, transparency, and informed decision-making across studies and organisations, regardless of whether users are contributing to a shared database or conducting their own independent assessments. Beyond technical guidance, the handbook aims to foster a deeper appreciation of the critical role that data and data quality play in estimating and in interpreting clinical trial carbon footprints.

This handbook is also intended for practitioners conducting their own life cycle assessment (LCA) or product carbon footprint (PCF) studies independently of the SHC's calculator tool and database, offering guidance on the role and interpretation of data in clinical trial footprinting. This handbook assumes a general understanding of clinical trial processes and a basic familiarity with emissions or sustainability reporting practices.

The user handbook provides practical guidance on:

- Identifying and collecting relevant activity data;
- Understanding data quality, limitations and uncertainty;
- Avoiding common errors in data handling;
- Preparing data for verification and review; and
- Integrating user-generated data with broader footprinting frameworks.

This handbook is intended to evolve over time following its initial publication in 2025. As users gain experience, and as new data and feedback on the application of the SHC's resources become available, the handbook is expected to be updated to reflect emerging insights and methodological improvements.

1.1 The Sustainable Healthcare Coalition and the industry Low Carbon Clinical Trials group

The SHC accelerates progress towards net-zero healthcare by fostering collaboration between the public and the private sectors, delivering solutions that protect both human health and the environment.

Clinical trials are essential to advancing healthcare, but they also contribute significantly to the sector's greenhouse gas (GHG) emissions. Recent studies have highlighted the need to quantify and to reduce these impacts. An article in the Lancet (Adshead et al., 2021) emphasises the urgency of decarbonising clinical trials and proposes a strategy that includes measuring carbon footprints, justifying trial necessity and integrating sustainability into ethics and funding processes.

Led by the SHC, in partnership with the Sustainable Markets Initiative (SMI), the industry Low Carbon Clinical Trials (iLCCT) group aims to establish a standardised framework for assessing and reducing the carbon footprint of clinical trials across both the public and the private sectors. Clinical trials involve a range of activities including, for example: investigational medicinal product (IMP) supply chain and manufacture; sample handling; and participant travel, activities which are not often well-represented in conventional carbon accounting tools. Accurate and context-specific data are essential to address this gap.

The iLCCT database has been developed in response to this gap, providing a standardised, life cycle based set of emission factors and default activity data assumptions relevant to clinical trial activities to support practitioners where they have no specific data, in particular to facilitate materiality assessments

and to enable first iterations of trial footprints where these data are recognised as potential hotspots. The database is intended to be used principally where relevant primary data are unavailable, helping users to fill data gaps and to undertake more accurate and transparent carbon footprint assessments.

2. OVERVIEW OF CLINICAL TRIAL FOOTPRINTING

The SHC oversees a collaborative initiative, facilitated through the iLCCT group, which aims to advance low-carbon and environmentally sustainable clinical trials. As part of this initiative, the SHC has produced a ***method document***[1] that sets out a standardised approach for evaluating the environmental footprint of clinical trials. Complementing this, a ***guidance document***[2] has been developed to provide users with practical support in applying the method. To further operationalise this guidance, the SHC has also created a ***Clinical Trials Carbon Calculator***[3].

Accurately estimating the carbon footprint of any product, process or service requires a holistic, system-wide approach. This principle applies equally to clinical trials, where it is essential to consider the entire life cycle. Without such a comprehensive perspective, significant contributions to the overall footprint may be overlooked, potentially leading to inaccurate conclusions and misguided recommendations regarding emissions hotspots and reduction strategies. In some cases, without a holistic perspective it is possible that proposed interventions might prove counterproductive.

To ensure a robust and reliable footprint assessment, all materials and activities associated with the trial should be considered, excluding only those that are negligible in their contribution to the overall impact of the trial. The activities associated with a trial include, but are not limited to, the following. Some of these activities might be reasonably excluded from the scope of an assessment, depending on its objectives and their materiality.

- Designing and planning of the trial.
- Production and distribution of the IMP, device or other intervention materials.
- Staff commuting and participant travel.
- Sample collection, storage and disposal.
- Site operations and trial management activities.

Refer to Appendix A for an example map of a pharmaceutical clinical trial, which presents the key activity areas that a user may wish to account for in their footprint assessment.

Typically, the footprinting process is iterative, beginning with a high-level assessment to determine materiality (i.e. identifying which activities are likely to contribute most significantly to the overall footprint). This helps to prioritise data collection efforts and ensures that resources are focused on characterising the most impactful areas associated with the trial.

The granularity of the footprint estimate, and the extent of iteration, should be guided by the objectives of the study and the level of accuracy required, for example in justifying interventions to reduce trial footprints or in reporting. If the aim is to produce a footprint that conforms with the SHC method and guidance, particularly for external reporting at the trial-specific level, for benchmarking and for informing decarbonisation strategies, then a relatively high degree of accuracy is necessary. This requires detailed, context-specific data collection and careful alignment with methodological standards. Broader

[1] Clinical Trials Carbon Footprinting Method Document: https://shcoalition.org/wp-content/uploads/2024/03/ClinicalTrials_Method_PublicationVersion_240306.pdf

[2] Clinical Trials Carbon Footprinting Guidance Document: https://shcoalition.org/wp-content/uploads/2024/03/ClinicalTrials_Guidance_PublicationVersion_240312.pdf

[3] Version 2.0 of the calculator was released in July 2025 through the SHC's Sustainable Clinical Trials Knowledge Hub (Taking Action Clinical Trials | Sustainable Healthcare Coalition). Version 3.0 of the tool is scheduled for release in the first quarter of 2026. It is likely that further versions of the calculator will be released as its functionality continues to develop in response to user requests and in order to provide the latest available background data.

estimates that are less granular and less accurate may be fit for purpose for internal or exploratory contexts. However, they do not meet the requirements of conformant assessments and should be treated as indicative only. Users are encouraged to begin their studies with those data that are available and subsequently to iterate their assessments, improving accuracy and confidence as more primary data become available.

Following the appraisal of individual activities, the overall trial footprint can be estimated through aggregation. This may be carried out at various levels of detail, for example:

- **Activity level:** trial management, investigator meetings; and
- **Material level:** fuel used for sample transport

The level of aggregation will depend on the granularity of the data collected. Identifying key emissions hotspots at this stage is important for informing targeted reduction strategies.

3. DATA NEEDS FOR CLINICAL TRIAL FOOTPRINTING

Accurate estimations of clinical trial carbon footprints are best achieved through comprehensive studies employing LCA methods and data, in alignment with the ***method document*** and the foundational LCA framework. To achieve accurate results, users are encouraged to utilise as many primary data as feasible, reflecting the specific activities associated with the design, procurement and operation of their clinical trials. Where applicable, these primary data should be supplemented with life cycle data that quantify the environmental intensity of the materials and energy used in the trial (i.e. emission factors).

However, obtaining such data can be challenging, even for activities conducted within the user's own organisation. Suppliers may not routinely collect or disclose relevant data and may be unable or unwilling to share these. Furthermore, the data often originate from multiple suppliers, span several operational sites and cover extended time periods. In addition, users may lack access to LCA tools and databases, or the expertise required to apply them effectively. Given that full LCA studies are resource-intensive, high-level or streamlined assessments may be more practical and justified, enabling broader coverage and deeper insights across a portfolio of trials, while also informing more detailed evaluations where necessary.

Data quality and uncertainty are central challenges in clinical trial footprinting. Incomplete or unrepresentative data, often stemming from limited access to primary sources or reliance on assumptions, can undermine the credibility of results. To ensure meaningful outputs, users should actively assess and transparently communicate sources of uncertainty and their implications.

Consequently, users may need to estimate trial footprints without complete primary data or access to specialised LCA software and databases. In such cases, secondary data describing trial activities, along with default emission factors, become valuable resources.

Both the ***guidance document*** and the ***carbon calculator*** incorporate a database of default activity data and emission factors, offering indicative secondary values for GHG emissions associated with specific clinical trial activities. Practitioners are encouraged as far as possible to obtain primary values associated with the clinical trial being assessed before using these default values in their footprinting assessments.

The database and the calculator represent a significant advance in the capacity for interested parties to assess clinical trial footprints where full LCA studies are not affordable or practicable. Their availability and application markedly improve GHG accounting, footprint estimation and the development of decarbonisation strategies and roadmaps for clinical trials, compared to reliance on alternative spend-based, top-down approaches. Nevertheless, comprehensive LCA studies remain essential for validating and refining streamlined methods and supporting tools.

4. A STANDARD OPERATING PROCEDURE FOR DATA COLLECTION

This section presents a recommended standard operating procedure (SOP) for the collection of clinical trial activity data. It outlines a structured, step-by-step approach to identifying data needs, engaging with relevant stakeholders, using data collection templates, and validating data for completeness and accuracy, as outlined in both the ***method*** and ***guidance documents***.

The SOP provides to practitioners a structured approach for collecting and preparing activity data for clinical trial footprinting. It is designed to support both:

- Individual users seeking to assess and to improve the environmental impact of their own trials; and
- Contributors submitting data to the iLCCT emissions database.

The SOP applies to both primary and secondary data and is relevant for one-off assessments as well as recurring data submissions. It is intended to guide users in collecting data specific to the activity areas of interest, which may vary depending on the scope of the trial or the focus of the user's footprinting goals.

By following this SOP, users can ensure that their data are robust and compatible with clinical trial footprinting methods.

4.1 Procedure

4.1.1 A high-level overview

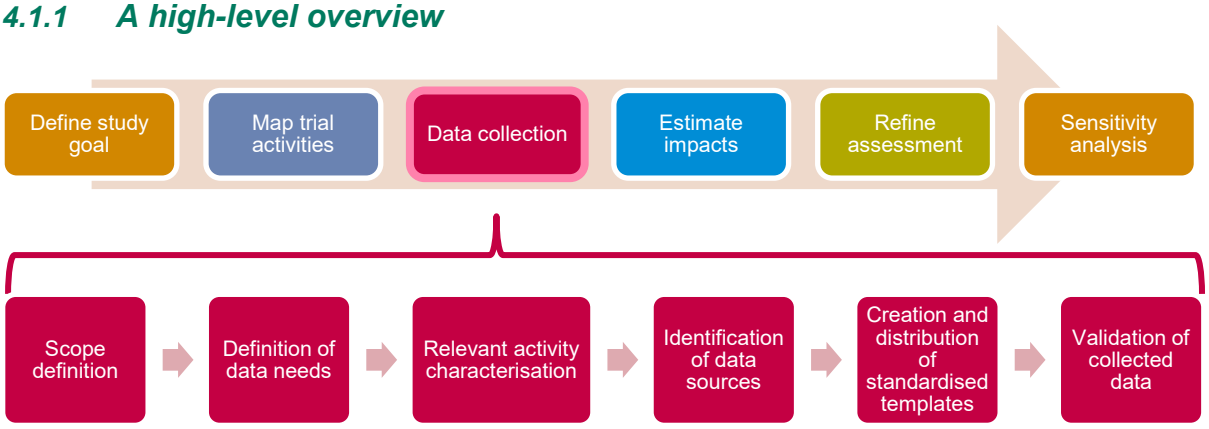


Figure 4.1 A structured approach for data collection

Figure 4.1 outlines a high-level breakdown of the key stages involved in footprinting a clinical trial and further breaks out the steps that a user should undertake for data collection.

The overall process begins with the definition of the study's goal and scope, establishing the framework for assessment. This is followed by the identification of relevant trial activities within the clinical trial. Subsequently, data are collected and appropriate emission factors selected to enable the estimation of environmental impacts. Based on initial findings, the study may be refined through targeted data collection or the development of more specific emission factors to improve accuracy. Sensitivity analysis is then conducted to explore the influence of key assumptions and data choices on the results, enabling the evaluation of alternative scenarios and enhancing the robustness of the study's conclusion.

Data collection forms a critical component of this process and is explained in greater detail in Section 4.2.

4.2 Data collection

4.2.1 Defining the scope of data collection

The data collection process begins with defining the scope of data collection. It is important to determine which trial phases and activities are relevant to the user's footprinting assessments. The user should also consider their goals of the assessment (i.e. understanding hotspots in clinical trials, comparing different trial sites or improving specific practices within trials). Practitioners may choose to focus on the activities that their organisation conducts, rather than the clinical trial as a whole, whilst there may also be circumstances where default data are used for IMP, so as to highlight activities outside the clinical supply chain. Iteration of preliminary assessments is likely to focus on those activities shown to be hotspots.

4.2.2 Defining the user's data needs

Following definition of scope, the user should define their data needs within each activity area to quantify the footprint of the included operations. This is achieved through a mapping exercise and a materiality assessment, which helps to identify the relevant data points that should be included or excluded from the footprint. These data points typically include IMP manufacture and supply, patient travel, lab kit usage, and other operational components. Refer to Appendix B for example data inputs for each clinical trial activity area. The mapping should reflect the full scope of the trial, including conventional and decentralised elements where applicable. Exclusions should be justified, typically based on materiality (i.e. the area is deemed to have a negligible impact on results) or data limitations. The user should then identify what type of data will be needed accurately and reliably to evaluate the identified points. For example, the data needs for IMP would be a cradle-to-gate assessment of the product, distribution mode and distance(s) transported.

4.2.3 Characterisation of relevant clinical trial activities

Once the relevant activities are identified, the next step is to characterise these in detail. This involves specifying what is entailed by each activity and identifying the staff requirements, materials, energy and wastes that are associated with it. For example, the means of IMP supply may differ significantly between conventional and decentralised trials, and such distinctions must be captured clearly to ensure accurate data collection. At this stage, it is also important to consider how these data will be obtained. There may be a variety of data sources, including: operational records; site-level reporting; direct input provided by trial teams; or estimates (where direct measurements are not feasible).

The ***guidance document*** complements this step by providing detailed instructions for data collection across various trial modules, including IMP, participant travel and trial site operations. It offers default values and proxy data to support users in completing their assessments in the absence of specific information and emphasises the importance of materiality assessments to prioritise data collection efforts. All assumptions and data gaps should be transparently reported and tested through sensitivity analysis.

4.2.4 Identification of data sources

Stakeholder engagement is essential throughout the process of data collection. It is important to identify, and to liaise with, individuals who manage the processes being assessed, hold relevant data or are responsible for procurement and operations. These stakeholders may vary, depending on the organisation and location, so guidance should be provided to help stakeholders identify appropriate contacts.

4.2.5 Creation and distribution of standardised templates

To promote consistency and ease of use, data should be recorded using standardised templates with clear instructions and support offered to the data provider. These templates should capture both

quantitative data (e.g. energy consumption, transport distances and material usage), and qualitative context (e.g. delivery methods, trial types, site types and operational practices). Typically, these templates will request:

- The activity type and description;
- Input tables for quantitative data (e.g. distance travelled by patient, number of trips to site etc.);
- Reporting period or timeframe; and
- Comments regarding data sources and any assumptions or limitations.

Support should be provided to stakeholders to ensure that data entry is as accurate and as complete as possible.

Where primary data are unavailable, secondary or proxy data may be used, provided their sources are documented and their limitations are acknowledged. Practitioners are encouraged to test the significance of secondary or proxy data through sensitivity analysis, unless materiality assessment has clearly demonstrated that the parameter values have little effect on the overall estimated footprint.

4.2.6 Validation of collected data

Once data are collected, they should be validated through checks, such as mass and energy balances. The data should be reviewed for completeness, consistency and plausibility, and any anomalies or gaps should be flagged for follow-up. This validation step is critical to ensuring the reliability of the data used in subsequent analysis. Users should document any known limitations, assumptions or estimation methods. Additionally, they should ensure traceability by recording data sources and collection methods.

Following validation, the quality of the data should be assessed. As mentioned in the ***method document***, validation includes confirming whether the data are primary or secondary, assessing whether they are representative of the clinical trial system under study, and determining whether they are sufficiently precise for the intended use in the assessment. For example, in multi-site trials, it is important to consider variation across sites to avoid generalising data from one location to others without justification.

5. UNDERSTANDING ACTIVITY DATA

A foundational step in clinical trial footprinting is identifying the activity data required to represent trial-related processes. This section defines key data types, distinguishes between primary and secondary sources, and introduces the approaches to activity data collection.

5.1 What are activity data?

Activity data are quantitative information that describe the extent of a specific activity in a trial that generates emissions or other impacts. They are vital inputs in calculating environmental impacts, and are combined with emission factors on a per unit basis for the activity concerned to provide an estimate of the emissions associated with the trial (see Section 5.4).

Typical examples of activity data in clinical trials include:

- The number of participant visits;
- The distance travelled by trial staff and participants to a trial site;
- The quantity of consumables used;
- The energy consumption at a trial site; and
- The quantities of waste generated.

Activity data should be as trial-specific and as accurate as possible to ensure reliable footprint estimates. Data are usually collected from operational records, site records, procurement systems or direct reporting by trial teams.

Accurate activity data enable users to reflect the real-world environmental impact of clinical trials and support more meaningful comparisons across studies, geographies and trial designs.

5.2 Data collection

When collecting data, users should aim to follow a life cycle approach, meaning that the data should reflect the full set of inputs and outputs associated with a given activity. This ensures that the emissions estimates are comprehensive and representative of real-world conditions.

There are two main approaches to generating or applying data in footprinting:

- **Bottom-up approach:** this involves collecting detailed, trial-specific data directly from operational sources. It allows for a high degree of specificity and is strongly recommended when users are generating their own primary data. A holistic, life cycle, perspective should be applied to ensure that all relevant stages, such as production, transport, use and disposal, are considered.
- **Top-down approach:** in cases where bottom-up data are unavailable or are impracticable to collect, users may rely on default emission factors associated with specific activities. These factors are typically derived from broader datasets or industry averages and represent a top-down estimation method. While useful for filling data gaps, default values may lack the specificity required for precise footprinting and should be used with appropriate caution and ideally tested through sensitivity analysis.

5.3 Primary and secondary data sources

The reliability and relevance of emission factors are strongly influenced by their source. It is important to distinguish between trial-specific primary data and other forms of data, as this affects how representative and accurate are the data for a given assessment.

- **Primary data:** these are data collected directly by users in relation to a specific clinical trial. They reflect real-world practices and products within that trial and are typically the most representative of actual clinical trial conditions.
- **Secondary data:** these are data collected from other trials either by the same organisation or by other organisations. Although these data reflect real-world trial practices, they are not likely to be perfectly representative of the clinical trial that the user is modelling (e.g. using site consumption data from a trial in the UK for a site in Japan). While these data are useful for filling in gaps where primary data are not available, these sources are less likely to be specific to the trial the practitioner is modelling and should be used with appropriate caution.

Users should prioritise trial-specific primary data wherever available, as these are the most representative of actual conditions and practices. In contrast, secondary data can lack the specificity required for accurate assessments in pharmaceutical contexts.

While secondary data can be useful in the absence of primary data, users should be aware of their limitations. Secondary sources can vary significantly in accuracy and relevance, particularly when applied to specialised or novel trial settings. This reinforces the importance of using trial-specific primary data wherever possible.

Even data from the organisation conducting the trial, but that are not specific to the trial in question (e.g. data collected by practitioners to be used in modelling other trials) should be treated with caution.

Although these may be more representative than other secondary sources, they still carry risks of misalignment with the current trial's conditions and assumptions.

Data from the trial planning stage are also likely to differ from observed data. While trial planning data can be useful when measured data are unavailable, they do not reflect real-world trial conditions and should therefore be treated as secondary data. For example, if the number of participant visits in a trial is known, but the number of MRI scans to be carried out is not, estimating emissions by multiplying the number of visits by a planned number of scans would constitute a secondary data point. Users should document when trial planning assumptions are applied and recognise that these estimates may introduce an uncertainty compared to primary trial data collected post hoc.

5.4 Emission factor sources

Emission factors are typically data obtained from external sources, such as published academic literature, LCA databases (e.g. DEFRA, ecoinvent, IEA etc.) or industry benchmarks. While useful, these sources may be less specific to pharmaceutical contexts and should be used with appropriate caution. These sources often rely on aggregated data or generalised assumptions, which may not reflect the nuances of clinical trial operations, leading to increased uncertainty in emission factor estimates. It is important to review the scope of the emission factors and to determine the life cycle stages and activities that are included and any exclusions before applying them in calculations.

5.5 Calculating greenhouse gas emissions for a specific trial activity

To estimate GHG emissions for a particular activity, users should first identify the relevant activity data (e.g. kilometres travelled by a participant to site, the energy consumption of a clinical trial site etc.), as described above. Emissions are then calculated by multiplying these activity data by an appropriate emission factor, which represents the environmental impact per unit of activity.

Using activity data obtained from their organisation, users can calculate emissions by multiplying these figures by the relevant emission factor, which can be found in either the 'Trial activity EFs' or 'Common EFs' tabs in the iLCCT database, or in other life cycle and emission factor databases. This process will yield an estimate of the GHG emissions for that activity. These can be useful for initial assessments or gap-filling, but it is essential to exercise caution when using default values. They are derived from previous clinical trials for which environmental footprints have been estimated and may not accurately reflect the characteristics of other trials, trial types or the specific contexts of the organisations conducting them. Variability in trial geographic location of sites and the distribution of staff and participants should all be considered when interpreting these estimates.

$$\textit{GHG emissions} = \textit{Activity data} \times \textit{Emission Factor}$$

Emission factors may be sourced from LCA databases, published literature or other sources (refer to Appendix C for some examples). Where trial-specific emission factors are unavailable, users may refer to default values or benchmarks.

It is important to consider the contextual relevance of both activity data and emission factors. Variability in trial design, site locations and logistics can significantly influence emissions outcomes. Practitioners should document any assumptions made and be transparent about the sources and limitations of the data used.

6. DATA QUALITY AND LIMITATIONS

This section provides guidance on evaluating data quality, managing uncertainty, and understanding the implications of using incomplete, outdated, or non-representative data in footprinting assessments. It outlines key principles and practical considerations for ensuring data integrity through the footprinting process. This includes identifying common sources of user error and offering recommendations to improve the consistency and accuracy of calculations.

6.1 Data quality and managing uncertainty

Data quality is a foundational concern in clinical trial footprinting. Practitioners often face uncertainty due to incomplete, outdated, or non-representative data. This uncertainty can arise from various sources: limited access to primary data; reliance on secondary datasets; use of shared databases; or assumptions embedded in assessment tools. While these challenges are common, they must be acknowledged and actively managed to ensure that footprinting outputs are meaningful.

Uncertainty is a natural feature of footprinting assessments. However, if left unaddressed, it can undermine the credibility of results and misguide decision-making. For example, underestimating a trial's footprint may result in misleading public disclosures, while overestimating may prompt unjustified mitigation efforts. Users should place importance on understanding the sources of uncertainty, assessing their implications, and communicating these transparently.

The accuracy and reliability of the footprinting results are directly dependent on the quality and completeness of the data submitted. High-quality inputs will improve the trustworthiness of the footprint calculations. Users should aim to collect complete, relevant, and well-documented activity data across all applicable trial components. For example, if a trial involves shipping IMP between countries, the user should record the number of shipments, distances travelled, and modes of transport used. Incomplete or estimated data, such as assuming all shipments are by air without confirmation, can introduce significant uncertainty into the footprint.

It is also important critically to assess the relevance and accuracy of emission factors applied. For instance, using a generic emission factor for electricity consumption may not reflect the actual carbon intensity of the local grid where a trial site operates. In such cases, users should consider sourcing region-specific factors or documenting the rationale for their choice. Examples of reliable data sources are provided in Appendix C.

Assumptions made during data collection or calculations should be transparently recorded. Suppose a user estimates staff commuting emissions based on average travel distances rather than real site-level data. This assumption should be clearly stated, and where possible, sensitivity analysis should be conducted to explore how different commuting patterns might affect the footprint.

Variability in trial design, geographic location and operational practices can all influence emissions outcomes. Users are encouraged to reflect on these factors when interpreting results and to communicate limitations clearly in external and internal reporting. This transparency supports more meaningful comparisons across studies and strengthens the credibility of sustainability efforts.

While tools and databases can significantly enhance the feasibility of footprinting, particularly in contexts where detailed life cycle data may be hard to obtain, practitioners must remain aware of the limitations inherent in all data sources. For example, the data underpinning the iLCCT database may be derived from a relatively small sample of clinical trials. Despite the diversity of trials conducted globally, this limited sample introduces the potential for unintentional sample bias. As a result, the assumptions and emission factors presented may not be fully representative of all trial types, geographies, or operational models.

Additionally, such datasets may be disproportionately informed by a small number of organisations responsible for commissioning and conducting trials, introducing the potential for unintended bias. Consequently, the activities and resource consumption patterns captured may not reflect broader sector practices or the specific contexts of individual users. While secondary data values may be of high quality, they should not be assumed to serve as precise proxy values for unavailable primary data. Their representativeness for any given trial is uncertain, and the level of uncertainty in resulting footprint estimates cannot be quantified.

Equally, practitioners using their own data should critically assess their reliability. This includes evaluating the completeness of activity data, the relevance of chosen emission factors, and the transparency of any assumptions or estimation methods. Variability in trial design, geographic location

and operational practices can all influence emissions outcomes and should be considered when interpreting results.

Users are encouraged to document their data sources, reflect on uncertainties, and communicate limitations clearly, whether reporting internally or externally. This supports more robust decarbonisation strategies, allows for more meaningful comparisons across studies and promotes transparency in sustainability reporting.

6.2 Recommendations

Clinical trial footprinting studies often rely on a mix of data types: primary data collected directly from trial operations; secondary data from internal sources or literature; and values drawn from databases. Each of these data types carries different levels of uncertainty, and practitioners must remain mindful of their limitations when interpreting results.

Studies that rely heavily on secondary data should be regarded as indicative rather than definitive. Users are strongly advised to recognise the fundamental distinction between primary data (specific to their own trials) and secondary data, which may not fully reflect the unique characteristics of their studies. This distinction is critical when assessing the reliability of footprint estimates and identifying emission hotspots.

Wherever feasible, users should evaluate the degree to which an estimated footprint is influenced by secondary data inputs. Sensitivity analysis should be considered a standard practice, not only when users are uncertain about their assumptions, but as a routine method to test the robustness of findings. This can be done using parameter ranges provided in the database, or by applying hypothetical ranges where such data are absent.

In cases where secondary data contribute significantly to identified emission hotspots, users are encouraged to iterate their studies with a focus on collecting relevant primary data. This approach will help to reduce uncertainty and to improve the reliability of the results. As more primary data are incorporated, users will be better equipped to judge the extent of uncertainty associated with secondary data use and to refine their footprinting method accordingly.

Users should exercise caution in the reliance placed on the footprint estimates derived from secondary data. When reporting findings, particularly in contexts such as corporate GHG disclosures or Scope 3 inventories aligned with Science Based Targets, it is advisable to acknowledge the potential margin of error and to engage with assurance providers early in the process to validate assumptions and data sources.

Furthermore, when developing decarbonisation roadmaps, users should reconsider the possibility that certain emission hotspots may have been overlooked due to limitations in the secondary data. This could result in strategies that are less effective or efficient than those informed by comprehensive primary data.

7. AVOIDING USER ERROR

Even with high-quality primary data, errors in handling and interpretation can significantly affect footprinting outcomes. This section outlines common pitfalls and offers practical strategies to mitigate them.

7.1 Common errors

A critical component of robust clinical trial carbon modelling is the consistent and accurate application of data. The outcomes of any footprinting exercise ultimately depends on the accuracy of user inputs and the appropriateness of their methodological choices.

Misaligned system boundaries and exclusion of activity areas

A frequent issue arises when users apply inconsistent boundaries across different parts of the model. This can often lead to the exclusion of certain activity areas. For example, if one part of the footprint includes emissions for staff commuting for trial management, but another excludes travel for trial site staff, the results may be misleading.

To mitigate this issue, the following actions can be taken:

- Establishing a clear modelling boundary (e.g. cradle-to-gate) at the start of the modelling and applying this consistently throughout;
- Reviewing whether the emission factors selected cover the same life cycle stages and contributions; and
- Where mixing boundaries is unavoidable, documenting these assumptions clearly and, if possible, adjusting calculations to align stages.

Misidentification of data sources and heavy reliance on secondary data

During data collection, users may misidentify data sources, rely too heavily on secondary or default data or fail to engage the right stakeholders. These issues can result in incomplete, outdated, or non-representative datasets.

To mitigate this:

- Users should begin with a clear mapping or materiality assessment to define which data are needed and why;
- Standardised templates should be used to ensure consistency, and guidance should be provided to stakeholders to support accurate completion of these;
- Engaging individuals who manage operations, hold relevant data or oversee procurement is essential; and
- Additionally, documenting metadata (e.g. data sources, collection dates, and assumptions) helps to maintain traceability and supports future replication.

Misapplication of emission factors

Emission factors must be used correctly, with attention to units, scope, and source. For instance, applying a per-kilogram emission factor to data recorded in litres without conversion will distort results.

To mitigate this issue, the following actions can be taken:

- Carefully reviewing metadata accompanying each emission factor (e.g. functional unit, data source, scope);
- Ensuring activity data are expressed in the correct units and aligned with the intended boundary of the emission factor (e.g. cradle-to-gate vs cradle-to-grave); and
- Avoiding mixing incompatible emission factors (e.g. supplier-specific and generic literature values) within the same calculation without appropriate documentation.

Inadequate documentation of assumptions

Without clear records of assumptions, data sources and calculation logic, results cannot easily be reviewed, verified, or repeated. For example, if a user updates a footprint using a newer version of the database without rechecking the original assumptions or emission factors, the results may no longer be comparable, especially if unit definitions or scope boundaries have changed.

To mitigate this issue, the following action can be taken.

- Maintaining structured documentation alongside all footprinting calculations, including data sources, assumptions made and methodological notes. This ensures that changes can be tracked and understood, preserving backwards compatibility and enabling meaningful comparison over time.

Sensitivity analysis should be considered a standard part of footprinting practice, not only when users are uncertain about their assumptions, but as a routine method to test the robustness of results across plausible scenarios. This helps to ensure that findings remain meaningful, even when input data or assumptions vary.

8. ASSURANCE

Assurance is the process of providing a level of confidence that the reported trial footprint and accompanying report are complete, accurate, consistent, transparent, relevant and without material misstatements. Obtaining assurance over the estimated footprint of the clinical trial is valuable for reporting companies and other stakeholders when making decisions using the footprint results.

Achieving assurance over the trial environmental footprint can be achieved through two methods: verification; and critical review.

8.1 Preparing for verification

Third-party verification of the estimated environmental footprint of the clinical trial(s) is strongly recommended. Third-party verification will provide confidence, both to internal management and to external stakeholders, that the footprint is complete and accurate, within stated limitations.

Third-party verification should be conducted by a verification body and will follow an assurance standard, typically ISAE 3000[4]/ISSA 5000[5] or ISO 14064-3:2019[6]. These assurance standards define the level of assurance to be provided, along with the tasks necessary to complete verification. To support verification, users are encouraged to develop a written method describing how the environmental footprint of the trial was estimated. This method should include the following.

- The reporting criteria that were applied. Examples of reporting criteria are the GHG Protocol Product Standard[7], ISO 14064-1:2018[8] or any other industry standard that governs the requirements of the estimated environmental footprint, for example the SHC's ***method document***.
- The boundaries of the environmental footprint.
- A description of the major contributions to the environmental footprint, which could include:

[4] ISAE 3000:2013, International Standard on Assurance Engagements – Assurance engagements other than audits or reviews of historical financial information

[5] ISAE 5000:2024, International Standards of Supreme Audit Institutions – Guidelines on audit of environmental and sustainable development

[6] ISO 14064-3:2019, Greenhouse gases – Part 3: Specification with guidance for the verification and validation of greenhouse gas statements

[7] GHG Protocol Product Standard, Product Life Cycle Accounting and Reporting Standard

[8] ISO 14064-1:2018, Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals

- Participant transport-related emissions (which would be the function of the number of participants enrolled, the frequency of participant travel to the trial site, distance travelled and mode of transport);
- Trial site staff transport emissions (a function of the number of staff, commuting distance and mode of transport);
- Emissions associated with the transport of samples (a function of the number of samples taken during the trial, the distance transported and the mode and conditions of transport) or the method by which these are estimated;
- The carbon footprint of the IMP, if available, which should include a description of the calculation method for the footprint or the source of the study if a proxy is used;
- The method by which energy usage at the trial site is attributed to the footprint; and
- Any other major contribution to the footprint.

- Underlying assumptions and limitations.
- The emission factors applied in estimating the footprint and their sources.
- A description of the data collection and calculation procedures associated with each contribution or source of emissions.
- Roles and responsibilities of individuals involved in the data collection and estimation process.
- A description of quality assurance / quality control activities.

Based on the written method, the estimated environmental footprint and the professional judgement of the verifier - which includes evaluating material contributions and identifying areas with a higher risk of incompleteness or inaccuracy, the verifier will request additional source documentation or evidence to support the estimated environmental footprint. Additional source documentation might include items such as invoices, justification for assumptions and limitations, meter readings, results of surveys or other evidence present in the audit trail.

The extent of evidence required by the verifier depends on the level of assurance (limited or reasonable) that is sought by the practitioner's organisation. Reasonable assurance generally requires a larger sample size to be provided than does limited assurance.

It is important to note that primary evidence or source evidence can be anonymized. There is no requirement to share personal data or information with the verifier.

The verification process will result in an assurance report. This report will summarize the scope of assurance, the reporting criteria, the work performed, the assurance standard applied and the verifier's conclusion. Assurance standards require that this report be published alongside the estimated environmental footprint. The environmental footprint estimate and assurance report should be made available to its intended users and must discuss the context of the environmental footprint, including:

- The actual estimated footprint of the trial (in t CO_2e);
- Information concerning the boundaries of the footprint estimate;
- Major assumptions and limitations; and
- The emission factors used.

Providing context is essential to the reader's understanding of the information and data provided, especially in cases where it is used for the purposes of comparison.

8.2 Preparing for critical review

Whereas the GHG Protocol Product Standard allows for both verification and critical review, the latter is the norm within the field of LCA. Methodological choices are typically made by the practitioner in

accordance with the defined study goal and scope, and are justified in the face of the scrutiny of an expert critical reviewer. The critical reviewer will cover much the same ground as described above, but without strict adherence to either ISAE 3000/ISSA 5000 or ISO 14064-3:2019. The role and expectation of critical review are defined in ISO 14040[9] and ISO10444[10]. Additional guidance and requirements for critical review is provided for in ISO 14071[11].

A critical review will be carried out by one or more internal or external independent reviewer(s), or by a panel of reviewers, as defined in ISO 14044:2006, 6.2 and 6.3. The critical review may be performed concurrently with, or at the end of, the study. A concurrent review is more interactive, offering benefit to the study and aligning with the iterative nature of assessments. The commissioner or practitioner undertaking the study will recruit the internal or external independent expert to perform the review, or in the case of a panel review will recruit the chair of the review panel.

A LCA critical review is carried out to ensure that:

- The methods used to carry out the assessment are consistent with the international standards for LCA, ISO 14040 and ISO 14044 and/or with the GHG Protocol Product Standard and the SHC method document;
- The methods used to carry out the LCA are scientifically and technically valid;
- The data used are appropriate and reasonable in relation to the goal of the study;
- The interpretations reflect the limitations identified and the goal of the study; and
- The study report is transparent and consistent.

A critical review statement will be appended to the study report.

9. ITERATION AND CONTINUOUS IMPROVEMENT

Footprinting should be viewed as an iterative process that improves over time. The ***method document*** notes that the scope of assessment may need to be refined during the study. Iteration is also embedded in the system boundary refinement process, which relies on sensitivity analysis and materiality assessments to determine choices regarding the inclusion and exclusion of data.

This section discusses how to use the results of initial assessments to refine data collection strategies, to improve data quality and to enhance the overall robustness of future footprinting exercises.

Carbon footprinting in clinical trials is an iterative process that evolves as more data become available, methods are refined and user understanding deepens. Each iteration offers an opportunity to improve the accuracy, relevance, and credibility of the assessment, making it a vital part of responsible environmental reporting and decision making.

There are several drivers for iteration. As trials progress or conclude, users may gain access to more detailed primary data, such as site-specific energy use, transport distances, or procurement records, that can replace earlier estimates or default values. Updates to emission factors, changes in trial design and feedback from stakeholders may also prompt reassessment. In some cases, sensitivity analysis may reveal that certain assumptions or data inputs significantly influence the results, highlighting areas where refinement is most needed.

During each iteration, users should revisit and update key components of their assessment. This includes replacing secondary data with primary data where feasible, refining modelling assumptions, and ensuring that system boundaries and functional units remain consistent. All changes should be

[9] ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework

[10] ISO 14044:2006, Environmental management – Life cycle assessment – Requirements and guidelines

[11] ISO 14071:2024, Environmental management - Life cycle assessment - Critical review processes and reviewer competencies

clearly documented, including the rationale for updates and any limitations encountered. Maintaining version control is essential to ensure that results remain comparable over time, especially as tools and databases evolve.

Sensitivity analysis plays a central role in continuous improvement. It should be considered a routine part of footprinting. This helps users to identify which inputs have the greatest impact and where future data collection or methodological refinement will be most beneficial.

Ultimately, continuous improvement enables users to move from more indicative estimates towards more definitive assessments, strengthening the credibility of their reporting and supporting more meaningful action on climate goals.

10. SENSITIVITY ANALYSIS

Sensitivity analysis is a critical component of clinical trial footprinting. It allows users to explore how potential variation in key assumptions or data inputs affect the overall results, helping to identify which parameters have the greatest influence on the footprint and where further data collection or refinement may be most valuable.

The purpose of sensitivity analysis is not only to test the robustness of results but also to support transparency and informed decision-making. By systematically varying input values, such as emission factors, transport distances or energy consumption, users can assess the range of possible outcomes in the footprint of a trial assessed and better understand the uncertainty associated with their estimates.

Sensitivity analysis should be considered a standard practice, not only when there is uncertainty. Even when data appear to be reliable, testing alternative scenarios helps to ensure that conclusions are not overly dependent on a single assumption or data point. This is particularly important when results are used to inform decarbonisation strategies or public reporting.

Users may apply sensitivity analysis in several ways:

- **Parameter range testing:** users can vary individual inputs within justifiable bounds to assess their impact. For example, testing the effect of different patient travel distances.
- **Scenario modelling:** constructing alternative operational scenarios, such as switching to renewable energy, can help users to understand how structural changes affect emissions.

Again, clear documentation of sensitivity analysis is essential for transparency, reproducibility, and credibility. Users should record:

- A list of the parameters varied, with justification for their selection;
- The ranges or scenarios applied, with the values used, their sources and any assumptions made; and
- A summary of how the footprint changes across scenarios, highlighting which parameters had the greatest influence.

11. INTEGRATING YOUR OWN LIFE CYCLE ASSESSMENT AND ITS RESULTS

Integrating the database into the user's LCA workflow requires alignment between activity data, modelling assumptions and the structure of the emission factors provided. This section outlines key considerations for incorporating these data sources into LCA models, carbon accounting tools, or existing emissions inventories, with a focus on ensuring consistency, accuracy and transparency throughout the process.

It is important to ensure that the activity data (e.g. the distance travelled by a patient or energy consumed by a trial site) aligns with the units and scope of the emission factors. In some cases, where the data only differ in their units, appropriate conversions can be applied by the user before integration.

Equally important is the alignment of system boundaries. For example, if the LCA is cradle-to-gate, the emission factors selected should reflect the same boundary conditions. Functional units should also be consistent across the LCA model and the database, whether expressed per patient, per sample or per staff hour.

Temporal and geographic relevance must also be considered when selecting emission factors. Each factor should be reviewed for its associated year and region to ensure it reflects the context of the study. If the assessment spans multiple regions, region-specific factors or weighted averages should be considered to maintain representativeness.

Comprehensive documentation of the modelling is essential for transparency and reproducibility. This includes maintaining a clear record of the emission factors used, the rationale for their selection, any conversions or assumptions applied, and any limitations encountered.

12. USING THE ILCCT DATABASE

The iLCCT database provides a repository of secondary data and assumptions that can be used when primary data are unavailable or incomplete. This section provides an overview of the structure and contents of the iLCCT database. It explains the methodological approaches employed in the data generation, namely the bottom-up and top-down techniques, and distinguishes between primary and secondary data sources. This section also addresses considerations relating to data quality, uncertainty and reliability, and offers guidance for applying the database in clinical trial footprinting or other specific needs.

12.1 Structure

The database is organised into three sections relating to clinical trial activities:

Default values	Trial activity emission factors	Common emission factors

12.1.1 Default values

These are baseline activity data (e.g. testing kit weights, transport distances and modes of travel) relevant to various activity areas in clinical trial operations. These data do not represent GHG emission factors themselves, but rather serve as the underlying inputs from which emissions may be estimated or updated. The purpose of this tab is to facilitate trial footprint estimation where the user does not have their own primary data, and would otherwise face a data gap. However, it is important to note that these are secondary data, and while they may be sufficiently fit for purpose to fill gaps in a footprinting assessment, they are not specific to the trial in question. Where such default values contribute significantly to the footprint, particularly in identified hotspots, users should consider iterating their study and making a concerted effort to collect relevant primary data, especially if the results are intended for reporting or external assurance.

12.1.2 Trial activity emission factors

This provides GHG emission factors associated with specific clinical trial activities, including IMP, sample handling and imaging procedures. These factors are also secondary data and may be based on literature, industry averages or aggregated datasets. While they offer a practical starting point, users should remain aware of their limitations and seek more representative data where feasible.

12.1.3 Common emission factors

This contains GHG emission factors for general activities commonly encountered across clinical trials, such as travel, distribution, electricity consumption and waste management. Typically, these values are from established sources and may be suitable for many assessments, but they remain secondary data and should be used with appropriate caution.

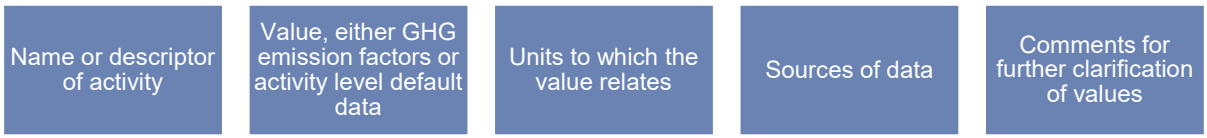
Across all sections, the principle remains the same: primary data are preferred. Where secondary data are used, users should assess their materiality and influence on the footprint. If they are shown significantly to affect the results, particularly in areas of high emissions, the study should be iterated and improved through targeted data collection. While it may be more difficult to obtain primary data, this does not diminish the importance of doing so, especially when accuracy and conformance with guidance are objectives.

Within these three sections, the data are categorised according to a standard set of activity areas that reflect common clinical trial activities. As of the 2024 version of the database[12], these activity areas are:

- IP kits and their distribution;
- IP manufacture and distribution;
- Monitor visits;
- Non-IP trials;
- Participant and staff travel;
- Sample analysis, storage and transport;
- Testing kits production and distribution;
- Trial meetings;
- Trial sites; and
- Sponsor facility utilities.

An example clinical trial map is shown in Appendix A.

Within each activity area, individual emission factor entries or default data values are provided, along with the following metadata:



The structure is intended to promote traceability and informed decision-making by users when selecting and applying appropriate emission factors to their calculations.

As of the present time, the intention is to launch a new version of the database in Q1 of 2026.

12.2 Considerations when using the iLCCT database

The database contains secondary data:

- Collected from specific trials commissioned and operated by a limited number of healthcare companies and contract research organisations;
- Derived through simple LCA methods; and
- As reported in the public domain.

[12] This list is subject to change based on the meta and gap analyses conducted prior to the annual database update. These analyses aim to identify activity areas that may not be covered in the database currently.

Although the data are of high quality, they are secondary in nature when used by other parties.

The data are provided by the SHC to facilitate appraisal of clinical trial footprints, materiality assessments and for the purposes of identifying key areas for primary (or improved secondary) data collection in an iterative approach to understanding the footprint of a trial.

Despite their high quality and utility, they are not a precise and accurate substitute for specific primary data characterising the activities and consumptions associated with an individual trial, since they report the extent of activities and consumptions associated with a different trial or trials. As a result, users should be cognisant of the uncertainty introduced into their assessments by employing the data, and exercise care in relying on them in the absence of primary data.

Users should consider the materiality of each contribution and the extent to which the trial they are studying is likely to be similar to those on which the database is founded.

As studies are iterated and more primary data are collected, users will be better placed to judge the extent of the uncertainty associated with using the database. The SHC has undertaken a further programme of data collection in 2025, further to improve the representativeness and extent of the database, in part to reduce the uncertainty associated with the parameter values presented, to add to the ranges and variation included for trial hotspots and to support users in sensitivity analysis and iteration of their studies.

APPENDIX

Appendix A: Example map of a pharmaceutical clinical trial

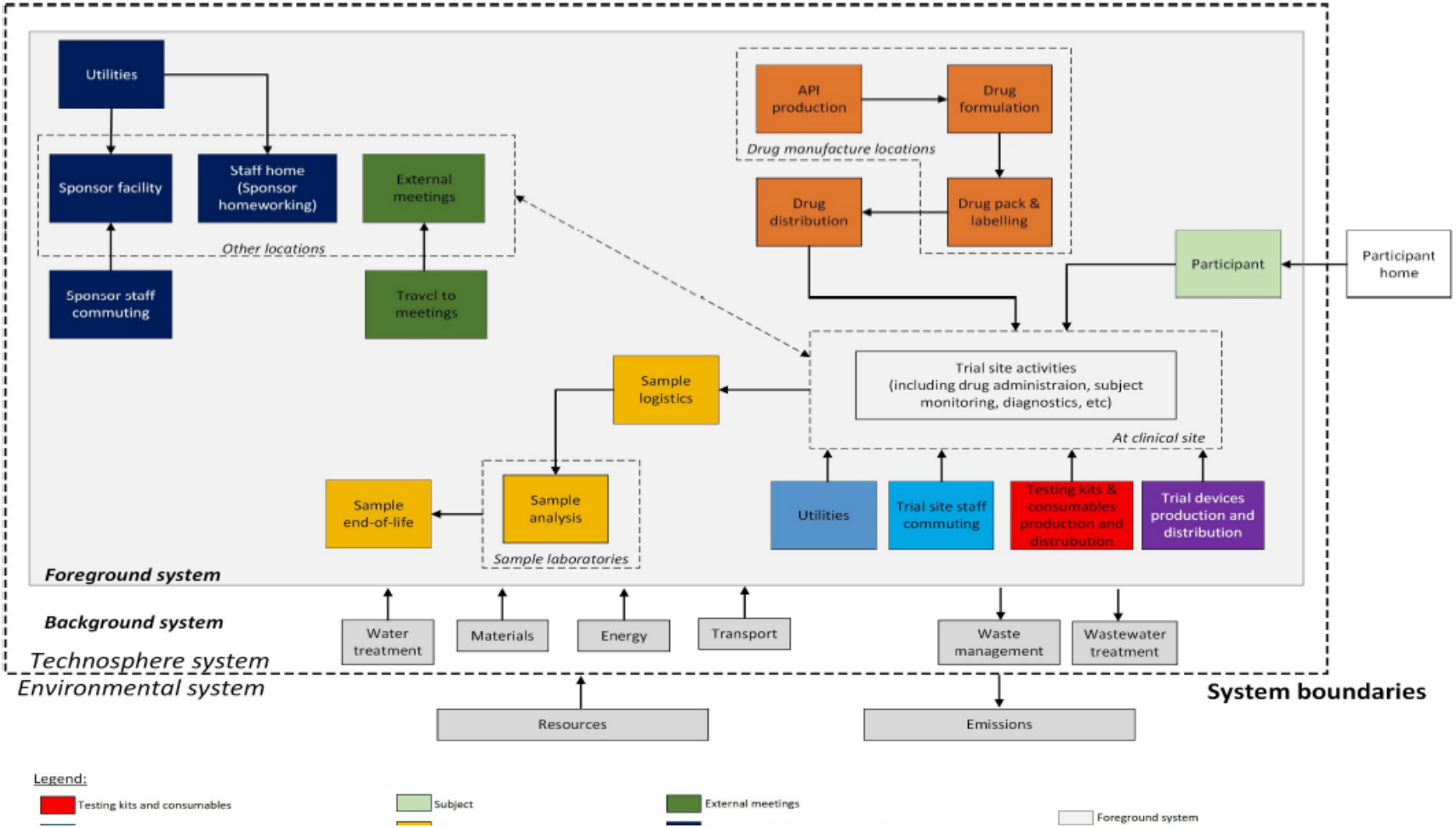


Figure A. 1 An example clinical trial map

Appendix B: Example data inputs for each clinical trial activity area

Table B. 1 Example data inputs for different clinical trial activity areas

Activity areas	Required data inputs
General information	• Name of trial • Name of individual completing assessment • Time of period of trial (specify start and end date)
Countries trial undertaken in	• Country • Number of trial participants • Number of expected in-person site visits (per participant within this country) • Average duration of in-person visits (hours) • Number of remote visits (per participant within this country) • Average duration of remote visit (hours)
Interventional medicinal product	• Product type • Product name • Is the product supplied locally or centrally? If centrally, name country (or countries) • Total intervention product quantity unit (per trial, per participant or total spend) • Total IMP quantity (e.g. number of tablets, vials, devices) • Kit quantity • Kit weight
Laboratory kits	• Lab kit type • Lab kit name • Is the lab kit supplied locally or centrally? If centrally, which countries? • Kit weight (or use approximate data) • Kit quantity unit (per trial, total per participant, total spend) • Kit quantity
Devices provided to site or participant	• Device name • Is the device supplied locally or centrally? If centrally, which country? • Device weight • Quantity unit (per trial, total per participant, total spend) • Quantity • Hours of device usage per participant
Procedures	• Procedure name(s)

	• Total number of procedures per participant • Average length of procedure
Participant travel	• Transport mode percentages: aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Average round-trip distance travelled
Trial site staff	• Number of trial site staff involved in the trial • Staff trips to trial site • Hours of staff time associated with participant visits (or use approximate data) • Transport mode percentages: aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Average round-trip distance travelled
Trial management – staff time	• Total staff hours • Proportion spent working from home (percentage)
Trial management – staff commuting	• Total number of management staff involved in trial • Number of trips staff make for the duration of trial • Transport mode percentages: aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Average round-trip distance travelled
Trial meetings – trial management	• Total number of trial management meetings • Average number of staff per meeting • Travel profile for meeting attendees (or use approximate value) : aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Profile type: in person (local or international) or virtual -> air distance, road distance, public transport distance, hotel nights per attendee, hours online
Trial meetings – monitor visits	• Total number of monitor visits meetings • Average number of attendees at monitor visit meetings • International/local/virtual attendance • Travel profile for meeting attendees (or use approximate value) : aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Profile type: in person (local or international) or virtual -> air distance, road distance, public transport distance, hotel nights per attendee, hours online
Trial meetings – investigator meetings	• Total number of investigator meetings that took place during the trial • Average number of attendees at investigator meetings • International/local/virtual attendance

	• Travel profile for meeting attendees (or use approximate value) : aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Profile type: in person (local or international) or virtual -> air distance, road distance, public transport distance, hotel nights per attendee, hours online
Trial meetings – ethics meetings	• Total number of EC meetings • Average number of attendees per meeting • International/local/virtual attendance • Travel profile for meeting attendees (or use approximate value) : aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Profile type: in person (local or international) or virtual -> air distance, road distance, public transport distance, hotel nights per attendee, hours online
Trial meetings – other meetings	• Total number of other meetings • Average number of attendees per meeting • International/local/virtual attendance • Travel profile for meeting attendees (or use approximate value) : aeroplane (domestic), aeroplane (long haul), bike/walk, bus, car, coach, light rail/tram, national rail, taxi • Profile type: in person (local or international) or virtual -> air distance, road distance, public transport distance, hotel nights per attendee, hours online
Local consumables	• Quantity of relevant consumables per participant/per visit • Waste generated
Samples- local	• Total number of samples used for local labs • % of samples analysed (or use approximate value) • Storage - % of samples stored locally, average duration of storage, frozen storage temperature
Samples - central	• Total number of samples for central labs • % of samples analysed (or use approximate value) • Country of central laboratory • Storage - % of central samples to store, average duration of storage, frozen storage temperature

Appendix C: Examples of emission factor sources

Table C. 1 Emission factor sources

Emission factor source	Link	Description
UK Government GHG Conversion Factors	https://www.gov.uk/government/collections/government-conversion-factors-for-company-reportinghttps://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting	Provides a broad range of life cycle emission factors (broken down by scope), including energy, transport (freight and passenger), materials and waste.
UK Government EEIO emission factors by SIC code	https://www.gov.uk/government/statistics/uks-carbon-footprint	Provides emission factors per unit of economic activity by each sector of the economy. Useful for all areas where financial data is only available, and a proxy is required.
GHG Protocol Third Party Databases	https://ghgprotocol.org/life-cycle-databases	Provides links to sources of life cycle inventory data and emission factors
Global LCA Data Access Network	https://www.globallcadataaccess.org	Provides links to sources of life cycle inventory data
HealthcareLCA a database of environmental assessments within healthcare	https://healthcarelca.com	Source of life cycle data and emission factors for healthcare related activities.
US Life Cycle Inventory Database (US LCI)	http://www.nrel.gov/lci/	US life cycle inventory database for materials, energy, transport, waste management processes
US EPA EEIO Supply Chain Greenhouse Gas Emission Factors for US Industries and Commodities	https://catalog.data.gov/dataset/supply-chain-greenhouse-gas-emission-factors-for-us-industries-and-commodities	Provides emission factors per unit of economic activity by each sector of the economy. Useful for all areas where financial data is only available and a proxy is required.
ecoinvent	https://ecoinvent.org	Life cycle inventory database (global and regional) for materials, energy, transport, waste management processes
Sphera LCA datasets	https://sphera.com/product-sustainability-gabi-data-search/	Life cycle inventory database for materials, energy, transport, waste management processes
Australian National Greenhouse Accounts Factors	https://www.dcceew.gov.au/sites/default/files/documents/national-greenhouse-account-factors-2023.pdf	Designed to support anyone estimating GHG emissions.
International Energy Agency (IEA)	IEA – International Energy Agency	Source of electricity emission factors for each country

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