MISSION INNOVATION
SOLUTION FRAMEWORK

Framework for Assessing Avoided Emissions

Accelerating innovation and disruptive low- and zero-carbon solutions

Part 2

Draft methodology for calculating avoided emissions

version 2018-1

Government Offices of Sweden

RISE · Swedish Energy Agency · WWF · eit Climate-KIC · Carbon Trust · Clean Energy International Incubation Centre — An initiative of Tata Trusts & Government of India

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Draft methodology for calculating avoided emissions version 2018-1

Introducing a draft methodology for measuring avoided emissions

Contents

Structure of the Document

This document has the following structure:

1. **Introduction**

   introduction and background to the framework

2. **Guidance**

   this section provides an overview of the framework and approach; the general steps for applying the framework

3. **Methodology**

   provides details of the methodology and discussion of some of the aspects of the methodology

4. **Worked examples**

   three examples are presented for applying the framework

Appendix 1

Examples and references

Appendix 2

Glossary

1. Introduction

The Paris Agreement set an ambitious aim to hold the increase in global temperature to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C. Achieving this aim is vital to avoid major disruption to human life on the planet. However, projections based on current NDCs predict a temperature rise of over 3°C.[1] To deliver the dramatic emissions reductions that are needed, will require more than a business-as-usual approach to companies reducing their existing emissions. It will require new approaches driven by companies delivering innovative and disruptive solutions that will bring about significant changes in societal behaviour and overall reductions in emissions. Many of the most significant emissions reductions today have been delivered by companies delivering solutions, not simply reducing their own emissions. Examples such as renewable energy, electric cars, dematerialisation, virtual meetings, etc. have been driven by companies providing solutions rather than by reducing their own emissions. The Fourth Industrial Revolution[2] (connectivity, new materials, and new business models) also provides ample examples of opportunities. This is not to say that companies own emissions are unimportant, we will only reach a zero-carbon society if all emissions are brought down to zero. However, rapid reductions in emissions require innovative solutions, and this requires an approach which can assess the impact of the avoided emissions from these solutions. This framework aims to provide a structure within which avoided emissions can be assessed and included into the strategies for overall emissions reductions and decarbonisation. It builds on existing practice and initiatives.

To accelerate emission reductions companies cannot only be driven by cost and risk reductions, but must also use their capacity for innovation to deliver the solutions that we need. Hence, solutions providers need the tools and credibility to be *able to demonstrate* their positive impacts in society. It is not sufficient to just allow polluting companies to show how they reduce their emissions, governments need to be able to direct support to providers of solutions in a cost-efficient way (most GHG emissions reduction for the buck). Investors need to be able to identify winners in a low/zero-carbon economy (not just avoid the losers). This will require a shift in emphasis from 'doing less bad' to 'doing more good', but will also need tools and methods to quantify and compare the impact of different solutions and potential solutions.

1.1 Introduction to framework

The Research Institutes of Sweden (RISE) is leading an initiative together with the Swedish Energy Authority, the Carbon Trust, and other partners, to provide an assessment framework that is able to identify companies, system solutions and technologies that have significant ability, or potential, to contribute to reduce greenhouse gas (GHG) emissions in society, so called avoided emissions. The initiative has been adopted as one of the activities in the Mission Innovation Action Plan for 2018-2020.[3]

The objective of the initiative is to develop a draft framework that is capable of classifying and then ranking companies/solutions, based on their positive climate impact, through their supply of low carbon products and services. The methodology framework will be applicable to: 1) Products/solutions; 2) System solutions; and 3) Companies.

This document is an initial step in the development of the methodology framework. It has been developed by starting with existing published methodologies that relate to avoided emissions.

1.2 Concept of avoided emissions

The overall concept of avoided emissions is that a solution (product or service) enables the same function to be performed with significantly less GHG emissions. The method of measuring avoided emissions is to compare a baseline scenario without the enabling solution with a scenario using the enabling solution, where the baseline represents the 'business as usual' (BAU) scenario.

1.3 GHG accounting, reporting and ranking frameworks

A short history of GHG accounting and reporting

Arguably, the formation of the United Nations Framework Conventions on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol of 1997 focussed attention on the measurement of GHG emissions at a national scale. And this then looked at industrial sectors that contribute significant emissions. Hence the first generation of companies that measured their emissions were those companies directly responsible for significant emissions such as power plants, steel, chemical and cement plants (those with significant scope 1 emissions).

Over time, other companies also began to measure and report their emissions, including the emissions of their value chain which could also be significant – for example, automotive companies (due to the emissions from the cars) and food companies (due to the emissions from farming). However, the focus remained on the companies responsible for large emissions. This was due to a combination of factors, from NGOs and environmental authorities focus on companies as a problem, to the financial investment approach of only considering climate change as a risk where companies with high carbon exposure should be avoided.

Reporting of GHG emissions by companies is now well established, with most large corporations reporting their annual emissions as a matter of routine. However, commonly agreed approaches and standards for GHG accounting have only been established in the last 20 years, which is a mere flicker in time compared to the history of financial accounting.[4]

Frameworks for reporting of GHG emissions, and frameworks for ranking of companies on sustainability criteria, are also relatively recent, with the GRI formed in 1997 and the CDP being founded in 2000.

While over the last 10 years there have been a number of initiatives related to avoided emissions and net-positive approaches, there are currently no agreed standards for the assessment and reporting of avoided emissions, although the GHG Protocol Product Standard refers to avoided emissions.[5]

For a more detailed perspective on the history and evolution of the net-positive approach see the Cybercom report:[6] 'Digital Sustainability – Global sustainability as a driver of innovation and growth'.

Summary of key GHG reporting standards and frameworks

The GHG Protocol supplies the world's most widely used greenhouse gas accounting standards.[7] Three key GHG Protocol standards (and initial publication dates) are: the Corporate Standard (2001, revised 2004), the Product Standard (2011), and the Scope 3 Standard (2011).

The GRI Sustainability Reporting Standards are used by businesses and governments worldwide to understand and communicate their impact on critical sustainability issues such as climate change, human rights, governance and social well-being. In 2000 the GRI launched the first version of its reporting guidelines, representing the first global framework for comprehensive sustainability reporting. The guidelines have been continually updated with new releases, G4 was launched in 2013.

CDP was formed in 2000 to support companies to disclose their environmental impact primarily in terms of GHG emissions. It has become the global repository for corporates to report their GHG emissions, with over 5,600 companies reporting in 2017. CDP uses the responses from companies to create a ranking by scoring company responses from A to D.

Other sustainability ranking systems exist, most notably the Dow Jones Sustainability Index (DJSI), and the FTSE4Good Index, (which is based on the FTSE Russell ESG rating system). The FTSE Russell Green Revenues model takes this further by measuring the proportion of a company's revenue that is linked to a green product or service, and providing a 'Green Revenue Factor' for different green revenue sectors.

However, all existing major measurement and ranking systems related to climate change impact still focus on companies' and cities' GHG emissions and emission reductions. The purpose of this document is to shift the focus to the potential positive impact that a company can have in reducing its customers' emissions through the use of its products and services, so called avoided emissions.

1.4 Avoided emissions - Maturity of approach and future ambition

There are today a number of examples of net-positive initiatives, approaches for assessing avoided emissions, and companies that are looking to change focus from 'doing less harm' to 'doing more good'. Appendix 1 lists some of these examples. One of the earliest documents to present an approach for assessing avoided emissions was GeSI's 'Methodology for evaluating the carbon-reducing impacts of ICT',[8] published in 2010. A number of ICT companies and other initiatives have since published work in the same direction, also using some of the earlier company led net-positive strategies from 2007-2010.

Thus the current examples and practice of net-positive approaches are developing and reasonably mature, although there remain a number of methodological challenges.

Current examples broadly fall into the following categories:

1. **Companies that are reporting avoided emissions and having net-positive targets**

   These include a number of international ICT companies, and other multi-national companies such as IKEA and Kingfisher.

   New initiatives are also emerging. The Net Positive Project is a cross sector collaborative initiative to develop principles, methodologies and promote the net positive concept (which extends beyond just GHG emissions to include other sustainability aspects).

2. **Financial investment and disclosure initiatives.**

   The finance and investor sector have historically had some ethical and socially responsible investment approaches that do not invest in certain sectors, and for a climate perspective do not invest in fossil fuel companies. More recent approaches are now looking at climate-positive investment decisions by actively selecting more sustainable companies, based on ranking criteria. Examples include: the FTSE Russell Green Revenues ranking model; the Transition Pathway Initiative; Carbon Delta's 'green patent' assessment methodology; and WHEB's sustainability fund.

Mark Carney, the Governor of the Bank of England, and Laurence Fink, CEO of Blackrock are two prominent leaders in the finance sector encouraging companies to fully disclose their climate change risks. The TCFD published its recommendations for financial disclosures in 2016.

3. Identification and acceleration of new solutions

WWF have for over 15 years been active in researching, promoting and publishing reports in relation to avoided emissions, and have developed the Climate Solver Tool – an on-line calculator for assessing the carbon reduction potential from technologies. The Swedish energy agency have used a version of the WWF framework to assess its portfolio of low-carbon entrepreneurs. The possibilities to assess Mission Innovation initiatives is most closely related to these initiatives. An increasing number of cities are also increasingly focusing on supporting solution providers, not only supporting emissions reductions from big polluters.

As mentioned above, existing reporting frameworks and methodology initiatives have focused on companies as sources of emissions, not sources of solutions. Their offer to the financial sector and other stakeholders has been mainly about avoiding risks associated with significant dependence on fossil fuels, or to identify the worst in existing sectors. In later years there has been a growing understanding about the need to also identify those companies with solutions.

The WRI produced a draft white paper on avoided emissions in 2016. Sector specific methodologies have been published for the chemicals and cement industries.

(See Appendix 1, for more details of these examples).

Challenges

One of the key challenges of current approaches is providing a consistent method for reliably quantifying avoided emissions. The process often has a higher uncertainty compared to measurement of emissions within a company's direct control such as Scope 1 & 2 emissions. This is because it often relies on estimates and assumptions, and is inherently considering hypothetical cases when comparing to the base case (i.e. what would have happened if this did not happen). This means that the assessment may be resource intensive, and therefore costly. As data and routines are established the costs will fall. It is therefore important to apply the appropriate level of detail to data gathering and calculation relevant to the purpose for which the results will be used, so that efforts and resources are directed to those areas which have the most significant impact on the overall result.

What is important is to initially establish an understanding of the order of magnitude of the potential avoided emissions opportunities, so that companies with significant opportunities to reduce emissions though their products and services are encouraged to increase those contributions.

In the future, as even more reliable data and studies become available and easier to process due to factors like digitalisation, increased transparency, inexpensive sensors, process power, etc., the process to estimate positive contributions should become easier and more accurate.

Future Ambition

A future scenario would be where relevant companies routinely publish their avoided emissions (for all relevant products, and for the company as a whole). This would sit alongside their financial reporting, and the reporting of their GHG emissions. This information would then be used by investors and analysts to help understand a company's exposure to climate change related risks as well as their potential to make money and be successful under different reduction scenarios.

This future scenario could also include a situation where avoided emissions would be verified and traded.

1.5 Different motivations for assessing avoided emissions

Different stakeholders will have many different needs and motivations for assessing avoided emissions. These could vary from very initial, high-level estimates to detailed and verified assessments. The required assessment process will change as tools and data develop for doing the analysis, and as organisations travel through the different stages on their 'avoided emissions journey'.

These different stages will therefore require different levels of rigour, which should be borne in mind as this framework is applied.

For example, the following three stages could be envisaged on the 'avoided emissions journey' for a company:

A A company is starting to think about its potential role as a solution provider: It needs to get a general and approximate overview of the current situation, using current sales data and multiplying this by average sector estimations of carbon abatement factors. This assessment will be very rough, but will help the company to understand its potential role as a solution provider and what parts of the company are delivering reductions in society and what parts are resulting in increased emissions.

B Providing guidance for the development of a strategic plan for avoided emissions: This could drill into more details in quantifying the actual amount of avoided emissions and allow for calculations of how the market and income could change over different scenarios. This, in turn, would help the company to prioritise the development of certain products, where to invest, and identify potential new markets and revenue streams.

C Get actual reduction measures that can be traded/sold on a market. At this stage, it is envisaged that there would exist established markets for trading of avoided emissions credits. In this case, the numbers need to be verified and allocated in ways that are not important in stages A and B. This stage therefore requires a much more rigorous approach to the calculations, traceability of the data and justification of the assumptions, and an independent audit of the process. (Note: C might never happen).

2. Guidance

2.1 Overview of Approach/Framework

2.1.1 A short note on terminology

'Avoided emissions' – definition
Avoided emissions can be defined as 'reductions in emissions caused indirectly by a product. This is where a product provides the same or similar function as existing products in the marketplace, but with significantly less GHG emissions'. This definition being derived from the GHG Protocol Product Standard – see chapter 11, sections 11.2 and 11.3.2. (Note that the Product Standard uses the term 'products' to mean either 'goods or services').

'Avoided emissions' is the terminology used by the GHG Protocol. This is elsewhere also referred to as 'carbon abatement' and is often referred to as being caused by 'the enabling effect' of a technology or solution.

Solutions
In this document the term 'solutions' is used to refer to either products or services that have an enabling effect to avoid emissions.

See the glossary in Appendix 2 for terminology used in this document.

2.1.2 Summary of Methodology

In summary, the methodology provides a comparison of the greenhouse gas (GHG) emissions from a business-as-usual (BAU) baseline scenario with those from a solution-enabled scenario to demonstrate the benefit of the solution to reduce overall system-level GHG emissions. This involves calculating the emissions in the following categories:

2.1.2.1 BAU system

The emissions from the BAU baseline, without the introduction of the enabling solution.

2.1.2.2 Enabling Effects

The avoided emissions due to the activities avoided as a result of using the solution. These are further subdivided into *primary (or immediate)* enabling effects and *secondary (or longer-term)* enabling effects.

2.1.2.3 Direct Solution Emissions

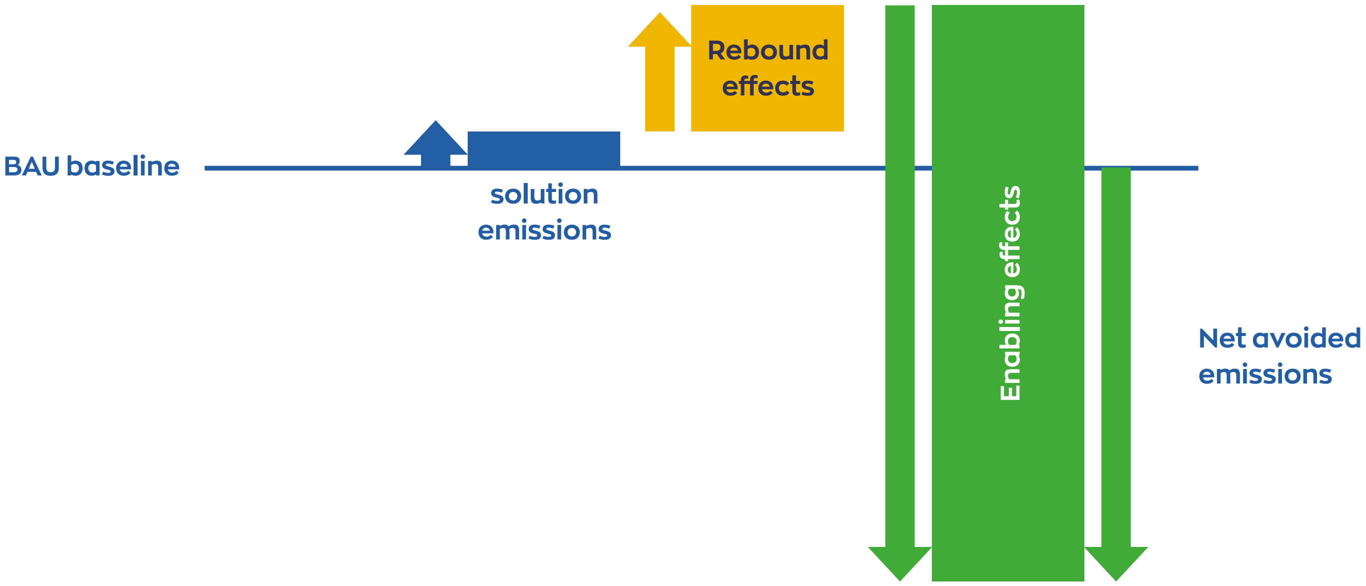
The life cycle emissions of the solution that is causing the enabling effect.

2.1.2.4 Rebound Effects

The increase in BAU emissions occurring as result of the enabling solution implementation. Rebound effects may be caused by related consequential effects or by unrelated (and sometimes unintended) effects and are often related to human behavioural changes in demand for carbon-intensive goods or activities. These effects are further subdivided into *immediate* rebound effects and *longer-term* rebound effects. Because of the nature of rebound effects, they are extremely hard to quantify and predict, and assessing them is inherently uncertain as it is difficult to accurately estimate the effects.

The net avoided emissions are then calculated as follows:

Net avoided emissions = Enabling avoided emissions - Direct solution emissions - Rebound emissions



The net avoided emissions can alternatively be defined in relation to the BAU emissions as follows:

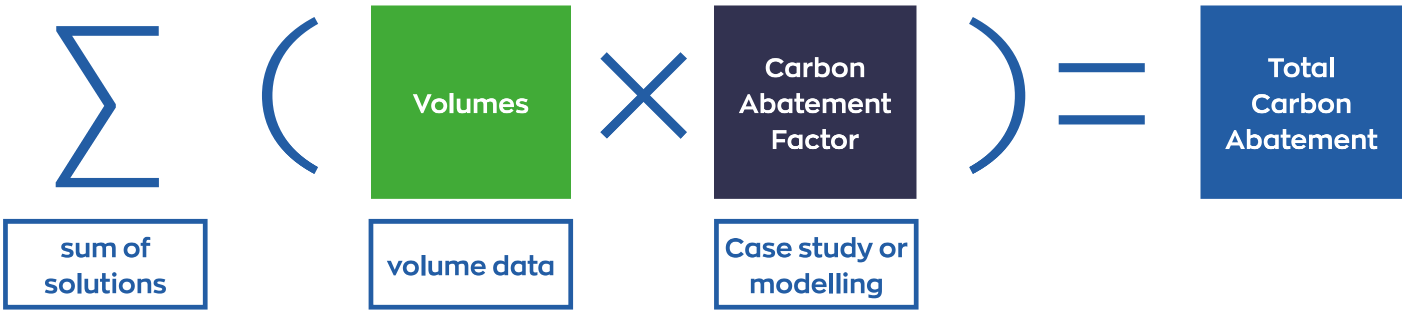
Net avoided emissions = BAU baseline emissions - emissions of the solution enabled scenario

2.1.3 Calculation Method

Each individual enabling solution is assessed by determining a carbon abatement factor that reflects the net avoided emissions per unit of the solution implemented. (Thus for video conferencing this would be the avoided emissions per video conference, and would be measured in kgCO_2e per video conference).

The advantage of using a carbon abatement factor is that it provides a normalised factor that can be compared between different assessments and studies, thus helping significantly with consistency and comparability. It can be thought of as analogous to the use of the 'emission factor' in product footprinting, which is multiplied by the activity data to calculate the product emissions.

The carbon abatement factor is based on existing academic or industry studies where available, or otherwise based on data or supported assumptions that demonstrate the carbon abatement. In order to calculate the total carbon abatement for a solution over a specific time period, the carbon abatement factor is multiplied by the volume of the solution deployed (this can be either an actual figure or a projected figure, depending on what analysis is being performed). And for multiple solutions, the total carbon abatement is the sum for the individual solutions:



In practice, the calculation is more complex than the simplified formula above suggests. Firstly, the 'carbon abatement factor' may require significant research and then additional analysis to appropriately apply it to the scenario being considered. Also, the carbon abatement factor may itself be multiple factors – for example where a solution that reduces electricity consumption is applied globally, the carbon abatement factor will vary regionally to reflect the local electricity grid emission factor. Further, a single solution may have multiple applications, and when used in different contexts can deliver very different outcomes. In this case, either multiple use-cases should be considered, or the analysis should be constrained only to those use-cases that are appropriate and relevant. In summary, it is important that the studies used to provide the carbon abatement factor are appropriate to the assessment, are scalable (i.e. do not only apply to an idealised test case), and the data and quality underlying the studies are relevant and transparent.

Also the calculation needs to acknowledge the uncertainty in the data and measurements. Ultimately the approach is an estimation, including some assumptions. An uncertainty analysis can be applied to each of the factors to derive an uncertainty figure for the total result. Or, alternatively, a qualitative discussion on uncertainty sources and their implications, combined with sensitivity analysis may be more useful.

Applying the calculation to assess future potential scenarios

Additionally, when applying this approach to future scenarios (which will often be the case for new technologies and solutions) then the probability of the solution delivering the expected benefits should be included (probability of successful development of the solution), as well as the probability of the solution being adopted at scale (probability of adoption).

Thus a more complex version of the calculation can be expressed as follows:

Thus if we want to assess the possible impact of a new technology, let us assume that the technology can reduce a person's annual emissions by 400 $kgCO_2e$. As this is a new technology we are not certain that it will be successfully developed due to technical challenges, and we assess the probability of success at 70%. The technology is applicable for all of the population, however not everyone will adopt the solution, and there may be alternative solutions that also take a share of the market, thus we assess the probability of adoption at 40%. Then for a country with a population of 50 million the avoided emissions would be:

Avoided emissions of solution = 70% x 40% x 50,000,000 x 400 [$kgCO_2e$]

'Flags' for potential lock-in threats

The solution should be analysed for potential long term 'lock-in' threats. This is particularly relevant for long-life high capital investments, where there might be short term benefits, but in the future either the technology may become obsolete, or may lock-in carbon emissions that could have been avoided by different investment. For example replacing a coal-fired power station with a gas-fired power station reduces emissions, but also locks in fossil fuel emissions for a further 30 years.

The solution should be reviewed with regards to its potential impact on society's ability to move in a decarbonisation direction. Any identified risks should be transparently considered and described.

2.2 General steps for quantifying avoided emissions

1 **Identify solutions to be assessed**
Identify the solutions that are to be assessed. This step may involve a rough calculation of the avoided emissions enabled by the solution in order to determine its significance, and therefore whether it would be useful to do a full detailed assessment, and if so to focus the data collection on the areas that will have the most significant contribution to the total avoided emissions.

2 Establish system boundary, carbon saving mechanism, and BAU baseline
For the chosen solutions, establish what the mechanism is that is causing the enabling effect – e.g. is it travel/fuel saving, or energy saving; and is the enabling effect directly attributable to the solution? Establish the system boundary, BAU baseline and functional unit

3 Document methodology and identify data requirements
Document the carbon saving mechanism and the calculation methodology. This will help to formalise the process, allow the methodology to be reviewed, and identify what data is required for the calculation. The documentation will be further refined when the calculation process has been completed.

4 Test mechanism & methodology
It may be useful to review the methodology at this stage. This may involve independent (internal or external) reviewers, and product specialists to test that the assumptions and proposed methodology are valid and reasonable.

5 Identify studies and determine the carbon abatement factor
Conduct research to collect data and studies that provide a quantitative basis for the calculation of the carbon abatement factor. These may be academic studies, other published reports, or internal project studies. The calculation of the carbon abatement factor should include the reference to the BAU baseline, the direct solution emissions, and rebound effects (where these can be quantified).

6 Collect data (for volumes and carbon abatement factor)
Complete the data collection related to the carbon abatement factor, and collect the data required to determine the volumes of the solution. (See discussion of data sources in section 3.7.4).

7 Calculate carbon abatement
The total carbon abatement can now be calculated by multiplying the carbon abatement factor by the volume for each solution, and then summing the results for all the products being assessed.

At this stage, where considering a portfolio of solutions, it is important to check for overlap between solutions, so that there is not double counting of the same avoided emissions being delivered by different solutions.

8 Final documentation and validation of the process
Fully document the methodology and calculation process, including the assumptions and data sources. Ideally, the documentation would be sufficient for someone to independently calculate the avoided emissions, and produce the same results. It is best practice to have the process independently validated. This provides for scrutiny of the assumptions, methodology and data sources; adds credibility to the process; and may identify any errors in the assumptions

or calculations. This validation can be performed by either an external expert, an internal expert, or by a panel of reviewers.

2.3 Application of framework at solution, company and portfolio level

This methodology has been developed as a 'bottom-up' approach for individual products and services, and can then be applied to companies by totalling up the avoided emissions from the separate products for all of the company's relevant products.

For investors with a portfolio of companies then the approach is to sum up the avoided emissions from each company.

At each stage of aggregation it is necessary to check for overlap, as the same avoided emissions may be being delivered by different products and by different companies.

In the future, it could be imagined that all companies will report their avoided emissions as routine all to a consistent agreed standard (similar to current reporting of Scope 1&2 GHG emissions to CDP). Then it cwould be a relatively simple exercise to aggregate avoided emissions from all the companies in an investment portfolio. The reality is that only a handful of companies currently report avoided emissions, and there are no officially recognised agreed standards for measurement and reporting.

2.4 Reporting of avoided emissions

When reporting avoided emissions at a company level, companies should take care to include this in context with other actions that the company is doing on climate change, and particularly to report its efforts in reducing its own emissions. Thus there should be a 'dual approach' of reporting the Scope 1, 2 and 3 emissions and actions to reduce these (including setting science-based reduction targets), as well as reporting on the avoided emissions enabled by the company. If this is not done then companies will be criticised for not taking responsibility for their own emissions, while claiming credit for reducing emissions elsewhere. Note that different companies will validly have different priorities and emphasis between own emissions and avoided emissions – for example a heavily emitting company (such as a steel or cement manufacturer) should focus on reducing their own emissions, while a service company with significant potential to enable avoided emissions can validly focus on their avoided emissions (such as an architecture company that can reduce the emissions of buildings that it designs). In any case, reporting of avoided emissions should not be used to focus attention only on positive examples while ignoring significant emissions elsewhere.

Avoided emissions should be clearly reported as separate from a company's own Scope 1, 2 and 3 emissions, and should not be subtracted from its own emissions.

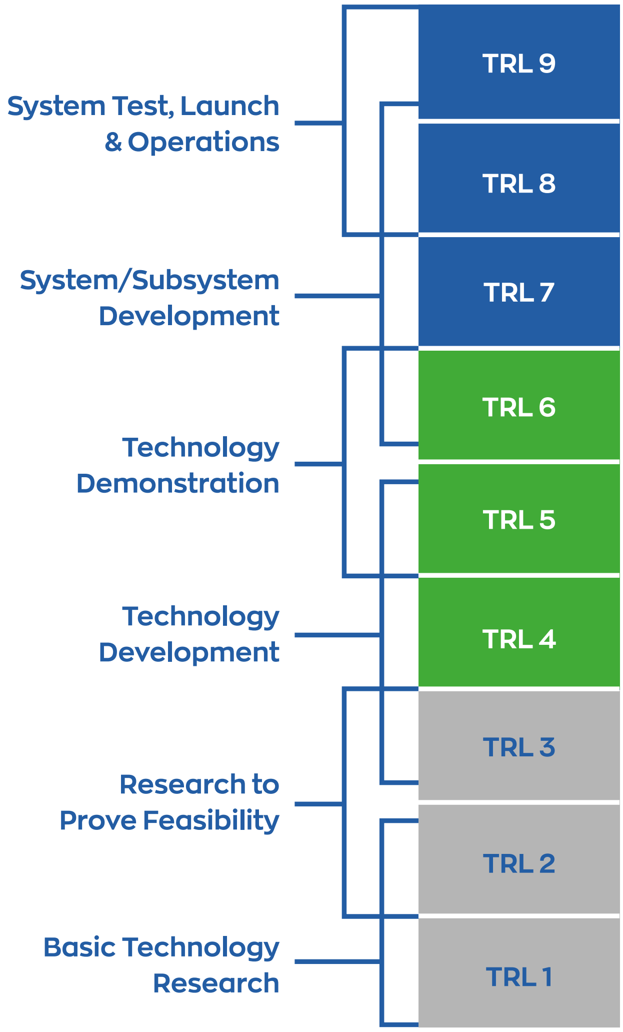
The reporting of avoided emissions should be transparent, clearly stating assumptions, and referencing sources of data. Ideally, the reporting would be sufficiently transparent that someone could independently calculate the avoided emissions, and produce the same results.

2.5 Assessing solutions at different TRL levels

In the calculation method (section 2.1.3) the concept of a 'probability of success' was introduced. This reflects the probability that the solution will be successfully developed, which relates closely to the concept of the 'Technology Readiness Level' (TRL). The greater the TRL, the greater probability that the solution will be successful. Thus if comparing two solutions that are at different TRLs, then all other things being equal, the solution with the higher TRL is likely to deliver greater avoided emissions.

This framework can be used to understand the impact of different development options for new technologies and what to focus on in the development process to deliver more significant avoided emissions. Depending at what stage of the TRL a technology is at, this analysis could fundamentally change the direction of the development (if at the lower end of the TRL scale), or might provide minor but significant changes in configuration and deployment of the technology (if at the higher end of the TRL scale).

The framework can also help with assessing different scenarios, in terms of the uncertainty of the solution, and how this might impact the magnitude and timing of the potential emissions reductions.



3. Methodology

This section expands and discusses further some specific aspects and considerations of the methodology, and explores challenges and opportunities presented by the methodology. It is expected that as this and other related methodologies and approaches are used more widely, then the methodology will further develop and mature.

3.1 General principles

It is expected that the assessment of avoided emissions follows the GHG Protocol accounting and reporting principles of relevance, accuracy, completeness, consistency, and transparency. These are reproduced here from the GHG Protocol Corporate Standard:

Relevance Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of users – both internal and external to the company.
Completeness Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.
Consistency Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.
Transparency Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.
Accuracy Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Additionally, as the avoided emissions typically relate to a product or solution, it is recommended that where practical a life-cycle approach is taken to the assessment of the avoided emissions.

3.2 Materiality and refining of estimates

Another important principle is that of materiality – that is, the calculations and estimations should reflect the order of magnitude of carbon reductions and carbon emissions. Generally, more detail and better quality data is relevant for the most significant reduction potentials, while less detail is necessary for less significant areas. To understand the materiality, it is often useful to perform an initial high-level scoping assessment, which will identify the largest contributors to the carbon reductions.

This same principle should also be applied in relation to the scope and context of the assessment. For example, the same methodology can be used at a number of different levels:

- Assessing an individual product
- Assessing a company's net-positive product portfolio
- Assessing an investment portfolio including a number of companies
- Assessing future potential avoided emissions from an existing solution in a specific country
- Assessing future potential avoided emissions from a solution under development in a variety of countries

For each of these different scenarios, different levels of data quality and estimation techniques would be appropriate. This can be imagined as a funnel of assessments, and as the scope and context is refined and becomes more precise, then so do the data and estimation methods needed also become more precise.

A further future scenario, is where avoided emissions can be verified and traded. This would have an additional level of rigour and independent validation required, and more detailed protocol to specify the calculation methodology, which could be sector or product specific.

3.3 Identification of solutions

When selecting solutions to be assessed, it is natural to focus on those that are going to have the most significant reduction potential. However, it is important to not only look at those solutions and ignore other related solutions that may have a negative impact. To use an extreme example, a company has an advisory service for energy efficiency that is 5% of the total company operations. It would be disingenuous to discuss the positive impacts, by only looking at the impact from the energy efficiency portfolio and ignoring the negative impact if the other 95% of the company is advising on exploration of tar sand and coal.

It is important to consider all of a company's product portfolio to avoid the accusation of cherry-picking. Although there may be situations where a company assesses only one product or a few products, this should only be the case if the ambition is to eventually use it across the complete portfolio of the company's products.

A related issue is where multiple products have similar impacts, and there is the risk of double counting the avoided emissions where different products enable carbon reductions that overlap.

3.4 Disruptive solutions

Disruptive solutions are ones that render existing technologies obsolete and create new markets. Truly disruptive solutions are rare and difficult to predict, and often have multiple and unexpected consequences that may be both positive and negative from a climate change perspective. The nature of disruptive solutions means that they have the potential to enable significant avoided emissions, but there is also inherent uncertainty in their impact.

Assessing the future avoided emissions of disruptive technologies, requires some major assumptions about future market, adoption of the technology, behaviour changes, and success of the technology. Due to the potential scale of the impact, changes in assumptions will lead to significant range of results. Therefore, it is important to clearly state the assumptions used, and to perform some sensitivity analysis on the results. It can be useful to present different scenarios, to demonstrate the possible range of outcomes, as it is unlikely that there is only one valid scenario. It is always a brave and ambitious task to predict the future.

An example of a disruptive solution was the introduction and uptake of the mobile smartphone. This enabled new ways of working and interactions such as collaborative and mobile working, and has led to significant behaviour change. It has led to the ubiquitous rise of social media, and has been adopted at a massive scale world-wide.

3.5 Boundary

3.5.1 System boundary (Functional unit, direct emissions, LCA approach)

3.5.1.1 System boundary

The system boundary that is being considered should be clearly documented. The key principle of completeness should be followed – i.e. nothing should be deliberately left out, and also checks should be made for overlaps between different solutions which may deliver the same benefits and thus could result in double counting of the avoided emissions (see also section 3.11 on double counting).

The system boundary should clearly define what is included and what is excluded from the assessment. The following are examples of where there should be clarity over the inclusion or exclusion of specific items: embodied emissions of products; transportation of equipment and people; environmental control (e.g. cooling) of equipment; capital goods; and buildings.

In particular, a consistent approach and boundary definition should be adopted for both the BAU scenario and the enabling solution scenario.

It is also important to state clearly what secondary enabling effects are included (if any), and similarly what rebound effects are included in the system boundary. For example, longer term secondary enabling effects are often excluded due to the greater uncertainty relating to these, and that these typically relate to infrastructure changes such as reductions in building infrastructure or transport infrastructure. (This is also further discussed in sections 3.5.3 and 3.5.4).

3.5.1.2 Functional Unit

The functional unit defines the system boundaries in which the BAU scenario is compared to the enabling solution. This means that the functional unit should be applicable to both the BAU scenario and the scenario where the enabling solution is used. The functional unit should be clearly defined and measurable.

The functional unit will typically define the following three parameters:

- The quantity of the solution
- The time period for the solution
- The quality of the solution

For comparison purposes, it is useful to express the avoided emissions for an annual period, even if the study period is different. The avoided emissions may be expressed in terms of more than one functional unit, where that is useful – for example the avoided emissions for a year and also for a five year period. (Although if doing this, then it is important to check that the results do simply scale over a longer timeframe, or if other considerations need to be made.

It is also recommended to estimate the life-time avoided emissions for a product, as the impacts for infrastructure that may be around for decades is very different from product with a life time of just a few years. (See also section 3.5.2 for further discussion of timeframe).

Example – Functional Unit:
Video-conferencing: Different functional unit could be used to calculate the avoided emissions.

- Per video-conference for one year.
- Per video-conference room for one year.
- Per video-conference room for life-time of equipment.

3.5.1.3 LCA approach - Direct emissions from the solution

The direct emissions from the enabling solution relate to any emissions directly or indirectly due to the introduction of the solution. This can include embodied carbon emissions of the solution itself (e.g. carbon emitted during its manufacture) or energy consumption resulting from the use of the solution. Direct emissions, particularly the embodied emissions of the enabling solution, may be difficult to quantify and can, depending on the solution, be small in magnitude when compared to the primary enabling effects.[9] [10] [11]

The impact of the direct emissions should be acknowledged and documented, and where likely to be materially significant should be included in the calculation of the net avoided emissions.

Example – Direct emissions:
Video-conferencing: the direct emissions of the enabling solution are the embodied emissions of the video conferencing equipment, the energy use of the video conferencing equipment, and the emissions associated with the telecommunications networks used to transmit the video data.

Typically for video-conferencing, (as for most other solutions based on digitalisation), the direct emissions of the solution are relatively small compared to the enabling emissions. When this is the case, appropriate approximations can be used to estimate the direct solution emissions, ideally based on relevant previously published studies or using a screening assessment.

To assess the emissions of the solution a life-cycle approach should be followed covering all the life-cycle stages: raw materials, manufacturing, transport, use, and end-of-life. A pragmatic approach should be taken, so for example where the embodied emissions are likely to be small compared to the use stage emissions, then appropriate estimations can be used. If an existing LCA is available and appropriate, then it can be used, or alternatively a proxy may be used for a similar product. The approach taken will depend on the materiality and data availability.

3.5.2 Timeframe

Avoided emissions are often reported for a one year period. This allows for simple comparison between solutions, and takes account of any season variability. However, there are a number of cases where it is important to also look over different time periods.

For new solutions the adoption rate can change rapidly over months or years – thus both historic and predictive assessments should acknowledge this.

It may be useful to include a life-time emission reduction estimation. This makes it easier to highlight different important estimations and identify potential lock-ins. This would also be helpful to illustrate the benefit of solutions that have a short-lifetime compared to those with long term impacts. For example, there are other factors that should be included if you deliver a building or bridge that might be around for 100 years, compared to a mobile charger that might be around for 2-3 years.

3.5.3 Rebound Effects

Rebound effects occur when carbon emissions increase due to often unintended or ancillary use of the enabling solution. These may be excluded from the calculation of the avoided emissions, where it is difficult to quantify rebound effects due to data limitations. As is the case with secondary enabling effects, any identified rebound effects should be acknowledged and documented.

Rebound effects relate to an increase in emissions caused by consequential or unrelated effects of the solution avoiding the emissions. These effects are often unintended and often relate to difficult to predict behavioural changes that are either a direct or longer-term effect of the newly introduced solution.

Rebound effects are difficult to estimate as a number of different variables will impact the magnitude of the rebound effect. As a result, despite being widely acknowledged in theory, rebound effects are often not accounted for when calculating the avoided emissions of solutions.

Example – rebound effects:
Video-conferencing: Due to the availability and ease of video-conferencing, this is likely to lead to an increase in the number of meetings. This will be reflected in an increase in the use of video-conferencing facilities and equipment, which consequently leads to an increase in the electricity used for videoconferencing equipment, and other emissions associated with the facilities.

Most calculations simply acknowledge the possibility of rebound effects, without further quantification. This highlights a very important gap between the theoretical and practical approach of estimating avoided emissions. Many documents on the topic of avoided emissions highlight the importance of taking all effects, including rebound effects, into account when calculating the avoided emissions of a solution. Forum for the Future for example encourage the estimation of rebound effects by conducting 'new research or by making an allowance based on existing complementary research'.

Acknowledging and assessing rebound effects are particularly important when their impact has the potential to outweigh the positive impact of the avoided emissions. In these circumstances, the failure to quantify rebound effects could lead to wrong conclusions about the net carbon impact of a solution. In these situations the likelihood of the rebound effect outweighing the positive carbon impact should be assessed by conducting a sensitivity analysis, which tests the impact of changes in different variables. Furthermore, it is recommended to investigate, over time, the uncertainty around individual variables allowing for a more accurate calculation of the rebound effect.

If the rebound effect is assumed to be relatively small compared to the impact of the avoided emissions, the most practical solution is to simply acknowledge the likely impact of the rebound effect on the total avoided emissions estimated.

Where it is not practical to quantify the rebound effects, a useful step is to identify the potential rebound sources and to identify ways to counteract them.

One particular kind of rebound effect is where the financial savings related to the enabling solution are used for other activities that cause additional carbon emissions. For example, a new domestic heating system saves energy and also saves money. This money is used for additional weekend holidays resulting in increased flight emissions. However, the counter-point to this is that as society decarbonises the alternatives for spending additional disposable income will also become lower carbon.

3.5.4 Primary and secondary enabling effects

Enabling effects, directly or indirectly attributable to the use of the enabling solution, should be identified and assessed in order to calculate the avoided emissions. The enabling effects are subdivided into two types:

1. **Primary Enabling Effects:**
   Immediate reduction of BAU emissions occurring as result of the solution implementation.
   All primary enabling effects should be included in the calculation of the avoided emissions.

2. **Secondary Enabling Effects:**
   Secondary enabling effects are those expected to reduce emissions relative to the BAU system, but which occur over a longer timeframe or as a result of increased scale of adoption.

Secondary enabling effects (sometimes called indirect effects) tend to have an impact over a longer time period. As a result it becomes difficult to establish a direct correlation between the enabling solution and the enabling effect. There is uncertainty both regarding the likelihood of these effects occurring, as well as the scale of adoption. This makes it even more difficult to quantify secondary enabling effects. In addition, secondary enabling effects may lead to unintentional rebound effects.

Secondary enabling effects, therefore, are often excluded from the calculation of the avoided emissions. However, any identified secondary effects should be acknowledged and documented.

Example – enabling effects (video conferencing):

Primary Enabling Effects: the reduction in business travel enabled by video-conferencing reduces distance travelled and associated emissions.

Secondary Enabling Effects: As the number of business trips is reduced, the use and need for company cars diminishes, and as a result the total number of vehicles owned by a company may also decrease resulting in a long-term reduction in emissions from the manufacture of new vehicles. Similarly this could lead to a reduced number of new aircraft manufactured.

3.6 Baseline

A reasonable and reliable baseline or BAU scenario needs to be defined in order to measure the avoided emissions of the solution. The baseline represents the 'before' scenario of a specific process, i.e. what is the most likely alternative solution to be used to achieve a certain outcome in the absence of the enabling solution. The BAU baseline reflects the situation in the absence of the enabling solution. Defining the baseline is a crucial step of the methodology, as the baseline is used to compare the enabling solution against, and will impact the scale of the avoided emissions.

One of the most important decisions to make when calculating the avoided emissions of a solution is to decide what to compare it to, i.e. what should the baseline or the Business-As-Usual scenario be. The baseline represents the situation as it would be without the enabling solution in place. The chosen baseline should represent the most widely used alternative to achieving the same outcome. The question that needs to be asked is: 'What would have happened without the solution?' As the baseline emissions will directly determine the magnitude of avoided emissions, it is important to choose an accurate and reliable baseline.

One challenge in choosing the baseline from which to measure the avoided emissions is determining the most widely used alternative. For example, the alternative to speaking to friends on the phone is visiting them in person. But what is the most widely used transport method to do so? It is obvious that today cars are preferred to horse carriages, which would have been the main form of transport more than a hundred years ago (before the telephone was widely available).

The emissions of the

Replace the emissions of the

However, in other cases, where technology has only recently been replaced, the decision may not be so obvious. The issue is that if a baseline is chosen, which no longer represents the most widely used alternative, avoided emissions might be over or understated. Furthermore, even at a single point in time, there may be more than one possible alternative. For example, the most widely used alternative to using a phone to call your friends today may be visiting them by car, airplane or even bicycle. This case highlights that location is another important factor that will influence what is considered to be the most appropriate baseline.

Furthermore, one could also argue that the most widely used alternative to using a phone to call friends is now using Skype to call your family over the internet. This highlights that the baseline might be rapidly changing due to changing technologies or because of a change in human behaviour. As a result, the baseline needs to be continuously reviewed and updated if necessary.

Recognising the challenges of choosing the most appropriate baseline, it may be sensible to develop a scenario based on a combination of different alternatives.

3.7 Data quality

3.7.1 Uncertainty

Uncertainty describes how accurate results are or how close to the 'true' value a result is. Typically the uncertainty will relate to a statistical or probability assessment of the results. The calculation of avoided emissions typically uses various data sources including volume data and other factors to calculate the carbon savings. Often, the result is highly dependent on saving factors and assumptions, which have few data points and therefore cannot be analysed statistically. In this case it is not practical to perform a statistical uncertainty analysis. In other cases, where it is possible to perform an uncertainty analysis, the resource and time required may be excessive. An alternative, and a complementary approach, is to carry out a sensitivity analysis by varying some of the key parameters and assumptions to understand the impact on the result.

3.7.2 Assumptions

Where possible, avoided emissions calculations should be based on available primary or secondary data. In the absence of required data, appropriate assumptions may be made. Assumptions should be clearly documented along with a justification and evidence supporting the assumption. Ideally, assumptions should be based on surveys, reports or other credible published data. If conflicting information is available for one assumption, the most conservative assumption should be used in order to not overstate the avoided emissions.

3.7.3 Types of Data

Different types of data can be used to calculate the avoided emissions. The different types of data include: primary, secondary and modelled data. Primary data relates specifically to the solution being assessed, secondary data is derived from other sources, and modelled data is derived from modelling based on sampling, proxies and assumptions. Primary data will always be the preferred option, although primary data may be substituted with secondary data in the absence of available primary data. Modelled data derived from a number of assumptions may also be used, but only if no other primary or secondary data is available. The level of data quality, including any uncertainties, should be documented.

3.7.4 Sources

In order to prevent the use of assumptions and data from biased sources, multiple sources should be considered for a single parameter and compared against each other wherever feasible. The source that offers the most relevant information for the calculation should be identified during the comparison of multiple sources. For example, a study providing a specific piece of data might be geographic-specific and therefore not appropriate to use. In order to avoid using dubious sources, all sources should be checked for unreliable data or inappropriate assumptions. All sources should be documented and clearly referenced.

Company sources may often be considered as biased - but in many cases companies are the only ones that have access to actual measured data and are preferred for that reason. This perhaps demands more validation, but not to use company sources may lead to lower data quality in many cases.

It is important to consider both the quality and original source of the data used in the calculation of the avoided emissions from any solution. First, it is important to ensure the highest quality data is used with primary data being applied where possible. If primary data is not available, secondary data from published sources can be applied. Finally, in the absence of secondary and primary data, estimations can be made based on validated assumptions. Any assumptions should be clearly stated and substituted with more accurate data if this becomes available.

The source of data is also important and considerations should be taken with regards to location and date of the data source. Where there are multiple sources for data points, the most recent data should be used and it is also important to consider the context and background of the study from which the data came. This will indicate whether the data point is appropriate for the calculation.

To avoid using biased data or data based on inappropriate assumptions, all data points used in the calculation of avoided emissions should be, if possible, cross-checked against multiple other data sources to validate that the data point is feasible. Furthermore, it is best practice to document and reference all data sources used for the calculation of avoided emissions of specific solutions based on digitalisation opportunities.

3.8 Transparency

Transparency is crucial to the process of calculating the avoided solutions from a solution. It helps to provide confidence to stakeholders that the avoided emissions calculations are as robust and accurate as possible. Being transparent includes clearly documenting all assumptions, data sources, gaps and issues, provided that this will not compromise any commercially sensitive information.

3.9 Emission factors

Emission factors should reflect full life cycle emissions – for example emission factors for electricity should include generation, transmission and distribution, and upstream 'well-to-tank' (i.e. emissions associated with extraction and transportation of fuel used for electricity generation).

Future projections should use emission factors that reflect projected decarbonisation of the electricity grid, and decarbonisation of transport. Thus future reductions in electricity use and reduction in transport will result in less avoided emissions than the same reductions today.

Emission factors should be appropriate to the assessment and the purpose. However, there may be a conflict, for example, between using a locally relevant emission factor compared to using one which is appropriate to the technology being considered. There may be a trade-off necessary to address such conflicts.

3.10 Attribution (Allocation)

Often avoided emissions are the result of multiple products or services working together. Therefore one solution alone is not responsible for all the avoided emissions. There is currently no consistent way to allocate avoided emissions, thus it is common practice to attribute all of the avoided emissions to a solution where that solution has a fundamental role in enabling the avoided emissions. The test of a fundamental role may be determined by whether the avoided emissions would only be realised with the existing of the solution (i.e. if the solution did not exist would the avoided emissions still take place?).

Example – attribution:
Video-conferencing: videoconferencing has an enabling effect through avoiding the requirement to travel for a business meeting. For the video-conference to take place we can assume that the following is necessary: the video-conference equipment, software running on the equipment, and the telecommunication network. Without any one of these technologies the video-conference would not be able to happen, thus they all have a fundamental role in enabling the avoided emissions.

Thus, in this example, all 3 companies (the equipment provider, the software provider and the telecommunications provider) could claim the total avoided emissions.

There are some challenges with this approach, including:

1. There is 'double counting' (with multiple companies claiming the same avoided emissions)

2. The avoided emissions claimed by each participant does not necessarily fairly represent their role in the overall solution (e.g. one participant may only have a minor role, but is still claiming credit for the total avoided emissions)

Companies have so-far not attempted to allocate avoided emissions because:

1. It adds an extra layer of complexity to an already expensive, complex and uncertain process.
2. Scope 3 carbon accounting allows for double counting. As an extension of an organisation's impact outside of their organisation, avoided emissions can be seen as analogous to an organisation's scope 3 impact (i.e. the positive side of their scope 3 impact) and therefore there is not a problem with double-counting of avoided emissions, so long as this is clear and transparent.
3. No obvious solution exists and no standards exist for assessment of avoided emissions.

An organisation may wish to allocate avoided emissions to different elements of the solution in order to communicate a 'fairer' picture of the positive impact they are playing. This may help drive organisations to innovate further and deliver solutions with a positive carbon impact.

A successful attribution methodology would meet the following criteria:

- Practicable (i.e. data exists that could be used for calculations, or could be easily measured)
- Objective (i.e. reduces how arbitrary an attribution is)
- Accessible (i.e. easy to understand)
- Fair
- Affordable
- Transferrable (i.e. can be consistently applied across different products / companies / sectors)

Possible attribution approaches to consider:

- Allocate equally between all different elements
- Financial cost attribution
- Financial value attribution
- Stakeholder consensus

3.11 Double-counting

Double counting of avoided emissions should be avoided where possible, although there are some cases where it may be valid to have double-counting. If this is the case, then this should be clearly stated and explained. Some possible situations involving double-counting of avoided emissions have been mentioned previously and are discussed further below:

- Accounted for in multiple contributors to the same solution
- Accounted for in other GHG scope of the company
- Accounted for by overlapping product of the same company

Accounted for in multiple contributors to the same solution
This situation has been discussed earlier in the section on 'Attribution' (see 3.10), and reflects the case where multiple products or services contribute to the overall enabling solution, and all claim credit for the avoided emissions. This may be valid, where this relates to products from different companies, as it is analogous to Scope 3 accounting, which by definition involves double-counting of emissions.

Accounted for in other GHG scope of the company
This situation is where a company is reporting its avoided emissions in comparison to its own Scope 1, 2 or 3 emissions and some of the avoided emissions are the same as a reduction in the company's Scope 1, 2 or 3 emissions. For example, if a company reports its avoided emissions in comparison to its own operational emissions, and it provides a solution that reduces the number of truck rolls required, and the trucks are owned by the company, then the emission reductions associated with the trucks would already be accounted for in company's scope 1 and 2 carbon footprint, and should not be included in the carbon abatement.

Accounted for by overlapping product of the same company
In the case where the avoided emissions of two products from the same company overlap, then the overlapping avoided emissions should only be counted once. For example, a company might provide vehicle telematics solutions, and also provide a mobile app to improve driver behaviour to its customers. Both these solutions enable carbon savings by improving driving behaviour. Where a customer has both the mobile app and the telematics solution, then the overlapping avoided emissions should only be accounted for once.

3.12 Best practices

These are some of the learnings from calculating avoided emissions by the companies. It is not intended as an exhaustive list, but aims to highlight some the key issues together with a discussion of how to address these, and how they impact the avoided emissions.

The following points highlight best practice when calculating avoided emissions:

- Where possible, **avoid using arbitrary assumptions** (e.g. 'we assumed 50% adoption'). Preferably, base all assumptions on data and studies, or undertake sample surveys to have a more factual basis.
- If there is high uncertainty about the assumptions then be cautious with the assumptions – i.e. understate the benefits and use conservative assumptions. And preferably present the results for different scenarios, and perform a sensitivity analysis.

- Documentation of assumptions and methodology should be sufficiently detailed that someone else could independently calculate the avoided emissions, and produce the same results. This adds credibility and may identify errors in the assumptions or calculations.
- It is best practice to carry out an Independent Review of the assumptions and calculations. This may be undertaken internally or externally. Guidance on carrying out independent reviews is provided in the GHG Protocol Product Standard,[12] Chapter 12: Assurance.
- Carry out sense checks on the assumptions, data and results:
  - Do the assumptions, data and results seem reasonable? Do they match with experience, are they credible? Often, expressing the savings in percentage terms helps to provide the context to do a reasonableness check.
  - Cross check against other data – compare with national statistics, other sources of data, and other studies. And where there are discrepancies discuss how the results differ, and the motivation for using specific data.
  - Carrying out both top-down and bottom-up assessments is another method to check how reasonable the results are. How close are the results from a top-down approach compared to a bottom-up approach? Do the two methods 'meet in the middle'?
  - Avoid using single source of data – some data and studies may not be representative, either because of the scope of the study, or because it was a trial under idealised conditions. Where possible get two or three sources for data and take a judgement as to which is the most representative, or take an average, or take the most conservative. Often an expert opinion may be more reliable than simply taking data at its face value, particularly where there is conflicting data, or the underlying assumptions behind the data are not clear.
  - Check the results against total sector emissions – expressing the avoided emissions results as a percentage of the total carbon emissions of the related sector (or of the total deployment of the original solution) will provide a very useful sense check. Is it reasonable that the scale of the enablement being considered is able to achieve this impact? For example, if the avoided emissions are more than 100% of the relevant emissions, then there is something wildly incorrect.
  - If reusing data from previous studies, check that the assumptions in the original study are relevant to the assessment being carried out. Are the same conditions applicable? Are the geographical and technological scopes the same?
  - Do the results pass the 'blush test'? That is, would you be comfortable to stand on a public platform and explain the results and the assumptions without fear of embarrassment and awkward questions that cannot be convincingly answered?

4. Worked Examples of Framework Application at a Solution Level

These three worked examples will help to illustrate how the methodology could be applied, and also include a discussion of the opportunities and challenges presented by these examples. These worked examples are currently being developed. A short description of each is included at present.

4.1 Mobility – Car club sharing

Car club membership is a low-carbon alternative to owning a private car, as it has been shown to reduce greenhouse gas (GHG) emissions whilst providing other benefits such as improved air quality and safety.

The car club model offers user private mobility without the commitment to car ownership, by allowing members to conveniently book vehicles on an hourly, daily or longer basis. Car club vehicles service a greater number of users and many members can either dispose of an owned vehicle or avoid purchasing one, resulting in avoided embodied emissions through reduced demand for vehicles.

At the same time, the per-use pricing of car clubs vs. the significant capital ownership of an owned car encourages the use of more sustainable modes of transport for shorter journeys or where good public transport links exist. Finally, car club vehicles are, on average, newer and have lower emissions than the private car fleet.

4.2 Buildings – Domestic heat pumps

This worked example considers replacing existing domestic heating by heat-pumps. The base case is the existing domestic heating systems, which may be gas, oil or conventional electricity-powered heating systems. The worked example is used to illustrate the calculation of the avoided emissions, and also considers the impact of different factors such as comparing different countries, different adoption rates, and different electricity grid decarbonisation rates.

4.3 Nutrition – reducing emissions intensity of food

This worked example looks at two ways that the emissions intensity of food could be reduced.

1. replacing animal protein based food with plant based protein
2. public information campaigns that provide information on low-carbon recipes and health related information, encouraging behavioural change to lower-carbon diets

The worked example illustrates the calculation of the avoided emissions, and also considers the impact of different factors such as comparing different countries, different adoption rates, and different options for the carbon intensity of the foods or diets.

Appendix 1 – Examples and References

Introduction

This includes a selection of related initiatives that are relevant for the concept of avoided emissions. These include related methodologies, standards, calculation tools, and examples of use by investors, companies and other organisations.

The list is purely meant to provide examples and references, and does not claim to be exhaustive or complete. Any omissions or errors are the responsibility of the authors of this document and do not reflect the organisations themselves.

It is intended that this list may be extended and added to in future.

Examples

The following table summarises examples of related initiatives. (Note: table to be completed).

Initiative	Category	Brief Description	Reference
FTSE Russell Green Revenues data model and Green Revenues Classification System	Classification Framework	The Green Revenues Classification System defines the 60 industry subsectors which are supporting the transition to a green economy within eight broad sectors: energy generation, energy equipment, energy management, energy efficiency, environmental infrastructure, environmental resources, modal shift and operational shift. The data model then measures how much of a company's revenue is linked to a green good, product or service.	https://www.ftserussell.com/financial-data/sustainability-and-esg-data/green-revenues-data-model
WWF Climate Solver Tool and methodology	Tool and Methodology	The Climate Solver Tool is an online platform that estimates the avoided greenhouse gas emissions and energy use from an innovative product. The calculations are based on the potential market for an innovation, the climate impact of the innovation, the climate impact of a baseline scenario and the estimated market share for the innovation. The tool was launched in 2012.	http://www.climatesolver.org/
Climate Impact Forecast (CIF) assessment tool	Assessment tool	The Climate Impact Forecast tool was developed by Climate-KIC, which is a public-private partnership that works on innovative ways to adapt to climate change. The tool allows a business to assess whether a product or idea has a negative or positive carbon footprint compared to the product or idea it is replacing. The user can input data about their product and analyse if it reduces, prevents or replaces fossil fuels within different areas of production.	Tool to be launched shortly.
Carbon Delta 'green patent' approach	Methodology	Carbon Delta's 'Climate Value-at-Risk (VaR)' methodology analyses the amount of patents a company has and categorises these into which are green as a predictor for low carbon profits. Patents are evaluated on their market potential, cost and monetisation strategy and are combined with other patents to determine how much a company's portfolio is green.	https://www.carbon-delta.com/

Appendix 1 – Examples and References

Initiative	Category	Brief Description	Reference
'Business Sustainability 3.0' - Lausanne	Methodology	The Business School Lausanne (BSL) in Switzerland has developed a methodology called True Business Sustainability/Business Sustainability 3.0. This approach evaluates the level that sustainability is integrated into a business and helps them take advantage of the benefits of aligning actions to the Sustainable Development Goals.	https://www.bsl-lausanne.ch/business-sustainability-typology/
WHEB Sustainability Fund and Impact Report	Investment assessment	WHEB's strategy is to invest in companies that benefit from, and enable, the shift to a more sustainable economy. The WHEB Sustainability Fund groups different environmental investment themes that are then used to calculate the green credentials of the fund. WHEB assesses the companies in the fund and measures the total ability to save energy, generate clean energy and avoid emissions to calculate an avoided emissions figure.	http://www.whebgroup.com/media/2017/05/WHEB-Impact-Report-2016-1.pdf
Blackrock - Laurence Fink open letter Jan 2018	Open letter	Blackrock is the world's largest investment management company with over $6.3 trillion in assets. Blackrock have published reports on adapting investment portfolios to climate change, detailing the risks and opportunities going forward. On 26 January 2018, Blackrock's CEO Laurence Fink sent an open letter about companies needing to think more about their long-term future and put purpose at the heart of their business, which has sent a clear environmental message to investors around the world.	http://www.ethicalcorp.com/comment-how-laurence-finks-letter-ceos-has-raised-bar-business
Transition Pathway Initiative (TPI) Methodology	Methodology and investment analysis	The TPI was set up between the investment bodies of the Church of England and the Environment Agency Pension Fund. It is supported by asset managers and owners with over £5 trillion under their control. The TPI assesses high-impact sectors, such as oil, gas and mining, to understand what the transition to a low carbon looks like and how businesses can adapt their business models. The analysis is also used to direct investment decisions and engagements with companies in an investment portfolio.	http://www.lse.ac.uk/GranthamInstitute/tpi/methodology/
Buildings EDGE tool for World Bank -	Standard and certification	The Excellence in Design for Greater Efficiencies (EDGE) is a sustainable building standard and a free online software that gives specific building stakeholders an insight into the most cost-effective options for resource-efficient design. The EDGE software and standard directs investments towards sustainable solutions that reduce water, resource and energy use, thus avoiding CO_2.	https://www.edgebuildings.com
IRENA avoided emissions calculator	Assessment tool	The International Renewable Energy Association, IRENA, has developed a tool to estimate the greenhouse gas emissions avoided each year as a result of renewable energy deployment in a country.	http://www.irena.org/climatechange/Avoided-Emissions-Calculator
Climate KIC Mitigation assessment	Methodology guidance	Climate-KIC invest in projects and solutions that help address climate change. All projects develop and implement products, processes, technologies, services and tools that can significantly reduce greenhouse gas emissions. Climate-KIC has developed a technical guidance that helps estimate the projects in terms of mitigating greenhouse gas emissions.	http://www.climate-kic.org/wp-content/uploads/2016/07/Guidance-Mitigation-Climate-Impact-Assessment.docx
Caring for Climate Initiative	Methodology	Caring for Climate is organised by the UN Global Compact, UN Environment and UNFCCC, and brings together businesses to tackle climate change. They published a paper in 2009 to provide an overview of the possibilities for calculating and reporting a company's positive contributions to societal emissions reductions.	http://caringforclimate.org/forum/wp-content/uploads/LCLP_Calculations.pdf
IFC GHG reduction accounting guidance	GHG reduction accounting guidance	The World Bank's International Finance Corporation (IFC) have published the 'IFC greenhouse gas reduction accounting guidance for climate-related projects' (May 2017). This is a technical guidance for IFC investment and advisory staff assessing the GHG emissions reductions for climate related projects.	https://www.ifc.org/wps/wcm/connect/21d21b80423bdbf19f39bf0dc33b630b/IFC+GHG+Reduction+Accounting+Guidance.pdf?MOD=AJPERES

Appendix 1 – Examples and References

Initiative	Category	Brief Description	Reference
ICCA and WBCSD avoided emissions guidelines for chemicals	Methodology guidelines	The International Council of Chemical Associations (ICCA) and the World Business Council for Sustainable Development (WBCSD) have developed guidelines for reporting avoided greenhouse gas emissions along the value chain of different chemical products.	https://www.wbcsd.org/contentwbc/download/1888/24018
LafargeHolcim avoided emissions protocol for cement-based products	Methodology	Protocol for quantifying avoided GHG emissions along the value chains of cement and concrete products.	https://www.lafargeholcim.com/sites/lafargeholcim.com/files/atoms/files/lafargeholcim-avoided-emissions-protocol.pdf
GEF Guidelines on GHG Accounting and Reporting for GEF Projects	Methodology	The Global Environment Facility (GEF) has developed guidelines for greenhouse gas emissions accounting and reporting for assessing GEF projects. It identifies the impact of a policy, action or project and then estimates a baseline scenario and compares it against a policy scenario and alternative solution in order to estimate the GHG reduction effect.	http://www.thegef.org/sites/default/files/council-meeting-documents/EN_GEF.C.48.Inf_.09_Guideline_on_GHG_Accounting_and_Reporting_for_GEF_Projects_4.pdf
GHG reductions enabled by solar PV systems	Academic paper	Academic paper describing a simple methodology for estimating the climate change mitigation of solar photovoltaic (PV) systems by calculating the avoided GHG emissions for specific PV applications in respective regions. Christian Breyer, Otto Koskinen, Philipp Blechinger.	http://www.sciencedirect.com/science/article/pii/S1364032115003317
ING	Investment fund example	In January 2018, Dutch Bank ING launched a €100m Sustainable Investments fund that will provide capital support targeted at companies with proven concepts that can deliver positive environmental impacts.	https://www.edie.net/news/6/ING-announces-EUR100m-Sustainable-Investments-fund/
Net Positive Project	Coalition and methodology guidance	The Net Positive Project is a coalition of organisations committed to developing a net positive approach for businesses. It has published frameworks and guidance principles for measuring and communicating an organisation's net positive approach. The Net Positive Project was launched in 2016 by Forum for the Future, BSR and SHINE, and had developed from the previous Net Positive Group (convened in 2013 by FFF, TCG and WWF).	https://www.forumforthefuture.org/project/net-positive-project/overview

Appendix 2 – Glossary

Avoided emissions

'Reductions in emissions caused indirectly by a product. This is where a product provides the same or similar function as existing products in the marketplace, but with significantly less GHG emissions'.

BAU baseline

The Business-as-Usual (BAU) baseline reflects the situation in the absence of the enabling solution.
The baseline represents the 'before' scenario of a specific process, i.e. what is the most likely alternative solution to be used to achieve a certain outcome in the absence of the enabling solution.

Enabling solution

The product, service, or technology that enables the avoided emissions.

Rebound effects

Rebound effects negate some portion of the enabling-effect avoided emissions due to additional changes in human behaviour within the system boundary caused by or related to the availability of the enabling solution.

Endnotes

1 https://climateactiontracker.org/
2 https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab
3 http://mission-innovation.net/wp-content/uploads/2018/05/MI3-Action-Plan.pdf (see under Goal 02).
4 It can be argued that financial accounting has existed for more than 7,000 years, with ancient accounting records having been found in Mesopotamia. The Roman Empire kept detailed financial records. Luca Pacioli, recognized as The Father of accounting and bookkeeping was the first person to publish a work on double-entry bookkeeping in 1494. The first international standard on GHG accounting was the ISO 14040 on life cycle assessment first published in 1997.
5 See the GHG Protocol Product Standard, chapter 11, sections 11.2 and 11.3.2. The Product Standard defines avoided emissions, but classifies them as outside the boundary of a product's life cycle, and as such must be reported separately from the product's life cycle emissions.
6 https://www.pamlin.net/s/Cybercom-Digital-Sustianability-full-report.pdf
7 http://www.ghgprotocol.org/standards
8 http://gesi.org/report/detail/evaluating-the-carbon-reducing-impacts-of-ict-an-assessment-methodology
9 Malmodin,J and Bermark,P. 2015. Exploring the effect of ICT solutions on GHG emissions in 2030. Ericsson. http://www.atlantis-press.com/php/pub.php?publication=ict4s-env-15
10 Ericsson.2011. Case study: Mobile Money Kenya : Life Cycle Assessment of ICT enablement potential. https://www.ericsson.com/res/thecompany/docs/success_stories/case_mobile_money_final.pdf
11 Ericsson.2009. E-health Croatia: Life Cycle Assessment of ICT enablement potential https://www.ericsson.com/res/thecompany/docs/success_stories/2009/e-health_croatia.pdf
12 GHG Protocol (2011), Product Life Cycle Accounting and Reporting Standard, World Resources Institute and World Business Council for Sustainable Development.

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