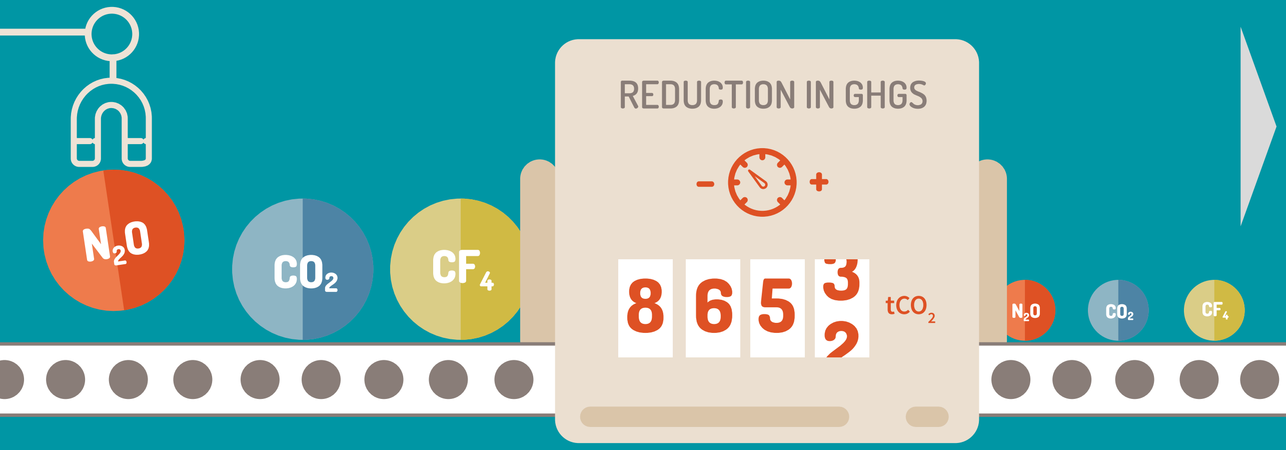
CLÉS POUR AGIR

QUANTIFYING THE IMPACT

OF AN EMISSION REDUCTION ACTION ON GHGS

VERSION 2

METHODOLOGICAL GUIDE



ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

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MINISTÈRE DE L'ENVIRONNEMENT, DE L'ÉNERGIE ET DE LA MER

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QUANTIFYING THE IMPACT OF AN EMISSION REDUCTION ACTION ON GHGS

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1. INTRODUCTION

Whether in compliance with regulatory requirements (Grenelle 2 Law No. 2010-788 of 12 July 2010, reaffirmed by the law relating to energy transition for green growth No. 2015-992 of 17 August 2015) or voluntarily, a large number of companies, organizations, local authorities and public bodies are currently taking action to reduce greenhouse gas emissions (GHG).

Whether part of a greenhouse gas emission balance assessment (BEGES) or the more general regional climate/air/energy plan (PCAET), these are iterative processes that are part of a results quantification process.

In fact, while the levers for progress relating to the reduction of GHG emissions have now been correctly identified, selecting relevant actions, defining the associated objectives and choosing the methods to implement continue to pose an operational challenge. Organizations must be able to adapt their efforts upstream, in line with the anticipated impact, and downstream, in relation to the results obtained during an implementation period: abandoning some relatively ineffective actions, stepping up efficient actions etc.

THIS PRIORITIZATION AND ONGOING DESIRE TO IMPROVE THE ACTIONS IMPLEMENTED CAN ONLY BE MANIFESTED IN CONJUNCTION WITH A PROCESS OF QUANTIFICATION, WHICH ALONE ENABLES CONSIDERED AND EFFECTIVE MANAGEMENT OF THE GHG EMISSION REDUCTION ACTION PLAN.

In light of the existing methodological shortcomings and following strong demand by those involved in the field, **ADEME has therefore provided a method to quantify the impact of an emission reduction action on GHGs. It is a practical step-by-step process that helps the user to characterize the intended action, draw up the consequence tree for the action and then identify and perform the calculations needed to arrive at a quantification.**

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This method enables the impact on GHGs to be quantified *ex ante*, midway and/or *ex post*. It provides environmental managers, liaison officers, elected officials and decision makers with every element they need to establish their GHG emission reduction action plan in the process of identifying, prioritizing, monitoring and measuring effort, and then reporting and making any adjustments necessary.

The method, which will hereinafter be referred to as "QuantiGES" for the sake of simplicity, is suitable for all organizations, whether or not bound by the regulations, that implement actions to reduce GHG emissions and seek to quantify the impact of these actions on GHGs.

For successful implementation of the method, it is recommended that the user has at least all the skills associated with the realization of a BEGES, from both the point of view of running the project - collection of data and management in particular - and of GHG accounting - access to suitable emission factors and relevant processing of action data. Expertise in additional concepts such as baseline scenarios and quantification scope will also be useful.

This methodological guide is based partly on the Greenhouse Gas Protocol[1] document and the principles of the ISO 14064-2 standard. It supplements the reference documents existing at national level: the regulatory method for producing BEGES[2], the Bilan Carbone® method and the ADEME Guide for assessing regional energy climate plans (PCET)[3].

IN ADDITION TO THIS METHODOLOGICAL GUIDE, AND IN ORDER TO ENCOURAGE ITS WIDEST POSSIBLE ADOPTION AND USE, THE FOLLOWING ARE ALSO AVAILABLE FROM THE ADEME BEGES RESOURCE CENTRE:

> A BLANK EXAMPLE OF AN "ACTION SHEET" to guide users in implementing the method. This is an Excel document, and contains the main points required to assist users in framing and producing their quantification[4]

> A COLLECTION OF "CASE SHEETS" applying the method to 52 concrete actions, together with all the related "Action Sheets"[5]

This is the second version of the guide to the method, enriched by improvements resulting from the 2015 experiments. The most significant changes are listed in Appendix 2: Main changes to the Methodological Guide. This new version does not in any way call into question the results obtained previously. Its aim is to clarify and refine the process in order to make it more robust and operational.

As GHG quantification methods, standards and tools are constantly evolving, the guide will change independently on the basis of experiential feedback collected by ADEME and/or through users of the current method.

1. Policy and Action Accounting and Reporting Standard, November 2014 – Available in French, English and Spanish http://ghgprotocol.org/policy-and-action-standard
2. www.developpement-durable.gouv.fr/IMG/pdf/Art_L229-25_Methodologie_generale_version_3-d.pdf
3. Comment construire et mettre en œuvre le dispositif évaluatif de mon PCET - http://www.pcet-ademe.fr
4. www.bilans-ges.ademe.fr/fr/accueil/contenu/index/page/evaluer+ses+actions/siGras/0
5. www.bilans-ges.ademe.fr/fr/accueil/contenu/index/page/2/siGras/0

2. BACKGROUND & CONDITIONS OF USE

2.1 DEFINITIONS AND ABBREVIATIONS

BELOW ARE THE MAIN ABBREVIATIONS AND DEFINITIONS REQUIRED TO OBTAIN A PROPER UNDERSTANDING OF THE DOCUMENT.

2.1.1 Abbreviations

BEGES: greenhouse gas emissions assessment (France)

CO_2e: carbon dioxide equivalent

CSQ: consequence

EF: emission factors

GHG(s): greenhouse gas(es)

PCAET: Regional plans for climate, air and Energy (France)

tCO_2e: tonnes of carbon dioxide equivalent

FIND OUT MORE

Please refer to Appendix 1: Terminology for the exhaustive list of terms used.

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2.1.2 Key definitions

Consequence tree	**Schematic tree representing all the consequences of the action in a cascade, starting with** its direct consequences then iteratively listing the consequences of those consequences and so on.
Emissions category	**All GHG emission sources.** Three emissions categories are distinguished: direct GHG emissions, indirect energy-related GHG emissions and other indirect GHG emissions. These categories are referred to as "scopes" in some international standards (cf. ISO 14064).
Consequence	**Change caused by the implementation of the action.**
Indirect greenhouse gas emissions	**GHG emissions resulting from the production of electricity, heat or steam imported and consumed by the organization** or that are a consequence of the actions of an organization, but result from greenhouse gas sources belonging to or under the control of other organizations.
Direct greenhouse gas emissions	**GHG emissions from greenhouse gas sources belonging to or under the control of the organization.**
External factor	**Element external to the action** and independent of its implementation that may influence its impact: e.g. a structural or climatic factor.
Impact on GHGs	**Refers to changes to GHG emissions as a result of the action.** Increases, reductions and the stabilization of emissions are all classified as changes in this context. The term "impact" is given preference over the term "effect" so as not to create confusion with certain types of consequences from the action, i.e. rebound, displacement and multiplier effects. The unit used to measure impact on GHGs is CO_2 equivalent (in tonnes, kilograms etc). *It is widely accepted that the impact of an action on GHGs assumes a negative value when the action causes a reduction of GHGs in the atmosphere and a positive value when it causes an increase of GHGs in the atmosphere.*
Non-GHG impact	**Refers to changes caused by the action on categories of impact other than GHGs.** These may be environmental (eutrophication, depletion of resources, water toxicity etc.) or societal (jobs, economy, safety, health, adaptation to climate change etc.).
Origin of emissions	**Processes and physical sources from which emissions result.**
Quantification scope	**Scope within which the impact of the action on GHGs is quantified.** This includes the concept of temporal scope (the period during which the impact of the action on GHGs is observed), consequences taken into account in the quantification and the GHGs taken into account in the quantification.
GHG sink	**Physical unit or process removing one or more GHGs from the atmosphere.** E.g. a tree, a carbon storage centre etc.
Baseline scenario	**A baseline scenario is a short-, medium- or long-term modelling exercise that** establishes what the greenhouse gas emissions would have been if the action had not been implemented, taking existing external factors into account as far as possible.
GHG source	**Physical unit or process expelling one or more GHGs into the atmosphere.** E.g. an internal combustion engine, thermal boiler, cattle etc.

2.2 OBJECTIVES AND LIMITATIONS OF THE METHOD

IT IS VITAL TO REMEMBER THAT THE QUANTIFICATION OF A REDUCTION ACTION MUST ALWAYS STRIVE TO COMPLY WITH THE FOLLOWING PRINCIPLES:

> RELEVANCE

Ensure that the quantification of GHG emissions appropriately reflects the effective modifications made by the action in respect of emissions and also meets the requirements of the decision-makers. The principle of relevance must be applied when defining the scope of study and selecting the data necessary for the quantification.

> COMPLETENESS

Include all relevant GHG emissions. Quantification takes into account all the sources of GHG emissions and the actions within a relevant study scope. Any exclusion of a source or action from the exercise must be documented and justified so as to be able to estimate the potential impact and relevance of the exclusion.

> CONSISTENCY

Use consistent methods to gather the data and quantify the changes observed in GHG emissions over time. All changes in data usage, scope and methods required for quantification must be able to be explained and documented.

> TRANSPARENCY

Provide clear information, sufficient to assess the credibility and reliability of the quantification exercise. Transparency is the degree to which information can be considered as being provided in a free, clear, factual, neutral, consistent and documented manner. Transparency also applies to the details of all calculation methods, hypotheses and uncertainties associated with quantification, and the referencing of the methods and sources of the data used.

> ACCURACY AND CAUTION

Reduce bias and uncertainties as far as possible so that the result of the quantification of GHG emissions is neither greater nor less than the actual reduction in emissions.

Note: the accuracy of the result obtained (the impact of the action on GHG) can be assessed using the confidence index. This establishes the use that can be made of quantification results in assisting decision-making and communications (cf. Stage 8 - Communicating and using results, p.75).

2.2.1 The method can be used to ...

QUANTIFY THE IMPACT ON GHGS ...

The impact of a GHG emission reduction action on GHGs is the variation in GHG emissions measured in tCO_2e that results from the implementation of said action.

In other words, the impact of an action on GHGs is the difference, over the observation period in question, between the GHG emissions in the baseline scenario (without the action) and those in the scenario with the action.

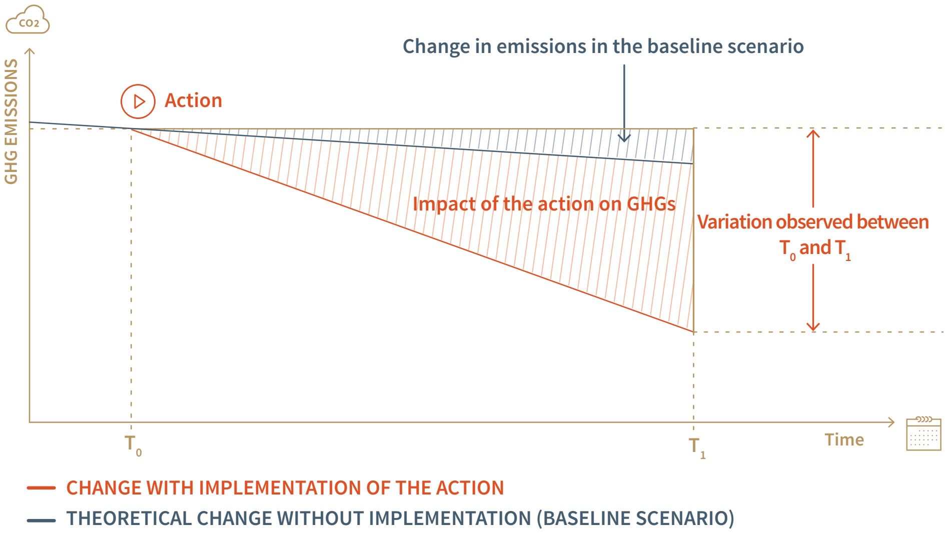

Figure 1: Impact of an action on GHGs.

The baseline scenario is the most probable scenario over the period in question if the proposed action is not implemented. By definition, it includes the factors external to the action, such as for example climate change (a more severe climate than in previous years etc.) and structural changes (a greater number of employees since the implementation of the action etc.). In practice, it often continues the trend being followed by the GHG emissions prior to the implementation of the action.

... AT VARIOUS KEYPOINTS IN THE ACTION

The objective of the method is to support the user in quantifying the impact of the reduction action on GHGs through an eight-stage process, irrespective of the point at which the exercise is undertaken:

> *Ex ante* (also known as *a priori* or "foreseeable impact")
The implementation of the action has not begun. Quantification makes it possible, for example, to determine the potential of an action, set a relevant objective appropriate to the context and/or contribute to the selection of the action from a number of alternatives. It should be noted that this *ex ante* quantification is required in terms of the BEGES regulations and also the rules relating to quantification for reduction projects (cf. ISO 14064-2);

> midway (also known as "intermediate")
The implementation of the action is under way; the quantification makes it possible - during the action - to monitor its correspondence with the objective set *ex ante* and to adapt the action guidelines as a result;

> *Ex post* (also known as *a posteriori* or "actual impact")
The implementation of the action has been completed or is integrated into standard long-term practice. The exercise enables the actual impact of the action to be quantified. *Ex post* quantification is used to verify the achievement of objectives, report on results and/or fuel reflection to help establish future directions and update the action plan of the organization .

... ACCORDING TO THREE LEVELS OF METHODOLOGICAL APPROACH

Of course, different levels of methodological precision will be required to quantify the impact of a reduction action on GHG, depending on whether it is undertaken *ex ante*, midway or *ex post*,This is why the ADEME method proposes three levels of approach so that the quantification effort in question can be suited to the objective being pursued:

01. Simplified approach
Moderate levels of time and resources are invested in the project;
this level of approach is generally suited to *ex ante* quantification.

02. Intermediate approach
Significant levels of time and resources are invested in the project; this level of approach is generally suited to *ex ante* or midway quantification.

03. In-depth approach
Substantial levels of time and resources are invested in the project;
this level of approach is generally suited to *ex post* quantification.

The level of approach is an indication of the initial effort the entity is prepared to put into quantifying the project. The aim is to match the quantification objective and target confidence index, i.e. in other terms match the anticipated use of the results (external communication, internal use etc.). **The confidence index for the result directly conditions the use that can be made of the quantification.** A detailed description of the correspondence between the levels of approach, target confidence indexes and quantification objectives is provided in Table 4 of §3.1.

2.2.2 The method cannot be used to ...

EVALUATE AN ACTION (IN THE BROAD SENSE)

The evaluation of an action, in the broad sense of the term, involves many aspects inherent in the implementation of that action: mobilization of resources, key factors for success, governance, mobilization of stakeholders etc. as well as the diversity of its direct or indirect impact on GHGs, socio-economic factors, health, toxicity, air quality etc.

The method proposed here is a single criterion evaluation and concentrates exclusively on quantifying of the impact of the reduction action on GHGs. Although it may provide elements that could contribute to a broader process (external factors, action consequence tree etc.), it is not intended for use in an exhaustive evaluation.

THE ECONOMIC APPROACH TO THE IMPACT OF AN ACTION ON GHGS

Following the quantification of the impact of an action on GHGs, organizations often wish to go further towards the economic interpretation of the result. However, this is not simple and requires a number of compromises.

Giving a value to the CO_2 tonne equivalent presupposes, for example, defining the cost of the action in addition to the impact of the action on GHG. The definition in itself raises a number of questions:

- Does it relate to investment costs and/or take account of maintenance and/or operational costs?
- How are the intangible benefits of the action, such as health benefits or improvements to employees' quality of life, integrated?
- How should one consider the cost of inaction?
- Should one take account of possible legislative changes such as the implementation of a carbon tax in future that would serve as an additional lever?
- etc.

Determining the exact cost of the action is a complex exercise and will be specific to each organization. More generally, one must be prudent in the economic approach to the impact of an action on GHG, both in calculating and interpreting the result. **This methodological guide does not therefore address the issue and merely covers the quantification of the reduction in GHG emissions with regard to the action being implemented.**

... EASILY ADD THE IMPACT OF INDIVIDUAL ACTIONS TO OBTAIN THE IMPACT OF AN ACTION PLAN OR PACKAGE

The method proposed applies primarily to **individual** actions to reduce GHG emissions.

In the case of an action whose description includes a set of non-homogeneous actions, and all the more in the case of an action plan, the issue arises of the addition of impact(s) calculated individually: can one break down a set of actions or an action plan into a sum of actions in such a way as to calculate the impact(s) separately, then add them together to obtain the overall impact of the set of actions or action plan?

In theory, there are two possible scenarios:

1. Either the fields of impact of individual actions do not intersect with one another, in which case the impact(s) can simply be added together because the actions are in fact independent.

*> **FOR EXAMPLE:** If one quantifies separately the impact on GHGs of a boiler replacement, the implementation of a corporate travel plan and a reduction in paper consumption, these three actions have no influence on one another, so the addition of the results will be valid.*

2. Or the fields of impact of individual actions intersect with one another, in which case every action is likely to influence the results of the others.

*> **FOR EXAMPLE:** If one quantifies separately the impact on GHGs of a boiler replacement, loft insulation and the installation of double glazing, the addition of the results of these three actions can only be valid if the quantification of the impact of each of the actions takes full account of the influence of the two others, in order to prevent any duplication.*

In such a configuration, the correct approach is to apply the quantification exercise directly to the set of actions or action plan as a whole, using action data representative of the overall impact of the set of actions or action plan.

*> **FOR EXAMPLE:** In the case of the implementation of a community travel scheme combining solutions favourable to the development of "soft" modes of transport (cycle paths, cycle parks etc.), carpooling (local Internet platform) and public transport (bus and train), the action data to be given priority for the quantification exercise will be the change in passenger-km for the various modal shares in the region. The total impact of the different sub-actions will therefore be taken into account with no risk of duplication.*

In practice, it is difficult to ensure addition in quantification exercises. So it is not generally recommended that the impact on GHGs of actions quantified separately be added together to calculate the total impact of those individual actions on GHGs.

ADDITIONAL INFORMATION ON THE LIMITATIONS OF THE METHOD

This method does not provide any type of methodological recommendation in relation to the realization of a BEGES by an organization, the means of drawing up an action plan or the selection of actions whose impact on GHGs must or can be quantified as a priority, nor on the means of correctly implementing actions.

Work carried out in parallel, particularly by the ADEME BEGES working group, is also available from the Bilans GES Resource Centre:
www.bilans-ges.ademe.fr

2.3 THE QUANTIFICATION EXERCISE WITHIN A CONTINUOUS IMPROVEMENT PROCESS

2.3.1 Quantifying the impact on GHGs: when and why?

ARTICULATING THE QUANTIFICATION OF THE IMPACT ON GHGS WITH OTHER PROCESSES

The quantification of the impact of an action on GHGs is a stand-alone exercise, but generally occurs within a wider process such as an eco-design, BEGES or PACET process, or even within a more comprehensive evaluation process (qualitative approach to implementation and governance or lifecycle analysis).

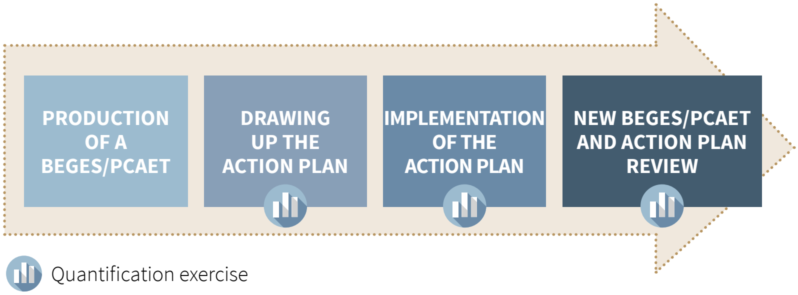

Figure 2: Potential quantification points in the context of a BEGES/PCAET process.

Whatever the context, quantifying the impact of an action on GHGs contributes to the overall process:

Overall process	Target	Objective	Taking account of direct and indirect emissions ...	What is the purpose of QuantiGES in this context?
GHG ASSESSMENT	Organization or Region	Assessing the climatic impact of an organization or region	... of the organization or region	**Enables the quantification of the impact of a reduction action**
ECO-DESIGN	Good or Service	Evaluating the environmental impact of a product or service	... on the good or service, from the point of view of its lifecycle	**Enables the quantification of the impact of an eco-design action on GHGs**
PCAET	Region	Defining and coordinating a regional strategy to combat climate change and air pollution	... in the region and/or property and community skills	**Enables the quantification of the impact on GHGs of an action implemented in terms of the PCAET**

Table 1: Articulation between this method and the main related environmental processes.

INTEGRATING THE QUANTIFICATION UPSTREAM OF THE ENTITY'S ENERGY-CLIMATE PROCESS

In an ideal configuration where the quantification of the impact on GHGs is an integral part of the process or progress from the outset, **the quantification exercise may occur at three key points during the implementation of the target action:**

1. Upstream of the action launch (*ex ante* quantification). The exercise helps to characterize the action, identify the field of action, external factors and their effects, and draw up the anticipated baseline scenario and necessary data (action data and emission factors) at the outset. The aim of this initial exercise is to quantify the projected impact of the action;

2. During the implementation of the action (midway quantification). In this case, the exercise targets the progressive optimization of the quantification (refining the calculation methodology, improving the data collection and monitoring system etc.) and as a result helps to optimize the management of the action (reorientation, adaptation of planning and/or resources etc.);

3. Downstream, after the action has been carried out (*ex post* quantification). This involves quantifying the actual impact of the action on GHGs using a set of specific data to report on, communicate and review the implementation of the action.

Ultimately, this iterative approach to the quantification exercise helps to guarantee more robust results. Over time, the quantification of the impact of the action on GHGs can be refined (by identifying all the external factors, indirect consequences of the action etc.), as can its implementation (e.g. by restricting undesirable indirect consequences).

The iterative nature of the process helps to facilitate data collection by progressively structuring and refining the relevant data set. *Ex ante* quantification enables the identification of the necessary indicators for monitoring the action and makes for a more robust process whilst midway quantification makes it possible to refine the methodology and data set available and progress the action. It helps to prepare the ground to theoretically enable the subsequent - and most reliable - quantification of the action.

2.3.2 Main methods for implementing a quantification exercise

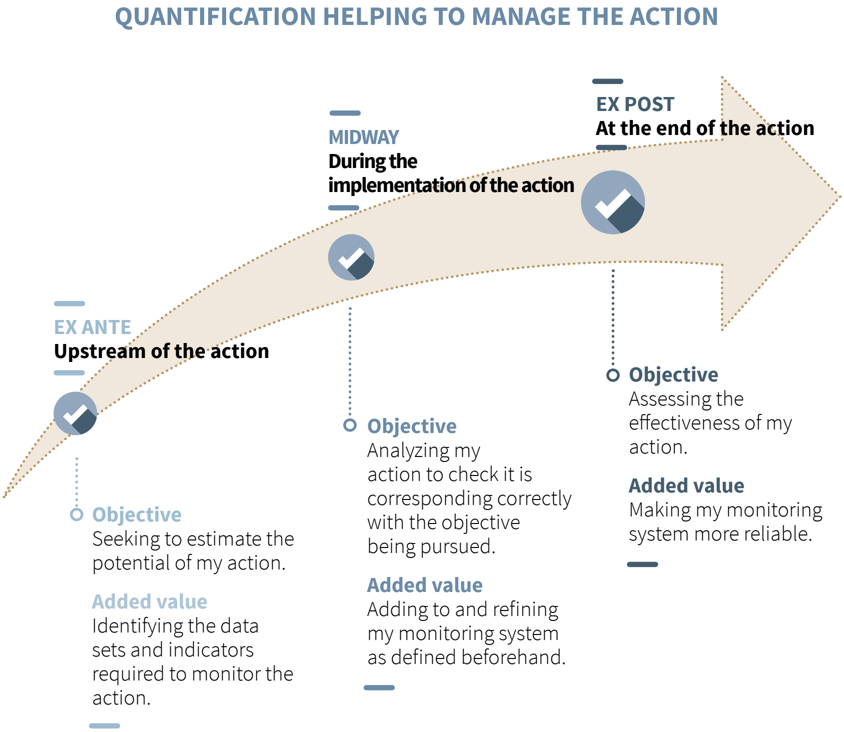

Figure 3: Principle of progressive improvement of quantification.

2.3.2 Main methods for implementing a quantification exercise

PARTICIPANTS TO BE MOBILIZED

The quantification exercise necessarily involves two main participants - in some cases this may in fact be one and the same person:

- **the proponent of the action,** who is the person responsible and who makes the decisions regarding the implementation of the action;
- **the manager of the quantification project,** who is the user of the method, and whose task is to quantify the impact of the action on GHGs. Depending on the context, they will hereinafter be referred to as the "exercise manager" or "user".

The exercise manager will be required to mobilize additional participants during the project.

- Experience shows that additional assistance is required while the consequence tree is being drawn up (*cf.* p. 36):
  - one (or more) people with excellent knowledge of every facet of the action;
  - a person skilled in GHG accounting;
  - and, as far as possible, another who has none of these skills but plays the role of the "innocent" in the process.
- The data collection process may mean approaching various participants, both internal to the entity (human resources, logistics, procurement etc.) and external (suppliers, transporters, customers etc.).

PHASING AND SCHEDULING

Although all quantification exercises can be organized differently, it is natural to structure the process to coincide with the stages in the method, described in detail opposite.

OUTLINE

STAGES 1 and 2

These involve the launch of the exercise: the proponent of the action and manager confirm the quantification objective and agree on a detailed description of the action.

It is also at this stage that they identify the participants they will mobilize during the following phases of the exercise, possibly in the form of a single project team for the entire exercise.

DEFINITION

STAGES 3 to 5

The major issues in this phase of the exercise are (1) identifying the relevant sources and sinks through the creation of the consequence tree and (2) defining the change scenarios as precisely and reliably as possible if (a) the action is implemented (action scenario) and (b) it is not implemented (baseline scenario).

QUANTIFICATION

STAGES 6 to 8

Once the scenarios have been described with the precision required, the descriptions must be translated in quantitative terms to arrive at the impact of the action on GHGs.

In practice, a substantial amount of work may be required to collect the data required for the calculation, during which the manager may need to approach people who are internal and/or external to the entity that is the proponent of the action.

Figure 4: The process, stage by stage.

The phasing given above is for information only and does not take account, for example, of the possible need for iterations between the different stages. The same reservations apply to the table below, the purpose of which is to assist in determining the working time and timescale required for the quantification exercise.

Phases	Actual working time for the exercise manager	Indicative length of the working phase
1. OUTLINE	2 hrs	2 hrs (meeting)
2. CHARACTERIZATION OF THE ACTION	1 day	2 weeks (including several meetings)
3. QUANTIFICATION	0.5 to 4 days (depending on the level of approach)	1 to 4 weeks (mainly data collection)

Table 2: Indicative workload and timeline for a quantification exercise.

USE OF A CONSULTING/ASSISTANCE SERVICE BY THE CONTRACTING AUTHORITY

It is not mandatory for the contracting authority to use a consulting/assistance service: the method may be used autonomously by the manager of the quantification exercise.

Nevertheless, it may be useful to consult a carbon consultant competent in the use of this method, particularly:

- when drawing up the consequence tree (Stage 3), particularly as they will be wearing two hats: carbon expert and external participant not involved in implementing the action;
- in order to draw on their expertise in existing databases during the phase quantifying the impact on GHGs (Stages 6 to 8);
- when programming and managing the exercise (depending on the manager's availability and experience).

Depending on the resources available for using an external service, this may be adjusted in such a way as to plan involvement limited to key points in the exercise and to verifying the relevance of work carried out and results obtained.

A framework to help produce a set of specifications is available from the ADEME BEGES Resource Centre[8].

8 www.bilans-ges.ademe.fr Rubrique Ressources > Plan d'Actions > Evaluer ses actions : la méthode

3.
THE PROCESS, STAGE BY STAGE

This section describes - stage by stage - the method enabling the quantification of the impact of an emission reduction action on GHGs. The eight stages summarized in the figure below are presented sequentially. An iterative approach may also be adopted however, to progressively optimize the quantification exercise.

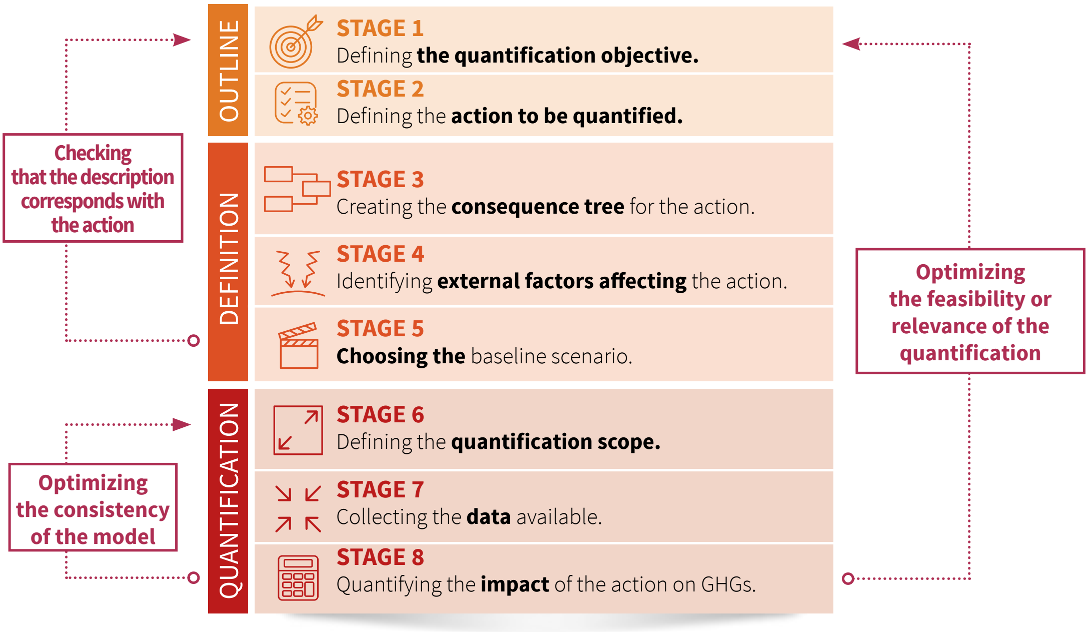

Figure 4: Flowchart summarizing the quantification process stage by stage.

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THE FOLLOWING SECTIONS EACH DESCRIBE THE STAGES IN THE METHOD, PROPOSE AN OPERATING MODE AND HIGHLIGHT THE PITFALLS TO BE AVOIDED. THEY ARE SET OUT AS FOLLOWS.

ISSUE: why do it?

Explains the usefulness of the stage in relation to the quantification exercise.

SUMMARY: what needs to be done

Presents a summary of the stage content.

A table helps to rapidly identify the sub-stages the method considers "compulsory" (essential sub-stages) on the part of the user and those it considers "recommended" (facilitating sub-stages). For additional information, the "standard" column indicates what the ISO 14064-2 standard requires in terms of the quantification of reduction projects.

IN PRACTICE: explanations, illustrations and practical advice

Introduces the elements needed by the user to implement the stage correctly.

APPLICATION to the main case study

In order to best illustrate the manner in which the method can be put into practice, we will refer throughout these eight stages to actual cases encountered during the 2015 experiments, when the method was trialled with 20 entities (businesses and communities).

We will follow **the main case study**, inspired by an actual case encountered (sheet 47), through all eight stages: the company Tartempion was implementing a car-sharing, carpooling system using electrical vehicles for its employees.

FIND OUT MORE

To find all case studies, please refer to Appendix 5: Practical cases from the collection of "2015 Case Sheets" in this guide. You can also find the elements detailed directly in the section entitled Évaluer ses actions – Les exemples ("Evaluating your actions - Examples") in the ADEME BEGES Resource Centre (www.bilans-ges.ademe.fr).
The complete "main theme" case study is available in Appendix 8: Complete main case study for this guide.

3.1 STAGE 1
DEFINE THE QUANTIFICATION OBJECTIVE

ISSUE: why do it?

The entire quantification exercise must be undertaken with the desire to achieve the objective for which the action is being quantified. Before any quantification, the question "Why quantify the impact of this action on GHGs?" should be asked, and answered clearly and precisely.

SUMMARY: what needs to be done

The user must explain the objective with which they are undertaking the quantification exercise together with the point at which the quantification will take place in relation to the timeline for implementing the action, then give the level of quantification approach they have selected so that the quantification meets the said objective.

	Sub-stage	Compulsory	Recommended	Standard	Find out more
# 1	Give the quantification point	✓			below
# 2	Give the quantification objective	✓			below
# 3	Give the level of approach selected			✓	p.22

Table 3: Details of Stage 1 requirements and recommendations.

IN PRACTICE: explanations, illustrations and practical advice

1. When is the quantification point?

In accordance with §2.2.1, the quantification can take place at different times: ***ex ante*, midway or *ex post*.** The point at which the quantification takes place in relation to the implementation of the action must be established at this stage. It inevitably orientates the objectives one can hope to achieve in that the definition of the action status, and more generally the information and data available, are strongly dependent on it.

2. What is the quantification objective?

Obviously, **the objective depends on the person asking the question.** Also, this preliminary stage consists of correctly identifying the objective of the decision-maker who requested the quantification.

The exercise can be undertaken to meet different objectives:

- have an initial idea of the potential of an action;
- estimate and interpret the anticipated reduction in emissions due to an action;
- choose from different actions;
- monitor the effectiveness and performance of an action;
- evaluate its contribution to achieving overall GHG reduction objectives;
- communicate on the effectiveness of a corporate strategy or public policy;
- facilitate the implementation of the most effective actions in terms of reducing emissions.

3. What is the level of approach of the quantification?

The quantification of GHG emissions relative to an action must be undertaken using resources (human and financial) that are suited to the intended objectives and the desired level of confidence. In fact, the level of confidence in the result obtained is directly dependent on the resources available as well as the exhaustiveness, reliability and precision of the data collected, the methodological choices made and the calculations performed.

The method defines three levels of approach (simplified, intermediate, in-depth), as shown in the table below.

Level of approach	Target confidence index	Scale of the field of study	Coverage of the quantification perimeter	Data types	Quantification objective
SIMPLIFIED	WEAK	Does not take much account of external factors and effects	Represents *at least* **60% OF THE TOTAL IMPACT**	• Data not particularly representative of the specific case studied • Generally based on statistical averages and data	**NOT VERY RIGOROUS** E.g.: have an initial idea of the potential of an action
INTERMEDIATE	CORRECT	Takes account of the main external factors and effects	Represents *at least* **75% OF THE TOTAL IMPACT**	• Data partially representative of the specific case studied • Generally composed of a mixture of average and specific data	**QUITE RIGOROUS** E.g.: choose between different actions
IN-DEPTH	OPTIMAL	Takes account of a maximum number of external factors and effects	Represents *at least* **90% OF THE TOTAL IMPACT**	• Data is the most representative of the specific case studied • Generally composed of specific data	**HIGHLY RIGOROUS** E.g.: communicating on the effectiveness of an action

Table 4: The 3 levels of methodological approach.

APPLICATION TO THE main case study

	Sub-stage	Illustration
# 1	Give the quantification point	Midway
# 2	Give the quantifica-tion objective	Monitoring the effectiveness of the action
# 3	Give the level of ap-proach selected	Intermediate

3.2 STAGE 2 DEFINING THE ACTION TO BE QUANTIFIED

ISSUE: why do it?

Clear presentation and a precise description of the action are necessary to prepare for the following stages. The better the action is defined, the simpler the quantification. This preliminary stage is also very important for the correct communication of the quantification results to the decision-makers and other interested stakeholders.

SUMMARY: what needs to be done

The user must describe in detail the action for which they wish to quantify the impact on GHGs.

	Sub-stage	Compulsory	Recom-mended	Standard	Find out more
# 1	Give the proponent of the action	✓		✓	
# 2	Give the name of the action	✓			
# 3	Give the status of the action	✓			p.27

	Sub-stage	Compulsory	Recom-mended	Standard	Find out more
# 4	Give the nature of the action		✓		p.27
# 5	Give the type of action		✓		p.28
# 6	Give the geographic location of the action	✓		✓	
# 7	Give a description of the action	✓		✓	
# 8	Give the main objective of the action	✓		✓	
# 9	Identify the origin of the GHG emissions targeted by the action	✓		✓	
# 10	Give the main sources of emissions by the proponent being theoretically targeted from an organizational perspective		✓		
# 11	Give the main sources of emissions by the proponent being theoretically targeted from a regional perspective		✓		
# 12	Explain the background prior to the realization of the action	✓		✓	
# 13	Give the main GHGs targeted by the action	✓		✓	
# 14	Give the start date for the implementation of the action	✓		✓	p.28
# 15	Give the length of the period required to implement the action	✓		✓	p.28
# 16	Give the start date for the main consequences of the action	✓			p.28

# 17	**Give the duration of the main consequences of the action**	✓			p.28
# 18	**Give the main action sector to which the action relates**		✓		
# 19	**Give any elements identified as documenting the action**		✓		
# 20	**Provide any other useful information**		✓		

Table 5: Details of requirements and recommendations for Stage 2.

IN PRACTICE: explanations, illustrations and practical advice

It should be ensured that the characteristics listed in the table below are described.

Information	Particulars/examples	Details
Proponent of the action	Which organization is responsible for the action?	
Name of action	What is the name of the action?	
Status of action	Is the action being considered, planned, deployed or integrated, or is it completed?	p.27
Nature of action	Is this a direct or indirect action?	p.27
Type of action	What type of action is this?	p.85
Geographic location	What is the site, facility or region to which the action applies?	
Description of action	Briefly describe the action	
Objective of action	What is the main objective of the action?	

Origin of the GHG emissions targeted by the action	What are the main sinks and sources targeted by the action?	
Sources of emissions targeted for an Organizational BEGES	Theoretically, what are the sources of emissions by the proponent targeted by this action for an Organizational BEGES? The split by source used can for example be that which is proposed by the regulatory BEGES method.	
Sources of emissions targeted for a Regional BEGES	*Theoretically*, what are the sources of emissions by the proponent targeted by this action for a Regional BEGES? For example: residential, services sector, agriculture, transport, industry, waste, domestic consumption.	
Background prior to the implementation of the action	Describe any element deemed to be relevant that describes the background to the implementation of the action.	
Greenhouse gas(es) targeted by the action	Describe the GHGs targeted by the action.	
Implementation start date	What is the date on which the action will start?	p.28
Length of implementation period	How long will the action take?	p.28
Consequence start date	What is the date on which the consequences of the action will start?	p.28
Length of consequence period	How long will the action consequences last?	p.28
Main action sector to which the action relates	What is the main action sector to which the action relates?	
Any elements identified as documenting the action	What documents can help to provide information on the action?	
Other useful information	As relevant.	

Table 6: List of characteristics of the action.

Some of these characteristics are explained in greater detail below.

1. What is the status of the action?

It is important to specify the context in which the quantification exercise is taking place in relation to the timeline for implementing the action inasmuch as the information availability, reliability and precision of the quantification change as the action progresses.

Status of action	Degree of deployment of the corresponding action	Quantification point
Under consideration	Action defined in its main outlines but not fully characterized	*Ex ante*
Planned	Action defined and sufficiently characterized for its correct deployment	*Ex ante*
Currently being deployed	Action initiated but its implementation is incomplete	midway
Integrated	Action implemented and now fully integrated into practices	*Ex post*
Completed	Action of limited duration, the implementation period of which is complete	*Ex post*

Table 7: The various possible action statuses.

The status of the action is characterised on the basis of the definitions given in the following table.

Note the distinction between the two different statuses relating to quantifications undertaken *ex post*, which correspond with two different types of action:

- **The action is completed if it involved the temporary modification of the action over an earlier period.**
  This can be the case with a limited-term financial incentive for example.
- **The action is integrated if it consists of a long-term modification of an action.**
  This is the case, for example, with the implementation of environmental criteria for an organization's purchases.

2. What is the nature of the action?

Establishing the direct or indirect nature of the action makes it possible to identify the nature of the main consequences of the action and consider the external factors that can influence them.

The direct or indirect nature of the action is defined using the BEGES Organization emission categories for the proponent of the action:

- **Direct action:**
  action primarily targeting the direct emissions in the BEGES of the proponent organization *(E.g.: replacing its boiler, insulating its premises, changing its vehicle fleet etc.).*

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• **Indirect action:**
action primarily targeting the indirect emissions in the BEGES of the proponent organization (*E.g.: working with its suppliers, optimizing freight, reducing the energy consumption of products sold etc.*) and/or emissions not appearing in this BEGES.

Generally, the goal of an indirect action is to galvanize one or more third parties into action through an incentive or obligation (*E.g.: for a local authority, offering financial assistance to its ratepayers for the acquisition of a condensing boiler; for companies, committing their suppliers to an eco-responsible production charter*), with the exception of actions relating to electricity consumption or leasing, indirect emissions for which the entity is responsible.

3. What is the type of action?

The 14 types of action are grouped into four different categories:

- **Physical:** modification of equipment or systems.
- **Organizational:** changes in organizational processes..
- **Behavioural:** changes in day-to-day behaviour.
- **Regulatory:** modification of rules.

The type of action is defined specifically to enable the user to base the implementation of the method on examples of quantification already undertaken for actions of the same type.

FIND OUT MORE

The detailed typology of reduction actions is presented in Appendix 3 of this document: Types of action.

4. What are the implementation and consequence periods of an action?

The implementation start date corresponds with the date on which the organization begins to change its operation whilst the **length of the implementation period** corresponds with the length of the period during which the organization is changing its operation. There are two possible scenarios:

1. The action is implemented in a limited manner over time, then stops. The corresponding period is then given (3 months, 4 years etc.);
2. The action is implemented over the long term and is integrated into the ongoing practices of the organization. The length of the action period is then given as "unlimited".

The start date of the consequences corresponds with the point at which the action implemented begins to produce consequences. This date often coincides with the action start date.

The length of the consequence period corresponds with the period during which the action produces consequences. There are two possible scenarios:

a. The consequences of the action occur over a limited time, then stop. The corresponding time is then given (9 months, 3 years etc.);

b. Theoretically, the consequences of the action occur over an unlimited time. The length of the consequence period is then given as "unlimited".

→ LENGTH OF CONSEQUENCE PERIOD ↓ LENGTH OF IMPLEMENTATION PERIOD	A limited time (a.)	Theoretically, an unlimited time (b.)
A limited time (1.)	**Possible** E.g.: introduction for one year of a shuttle to transport employees to their workplace.	**Possible** E.g.: improvement of insulation in a building.
Integrated into long-term practices (2.)	**Impossible**	**Possible** E.g.: implementation of a responsible procurement policy.

Table 8: Configurations relating to the combination of the length of the implementation and consequence periods of the action.

The various possible configurations are shown in the following table.

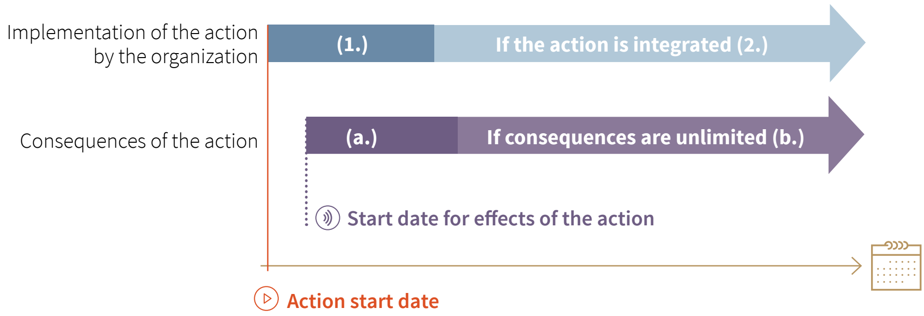

Figure 5: Correlation between the action implementation period and the action consequence period in the most common case.

These configurations may be expressed as follows:

In practice, in the most frequent situation, the implementation period of the action coincides with the period during which the consequences of the action are felt, i.e. for the figure above: (a) corresponds with (1) and, if necessary, (b) corresponds with (2).

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APPLICATION TO THE main case study

	Sub-stage	Illustration
# 1	**Give the proponent of the action**	(Organization) Tartempion
# 2	**Give the name of the action**	Car-sharing and carpooling service using electric vehicles
# 3	**Give the status of the action**	Currently being deployed
# 4	**Give the nature of the action**	Indirect
# 5	**Give the type of action**	Organizational action
# 6	**Give the geographic location of the action**	Organization's site
# 7	**Give a description of the action**	Providing the company's employees with a car-sharing/ carpooling service using electric vehicles, via a subscription system. The vehicles are rented. The priority target is the commute. For the moment, only one car is involved (4 people), but there is potential for 28 vehicles within the company.
# 8	**Give the main objective of the action**	Reducing the impact on the environment and the nuisance represented by vehicles in the village, whilst enabling the staff concerned to make savings.
# 9	**Origin of the GHG emissions targeted by the action**	Fuel consumption by vehicles with internal combustion engines
# 10	**Sources of emissions targeted for an Organizational BEGES**	Source 23 - Commuting
# 11	**Sources of emissions targeted for a Regional BEGES**	-
# 12	**Background prior to the realization of the action**	Prior to realization of the action, each employee came to work in their own internal combustion engine vehicle. At the end of 2014, a number of employees were faced with the issue of renewing their ageing personal vehicles (main use: commuting). It was decided to establish a vehicle rental service for employees.
# 13	**Greenhouse gas(es) targeted by the action**	CO_2
# 14	**Implementation start date**	March 2015
# 15	**Length of implementation period**	Action integrated over the long term (no end scheduled).
# 16	**Consequence start date**	March 2015
# 17	**Length of consequence period**	*Theoretically unlimited*
# 18	**Give the main action sector to which the action relates**	-
# 18	**Any elements identified as documenting the action**	-
# 20	**Provide any other useful information**	-

3.3 STAGE 3
CREATING THE CONSEQUENCE TREE FOR THE ACTION

ISSUE: why do it?

This stage is vital to the quantification of the action. As its name indicates, producing the consequence tree for the action makes it possible to identify the main consequences of the action and also the set of collateral consequences connected with it, all of which are likely to influence the result of the quantification of the impact on GHG.

*> **FOR EXAMPLE:** an action to tighten up the thermal regulations for buildings will generate an decrease in the energy consumption of buildings but increase the use of triple glazing, which will result in an increase in glass factories' production volumes and, as a result, the additional associated GHG emissions.*

The consequence tree must therefore be as exhaustive as possible, without prejudging the relative importance of the consequences and keeping in mind that not all consequences identified in this way will necessarily be the subject of a precise quantification. The consequences to be taken into account in the quantification of the impact on GHGs will in fact be determined in Stage 6, "Definition of the quantification scope".

SUMMARY: what needs to be done

The user must describe in detail the action for which they wish to quantify the impact on GHGs.

	Sub-stage	Compulsory	Recommend-ed	Standard	Find out more
# 1	Drawing up the consequence tree for the action in line with the creation rules.	✓			p.32
# 2	Explaining the hypotheses used to construct the consequence tree	✓			
# 3	Describing each consequence of the tree, as necessary		✓		
# 4	Indicating the origin of the emissions targeted for every consequence of the action resulting in an impact on GHGs	✓		✓	

Table 9: Details of Stage 3 requirements and recommendations

IN PRACTICE: explanations, illustrations and practical advice

The following section relates to Sub-stage 1 of this stage more specifically, i.e. the so-called creation of the consequence tree: it first sets out the rules to obey for the tree structure, then provides advice on the practical implementation of this work.

1 Creation rules

The consequence tree is represented on the flowchart model opposite.

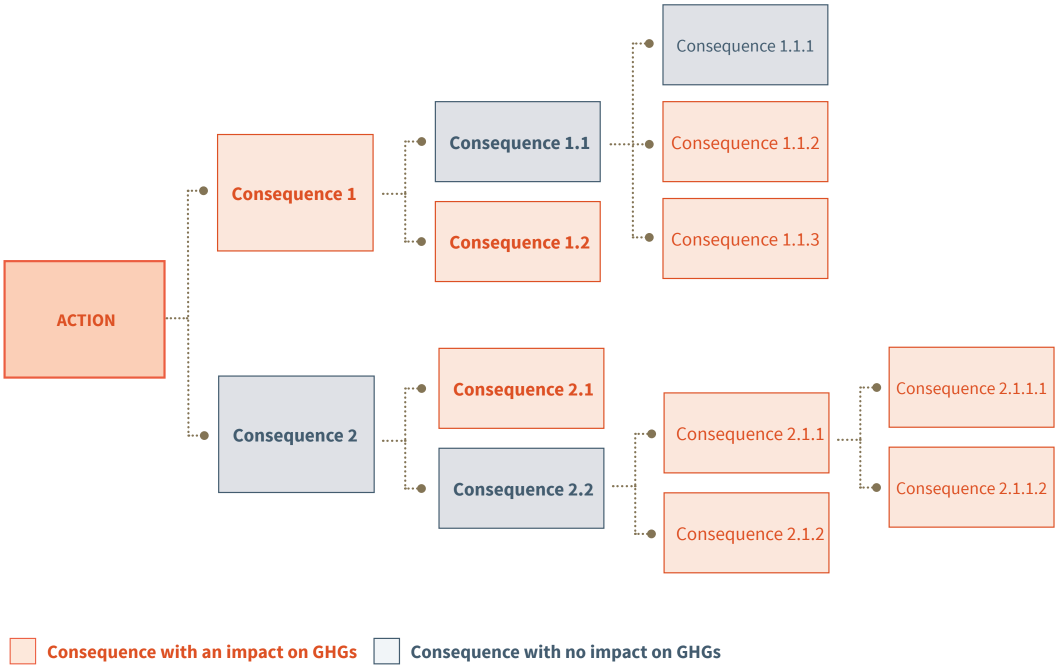

Figure 6: Generic model of the consequence tree for an action.

Rule 1: to create the tree, all the direct consequences of the action are identified, then by iteration, the consequences of the direct consequences, then the consequences of those consequences,etc.

Depending on the context in which the action is being implemented, the user may use hypotheses to justify the non-appearance of one or more consequences and more generally the choices made in the creation of the tree.

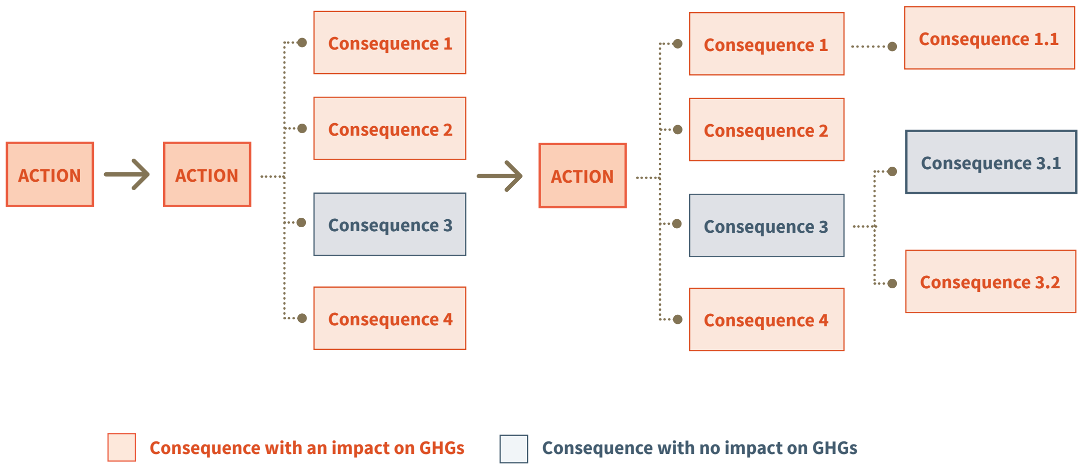

Figure 7: Schematic representation of the creation process for the consequence tree.

Rule 2: for each consequence identified, the tree indicates (via a set of different colours) whether or not this consequence has an impact on GHGs.

Although this is an exercise to quantify the impact of an action on GHGs, it is permissible to include a reasonable number of consequences in the tree that in theory have no impact on GHGs (economic, health-related etc.) if the user deems it important to highlight them to give a more exhaustive reading than the mono-criterion GHG reading alone.

Rule 3: for each consequence identified, the user indicates the origin of the emissions concerned in order to identify any interference between consequences.

In fact, as soon as two (or more) consequences have an influence on emissions from one source (or sink), these consequences are likely to interfere with one another. Then the impact on GHGs of the total of the consequences may be different to the total of the impacts on GHGs of each consequence considered separately.

*> **FOR EXAMPLE:** if an action provides a tax incentive for energy renovation work following the realization of an energy assessment, two priority areas will be identified. Firstly, insulation works (consequence 1), then changing the heating solution (consequence 2). If one wishes to quantify the reductions arising from the tax incentive, one cannot simply add the impact of the isolation works on GHGs to that of changing the heating solution because these consequences interfere with one another (overlap) by both influencing the same category of energy consumption within the building.*

Ultimately, identifying the origin of the emissions for each consequence helps to highlight the sinks or sources that will relate to several consequences of the action in question and therefore to identify the possible interference between consequences.

It is therefore recommended that the consequence tree be created, as far as possible, in such a way that each sink/source whose emissions will be changed by the action relates to only one consequence in the tree.

2 Representation convention

By definition, each consequence is associated with a specific impact on GHGs and is not the description of a previous consequence.

*> **FOR EXAMPLE:**Figure 8 shows a reduction in the quantity of cardboard bought (impact on GHGs linked to the production of the cardboard) that will result in a reduction in the upstream freight required for the cardboard (impact on GHGs linked to transporting the quantity of cardboard bought) and the volume of waste (impact on GHGs linked to the treatment of cardboard waste).*

However, to help understand the tree, it is possible to use "consequence headers", identified by a neutral colour code. These "consequence headers" will help to structure the tree, but will not themselves be the subject of a quantification. Only the consequences of the "consequence headers" may be subject to quantification.

*> **FOR EXAMPLE:** in the case of the tree in Figure 9, the consequence "1a - Drop in production in Germany" will not be quantified explicitly, but through the quantification of its four sub-consequences: 1a.1, 1a.2, 1a.3 and 1a.4.*

It is also possible to aggregate some consequences into a single consequence to make the tree easier to understand - the reverse process to creating "consequence headers". There is only one condition that must be observed: the aggregated consequence must take full account of all the consequences initially assembled under the "consequence header".

WARNING

When aggregating consequences, ensure that the emission factors planned for the quantification do indeed reflect all the unitary consequences aggregated. For example, in the case of the aggregated consequence shown in Figure 12 opposite, the emission factor used to calculate the impact of aggregated consequence 2 on GHGs ("Drop in use of cars") must incorporate the manufacture of the vehicle (corresponding with consequence 2a prior to aggregation), the upstream production of fuel (consequence 2b) and fuel combustion (consequence 2c).

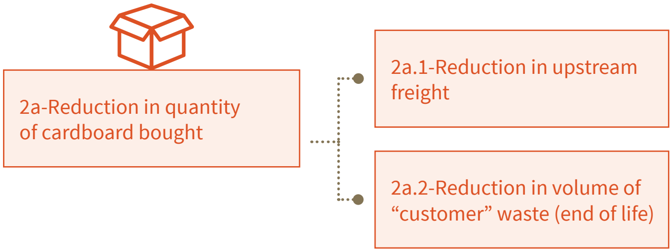

Figure 8: Example of consesquences of a consequence in a tree.

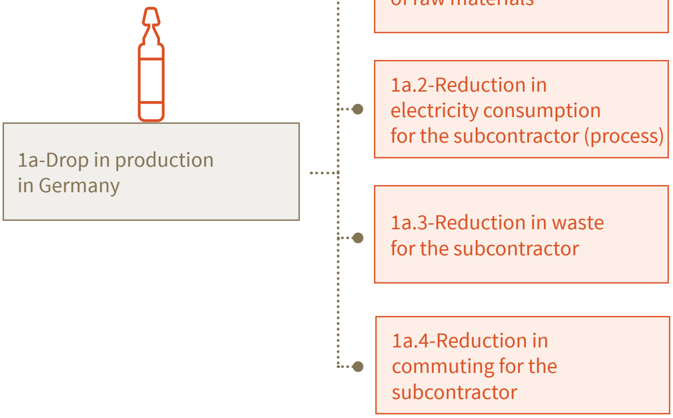

Figure 9: Example of consequence header (consequence 1a).

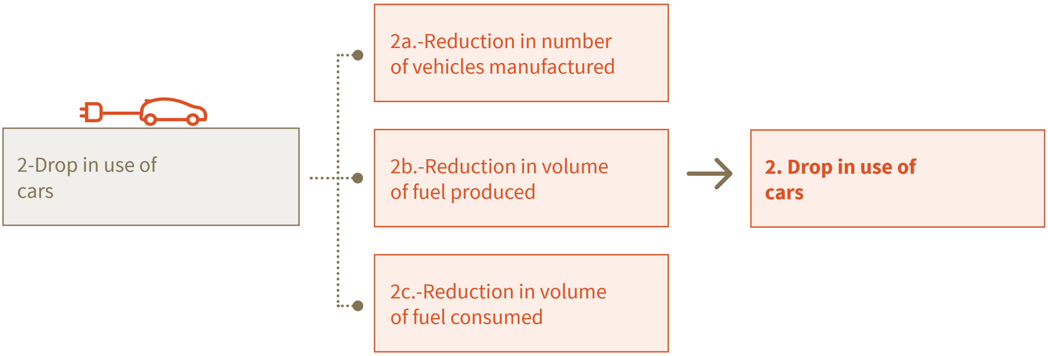

Figure 10: Example showing aggregation of consequences into a single consequence.

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3 Practical advice on implementation

> Upstream preparation

Before starting to create your consequence tree for the action, we recommend you do a number of other things.

1. Create a multi-discipline working group that will work with you to build the tree - ideally, one person with “carbon” skills, one person in charge (or nearly) of implementing the action and a third unrelated person who will enable you to challenge the result from an objective viewpoint.

Sharing and co-creating the tree will contribute genuine added value to its consolidation: identification of additional consequences, adjustment of branches to better relate to the available data etc.

2. Check that the title of your action is correct - precisely which action are you talking about? Like Stage 2 (“Description of the action”) this can seem trivial but a suitable description of the action is vital to launch the consequence tree correctly and ensure effective thinking.

3. Use experiential feedback that is already available to help you start your thought process. Over 50 examples of actions are already available from the ADEME BEGES Resource Centre[9] and listed in Appendix 5;

4. Remember that there is more than one solution. The action consequence tree is not a unique diagram, and shows the way in which the user interprets the action. If the exercise is undertaken correctly, even though its form may differ from one user to another, the tree will always show the same set of consequences, organized differently and in greater or lesser detail.

Furthermore, it is an **iterative exercise**: do not restrict yourself. This will be an initial outline that can be reworked and refined at a later stage.

> FOR EXAMPLE: *in the case of Case Sheet 35 (“Insourcing the production of Betadine unidoses”) another vision of the consequence tree could have been proposed. Figure 11 shows the tree as it was created during the 2015 experiment on the method: a general reduction/increase approach was applied (reduction of emissions in Germany vs. increase of emissions in France). Figure 12 offers a direct view of the action through the main sources of emissions: energy, waste, transport etc.*

9. www.bilans-ges.ademe.fr/fr/accueil/contenu/index/page/2/siGras/0

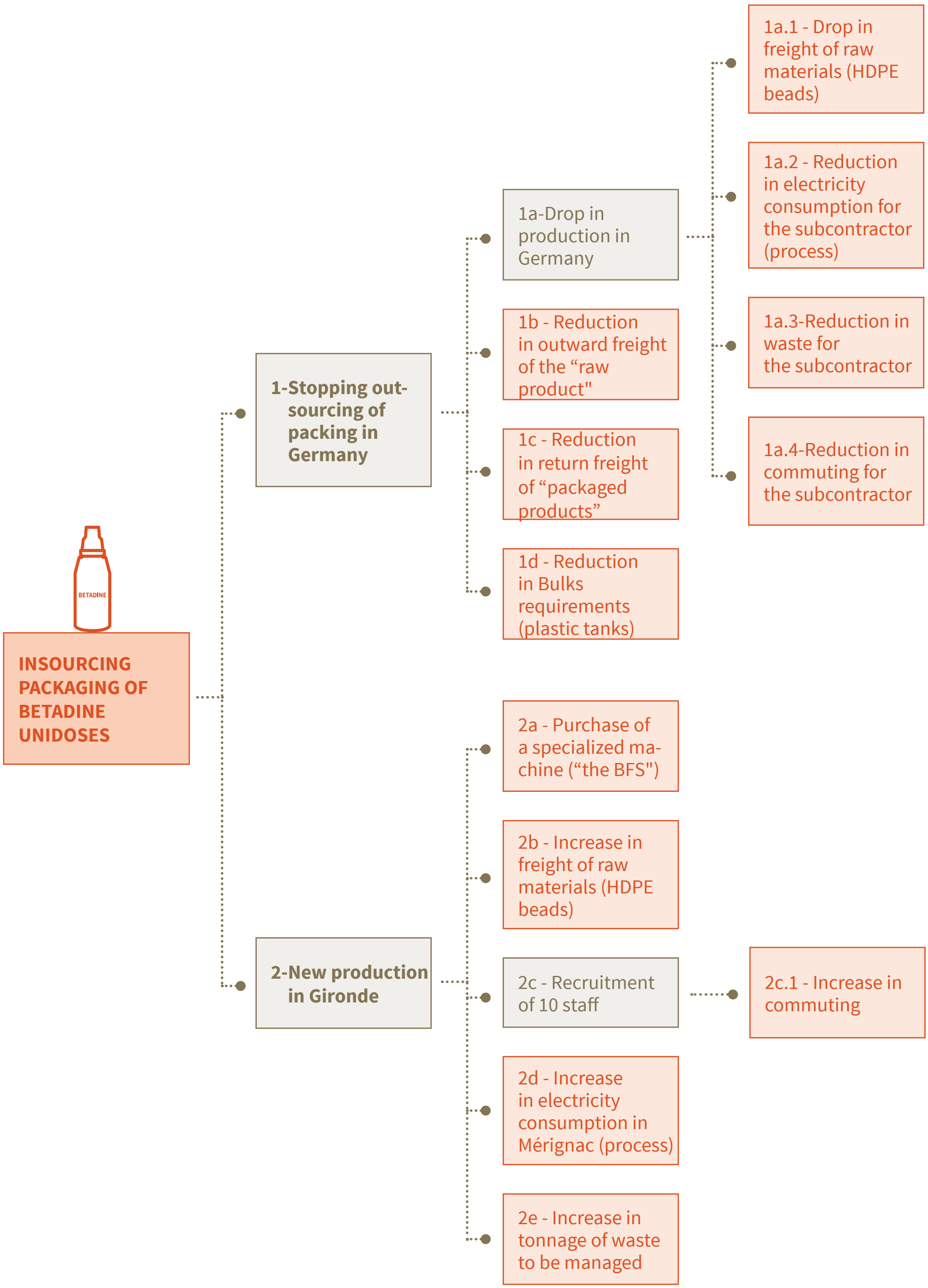

Figure 11: Consequence tree selected for Fact Sheet 35.

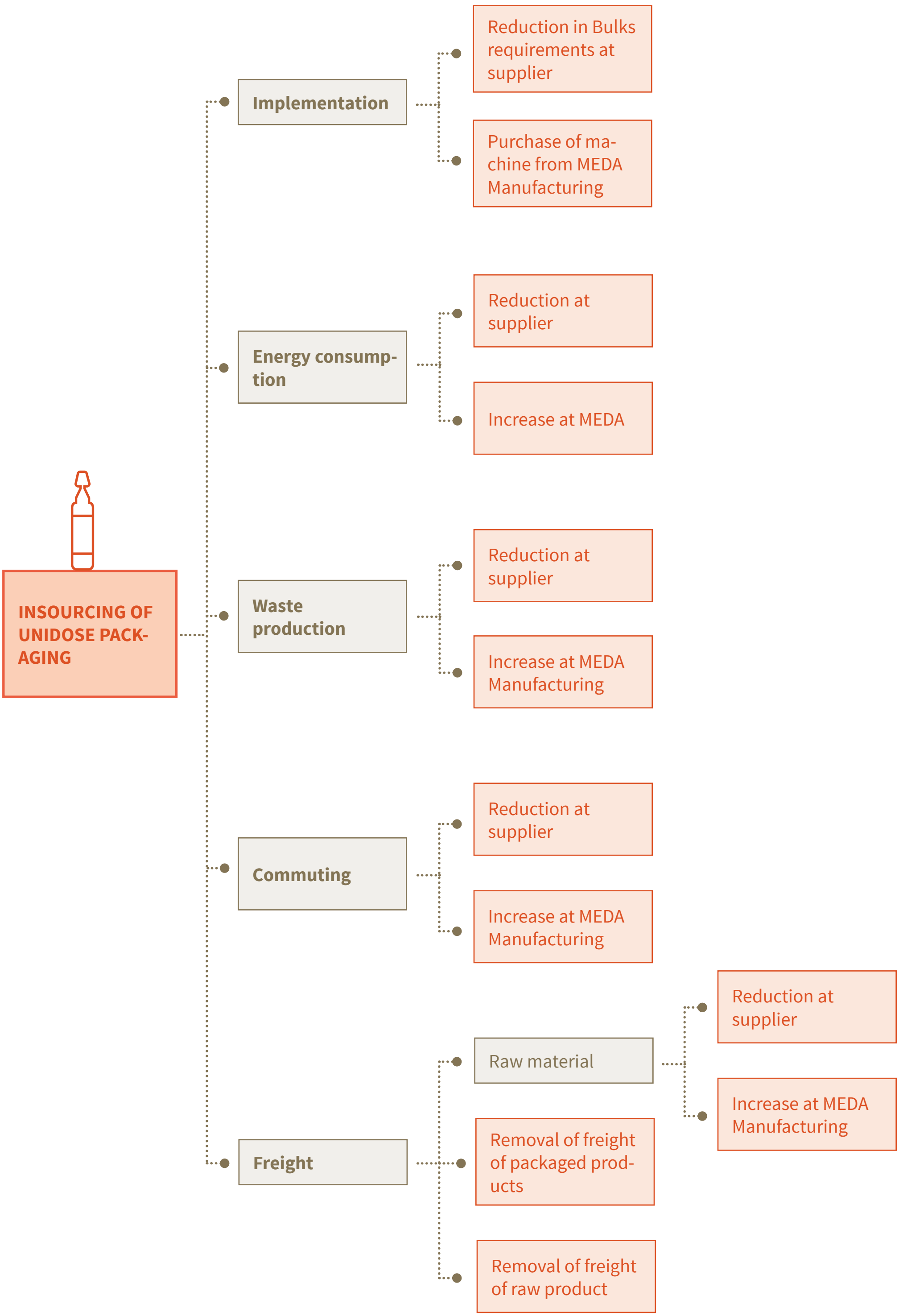

Figure 12: Another view of the consequence tree for Fact Sheet 35.

> How to start creating the tree

You have two options at the beginning:

1. Use the tree structure straight away as a resource for reflection.

2. Start with a brainstorming session on the consequences of the action: these will only be formatted and organized into a consequence tree at a later stage.

Whatever the option selected, a checklist of the main questions can help to fuel the thought process:

- What are the benefits you want the action to deliver?
- Does your action (or one of its consequences) result in changes in the production, use/maintenance and/or end of life of products or materials?
- Does your action (or one of its consequences) result in changes in energy consumption?
- Does your action (or one of its consequences) result in changes in the construction of infrastructure?
- Does your action (or one of its consequences) result in a multiplier effect?
- Does your action (or one of its consequences) result in a displacement effect?
- Does your action (or one of its consequences) result in a direct or indirect rebound effect?

NOTES

The multiplier effect arises when a consequence of the action consists in the total or partial reduction of its consequences in contexts other the initial action, for example due to its setting an example.

> FOR EXAMPLE: *if a company introduces an economic incentive to encourage the use of cycles for commuting, some of the targeted staff will adopt cycling for their commute as a direct consequence of the action. Nevertheless, whilst adopting this practice in this precise context, they may also increase the amount of cycling they do in their private life (in the evenings, weekends and holidays), which is then a multiplier effect of the action.*

The displacement effect arises when one of the consequences of the action has the effect of another consequence whose impact on GHGs offsets that of the initial consequence.

> FOR EXAMPLE: *implementing an action to assist the structuring of a wood-energy industry may put the supply of neighbouring regions at a disadvantage. In order to quantify the impact of the action on GHGs correctly, the quantification scope must include the consequences of the action relating to all the regions affected by the action, both directly and indirectly.*

This effect often occurs in a situation where it enables GHG emissions to be shifted (voluntarily or involuntarily) outside the immediate scope of the proponent of the action (legal, geographic, organizational or temporal responsibility), thus attenuating the visibility or vulnerability of the latter in respect of the corresponding GHG emissions.

.../...

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The rebound effect arises when some of the savings in resources achieved due to the action are offset by a change in behaviour of the beneficiary. As the action causes the resources available to it to increase (time, money etc.), this can in effect result in some or all of these additional resources being allocated to other consumption, which in general has the effect of decreasing the virtuous impact of the action.

It should be noted that the general issue of rebound effect quantification is complex: it is currently still the subject of research and experimentation and will in fact create difficulty when quantifying the impact of an action on GHGs.

We speak of a **direct rebound effect** when there is direct compensation.

***> FOR EXAMPLE:** after insulating their home, individuals can set the thermostat to a higher temperature because heating will be less costly than before.*

Conversely, we speak of an **indirect rebound effect** when there is indirect compensation:

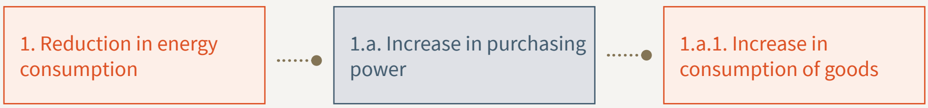
***> FOR EXAMPLE:** to use the same example: seeing their bill reduce, an individual buys another consumer product, which could also be a source of GHG emissions.*

In the consequence tree, the rebound effect can be represented in two distinct manners:

- included directly in the consequence connected with the rebound effect. It will then be taken directly into account when calculating the consequence;

A corrective factor is introduced when calculating the energy savings associated with the action.

- by way of an additional consequence.



> Structuring your tree

Given the experiential feedback currently available, it is not possible to extract a single tree structure, i.e. one that will allow every type of action encountered to be dealt with.

There are, however, several standard structures that can be highlighted. They can apply to either the overall structure of the tree or part thereof.

Construction in “Lifecycle”

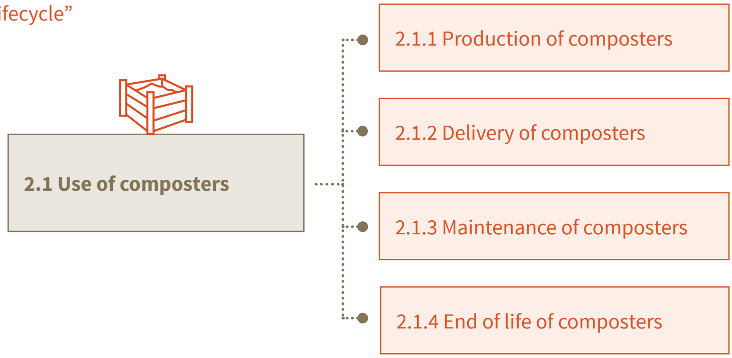


Figure 13: Example of standard structure in “Lifecycle”.

Creation “Implementation/Benefits/Setting an example”

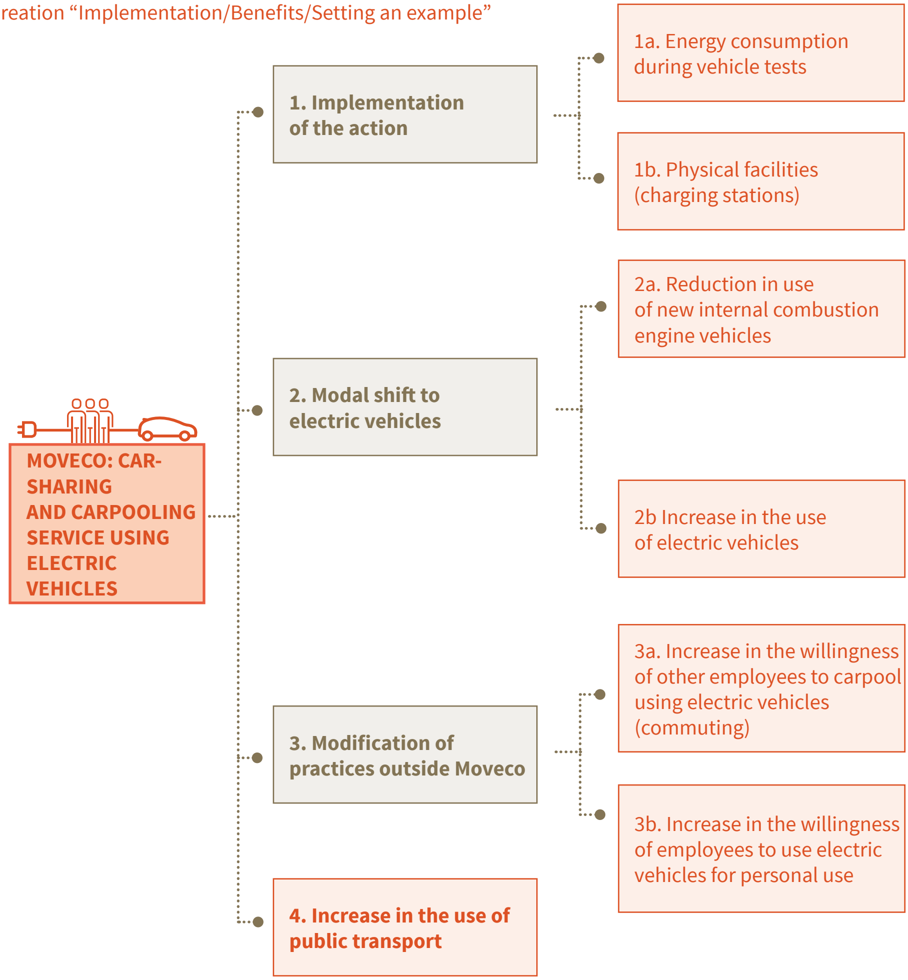


Figure 14: Example of standard “Implementation/Benefits/Setting an example” structure.

Creation by “Source of emissions”

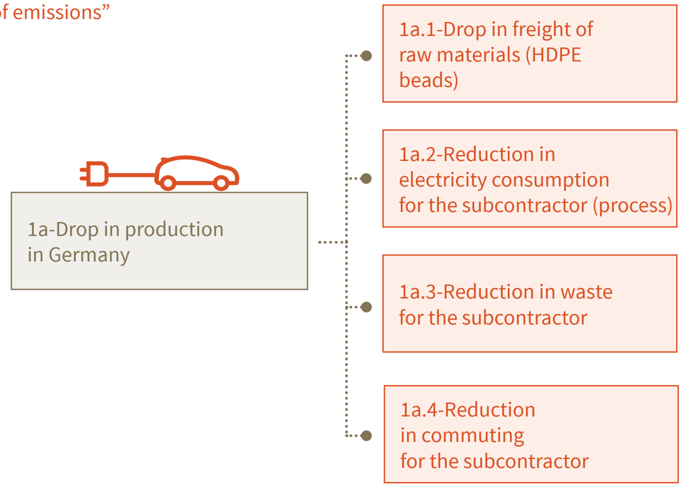


Figure 15: Example of standard “Source of emissions” structure.

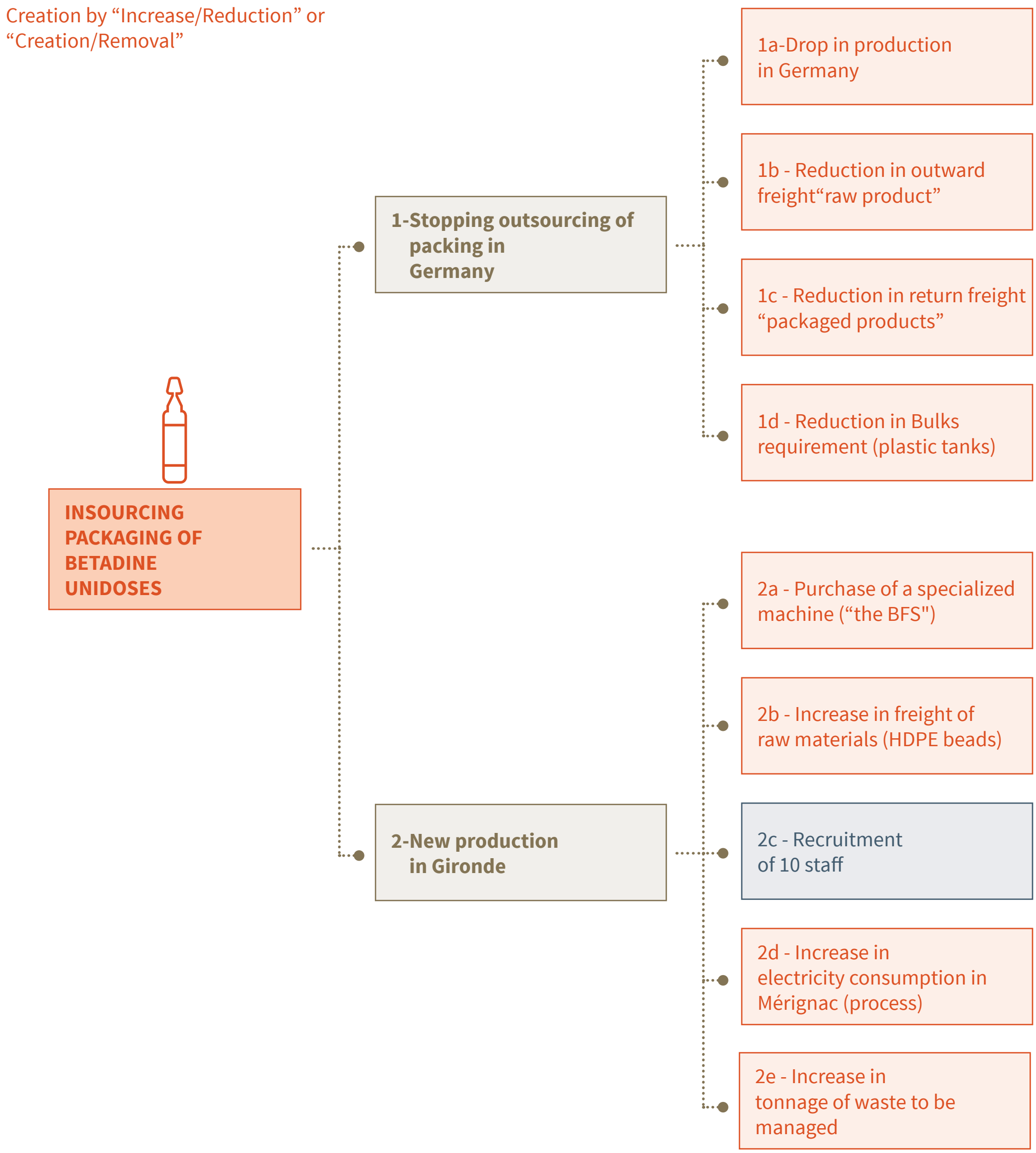


Figure 16: Example of standard "Increase/Reduction" structure.

> Finishing your tree

The extent of the cascade of consequences in the tree is left to the user's discretion.

Despite that, please do consult the brainstorming question checklist one last time to make sure you have not forgotten anything.

APPLICATION TO THE main case study

Sub-stage 1: consequence tree for the action

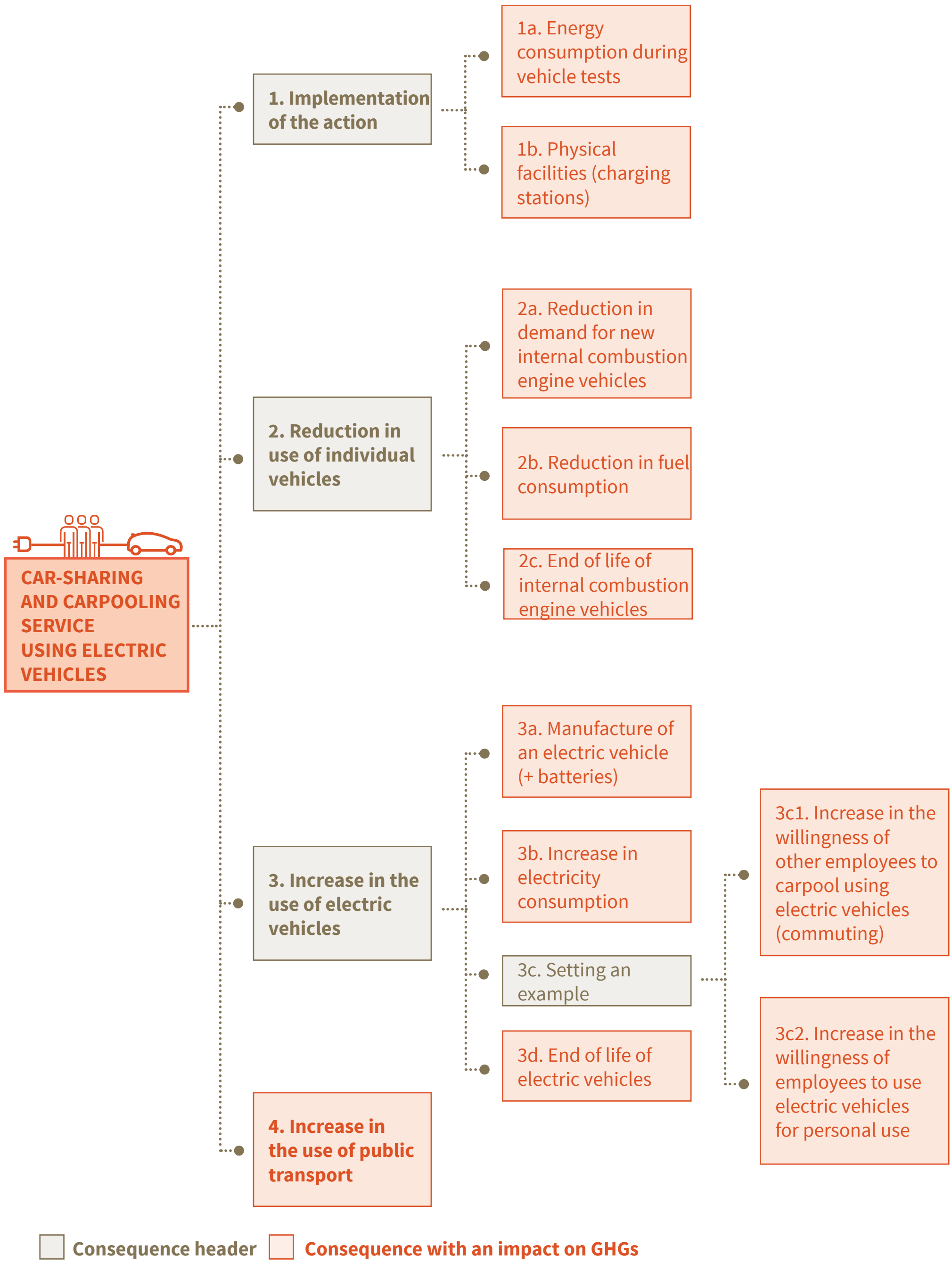


Figure 17: Consequence tree for the main case study.

Sub-stage 2: hypotheses used to create the tree

	Hypotheses
# 1	We will not include in the definition of the action any sub-leasing of the vehicle to local residents during the day (times when the vehicles are not used by employees), which is currently only an idea.
# 2	Inasmuch as the vehicles were parked in an underused public car park, the potential consequence "Reduction in parking spaces required" has not been included in the tree. These were GHG emissions relating to the downtime of the car park (the reduction in the number of vehicles reduces the spaces needed for parking).

Sub-stages 3 and 4: Description of consequences and identification of the origin of the emissions targeted (if necessary)

Consequence	Description	Origin of emissions
1	-	-
1a	The choice of vehicle was made after one day testing a number of vehicles	EV for test journeys
1b	Manufacture and installation of the charging station	Manufacture of the station and installation work
2	-	-
2a	Non-replacement of new private vehicles	Production of vehicles
2b	Reduction in fuel requirements due to car-sharing and carpooling using electric vehicles	Production and combustion of fuel by employees' vehicles - commuting
2c	Reduction in emissions relating to vehicles' end of life	Collecting and processing materials
3	-	-
3a	Manufacture of the EV and its battery	Manufacture of the EV and its battery
3b	EV for commuting	Electricity consumption of the vehicle
3c	Positive feedback could lead to a scaling up of the action	-

3c1	Other carpooling teams could be created internally at Tartempion	Same origin as the consequences of consequence headers 1 and 2 and for consequences 3a and 3b
3c2	Externally, employees persuaded by this initiative (carpooling and/or electric vehicles) could apply it to their personal travel	Same origin as the consequences of consequence headers 1 and 2 and for consequences 3a and 3b
3d	Collecting and processing the electric vehicle at the end of its life	Collecting and processing materials
4	One of the carpoolers (the one who lives furthest away) will use public transport to come closer to the others	Production and energy consumption of public transport

3.4 STAGE 4 IDENTIFYING EXTERNAL FACTORS AFFECTING THE ACTION

ISSUE: why do it?

The external factors must be identified and characterized in order to enable the impact of the action on GHGs to be correctly quantified: these factors affect not only the change in GHG emissions of the action scenario but also the baseline scenario.

SUMMARY: what needs to be done

The user must identify and characterize the factors external to the action, i.e. the factors that are not connected with the implementation of the action but whose effects will influence the consequences of the action and change its impact on GHGs.

	Sub-stage	Compulsory	Recommend-ed	Standard	Find out more
# 1	**Identifying and describing each eternal factor**	✓			p.47
# 2	**Indicating whether or not it has been taken into account in the quantification exercise**	✓			p.49
# 3	**Indicating the consequence of the tree on which each external factor operates**		✓		p.49

Table 10: Details of Stage 4 requirements and recommendations.

IN PRACTICE: explanations, illustrations and practical advice

Identifying the factors external to the action consists of analyzing each consequence of the tree established during the previous stage and reviewing the factors not connected with the implementation of the action that are likely to influence the change in the GHG emissions resulting from this consquence. It should be noted that when an external factor has an effect on a consequence of the action, it has the same effect on the consequences downstream - i.e. on the consequences of the initial consequence.

Describing an external factor consists of specifying what type of external factor it is and explaining the contextual reason for which this factor has an effect.

There are many types of external factors. In practice, the most frequently encountered fall into four categories, described below to assist the reader in identifying and characterizing them.

1 Examples of classic external factors

> The structural factor

The structural factor concerns a variation in population, number of pupils, building area, production volume, action volume etc. Depending on the variation observed (positive or negative), the impact of the action on GHGs may be over- or under-estimated.

> The climate factor

This factor concerns all the consequences sensitive to variations in climate (temperature, sunshine, rainfall etc.). Depending on the climatic variations observed between the baseline scenario and the actual situation, the impact may be over- or under-estimated.

The most commonly mentioned climate factor is that linked with temperature-sensitive energy consumption (heating and airconditioning). For example, in a harsh winter, an individual will have greater heating needs than in a mild winter. To factor this climate effect into the quantification, we use unified day degrees (DJU), which identify the degree of severity of a winter in a given place. The DJUs are a value that represents the variance between the temperature of a given day (average of minimum and maximum temperatures on that day) and a predefined temperature threshold (in a residential context, the baseline temperature is 18°C). Average annual DJUs (known as “normal”) vary in France from 1,400 for Corsica to 3,600 in the Alps and up to 3,800 in the Jura.

The climate factor can also occur in many forms and via parameters other than temperature alone. For example, it is common sense that the annual number of days’ rainfall has a direct impact - independently of temperature - on the effectiveness of an action targeting giving priority to a modal shift from the car to bicycles. In the same way, rates of sunshine will have a direct influence on an action aimed at prioritizing the use of solar energy as a substitute for fossil energy.

> The windfall factor (which gives rise to the well-known “windfall effect”)

Generally speaking, the “windfall factor” is when part of an action’s target group behaves in line with the incentive used to stimulate the action, without this change in behaviour being due to it. The term “windfall” refers to the fact that the targets concerned will benefit from the (often financial) compensation without any specific effort being required from them.

Practically speaking, windfall effects are often observed in the context of “financial incentive” public policies or actions. Without making a correction for the windfall effect, the impact of the action on GHGs will tend to be overestimated.

> The performance factor

As its name indicates, the performance factor seeks to take into account changes in the performance of equipment (vehicle, boiler, light fitting etc.) or process (manufacturing process, cultural technique etc.). Current standards are continuously pushing R&D towards equipment and processes that are more environment-friendly. Their environmental performance is constantly changing, particularly due to technological advances. Thus, the external performance factor can concern all actions with one or more consequences involving equipment or a process.

> FOR EXAMPLE: *in the case of an action to optimize loading a product for freight, it will be necessary to take account of the change in performance of the means of transport used in terms of fuel consumption, an external factor to the implementation of the action as such but one that will have a direct effect on its impact on GHGs. In the same way, an action aiming to substitute renewable energy for fossil energy in a production chain must take account of the possible improvement in energy performance of the production line in question.*

2 Representation of an external factor in the consequence tree

If an external factor influences a consequence of the action, it then automatically influences all the consequences downstream of that action in the same manner. For this reason and to make the tree more legible, external factors will only be shown in the consequence tree of an action as affecting the furthest upstream consequence to which they relate.

3 The usefulness of identifying external factors for the quantification exercise

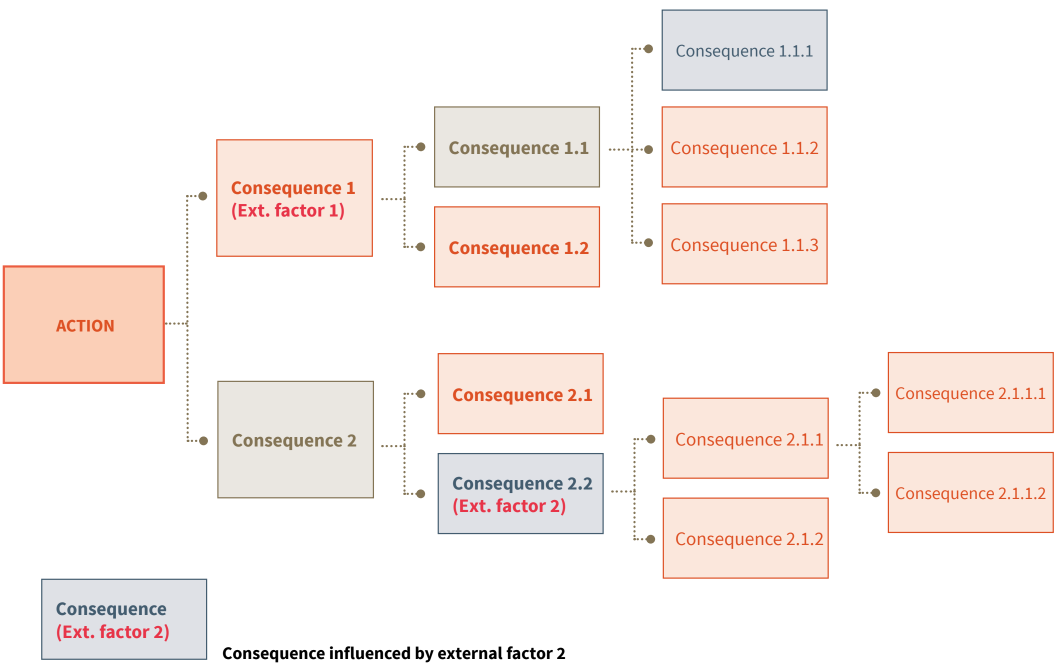


Figure 18: Positioning of external factors in the consquence tree.

Identifying and characterizing external factors is vital for the correct description of a scenario, whether it be the baseline scenario or one with action. This will help to manage the way in which they are drawn up and modelled, ensuring homogenous modelling of both scenarios in respect of all the contextual elements that are not connected with the action itself but which have an influence on one or other scenario.

The identification of external factors is particularly crucial when no actual measurement data is available to contribute to the description of the scenario. In fact:

- whatever the quantification point for the baseline scenario, this is naturally fictitious and cannot give rise to an actual measurement;
- in the case of an *ex ante* quantification (or in certain midway cases), no measured data can yet be collected to describe the action scenario.

In the case of an *ex post* quantification, the action scenario integrates the influence of external factors in the measured action data by definition. On the other hand, if the data used for the description of the scenario is not measured, one arrives at the same analysis as for an *ex ante* or midway quantification.

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	Sub-stage	Illustration
# 1	**Identifying and describing each eternal factor**	**Structural factor:** the number of kilometres travelled annually can be caused to change (employee moves home, prolonged absence etc.)
# 2	**Explaining how they are taken into account**	In the context of this exercise, one of the four employees involved in carpooling has just moved to a village further away, changing from 8,000 km per year to 15,400 km per year. To keep a constant scope between the baseline scenario and the action scenario, we will use the employee's new location, so the annual distance travelled will be 15,400 kilometers in both in the baseline scenario and the action scenario.
# 3	**Indicating the consequence(s) of the tree on which each external factor operates**	The structural factor operates on consequences 2b, 3b and 4.

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3.5 STAGE 5 CHOOSING THE BASELINE SCENARIO

ISSUE: why do it?

The impact of an action on GHGs is quantified by comparing the action scenario to a baseline scenario. The characterization of this latter scenario is therefore as important as the correct characterization of the action scenario.

SUMMARY: what needs to be done

The user must describe the baseline scenario[10], i.e. the scenario that is the most probable if the action is not implemented.

	Sub-stage	Compulsory	Recommended	Standard	Find out more
# 1	**Describing the potential baseline scenario(s)**	✓		✓	p.48
# 2	**Selecting the most probable scenario if the action is not implemented and explaining this choice**	✓		✓	p.50
# 3	**Determining the reliability score associated with the baseline scenario selected**	✓			p.52

Table 11: Details of Stage 5 requirements and recommendations.

IN PRACTICE: explanations, illustrations and practical advice

The baseline scenario is a virtual scenario, i.e. it will never become a reality. The choice of the correct scenario can therefore never be duly verified.

In practice, the user will be confronted with two types of situation (depending on the case): either the choice of baseline scenario appears obvious, in which case the issue at this stage is basically to ensure that this scenario is correctly described, or several alternative options must be considered and each option must first be described sufficiently accurately to enable the user to select the most probable and justify their choice.

1 Describing the potential baseline scenario(s)

Several techniques - possibly complementary - help to contribute to the precise description of a baseline scenario. Described and illustrated here are three approaches frequently used to describe a virtual scenario when an action is not implemented.

10. Frequently classified as a "business as usual" scenario.

> The continuation of a historic situation integrating the influence of external factors

It often seems as if a probable scenario when an action is not implemented is the continuation of the historic scenario, possibly integrating external factors identified during the previous stage. This is the case when it is sufficiently certain that the action concerned will be implemented. Even when this is obviously not the most probable scenario, it nevertheless remains a good candidate in the first instance, as one baseline scenario among several options.

***> FOR EXAMPLE:** to train a team of 12 drivers in eco-driving, the historic baseline scenario would be the average consumption of the 12 drivers before their training (year N) provided all things remained equal: number of kilometers travelled, vehicle model etc. In fact, the fleet of vehicles used by the 12 drivers could, for example, change from year N to year N+1 (replacement of one or more vehicles by more efficient models), giving rise to a reduction in average consumption independantly of the eco-driving training.*

> The use of a baseline standard

It is generally accepted that usual behaviour (i.e. unaffected by any action deliberately undertaken to change it) can be used as a baseline to describe what would have happened if the action had not been implemented. One can then hypothesize that if the action had not been applied to the target population, that population would have behaved according to the baseline standard.

"Population" in this case refers to a group of drivers, a set of new buildings (e.g. constructed to meet a certain standard), a range of domestic appliances (e.g. eco-designed to minimize their consumption during use) etc.

***> FOR EXAMPLE:** in the case of the construction of a set of new buildings according to the BBC standard, the hypothesis is adopted that, in the absence of BBC performance criteria, the set of buildings would have been designed and constructed in such a way as to comply with the regulatory thermal criteria in force at the time: in this case the thermal regulations constitute the baseline standard.*

> The use of a control sample

Control samples can only be used in the case of *ex post* quantification. This entails drawing up a baseline scenario for comparison with the action scenario - genuine in this case, because one is using *ex post* quantification - relating to a population comparable to that targeted by the action but to which the action has not been applied.

***> FOR EXAMPLE:** in the case of eco-driving training already mentioned above, one can observe the change in average consumption of the other company drivers performing the same action from day-to-day who have not undergone the eco-driving training. Provided this hypothesis is reasonable, i.e. the same external factors apply to the two groups of drivers, one can then define the baseline scenario as the change in the consumption of the untrained group of drivers.*

In practice, it is generally whilst preparing upstream to monitor the impact of an action that one can create or ensure the availability of a control sample that will act as a useful reference for the description of the baseline scenario.

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2 Selecting the most probable scenario if the action is not implemented and explaining this choice

The user must be able to justify the choice of baseline scenario from among several options, which most often requires a precise description of each option and can sometimes then require significant work to analyze and formulate an argument. Decisive arguments may be of an economic or technical order and relate to a comparison of performance, but they may also be behavioural, policy-related etc.

***> FOR EXAMPLE:** the manager of a steadily growing industrial zone decides to implement an inter-company transport plan (PDIE) in partnership with the companies operating there, to counteract the increase in traffic and systematic peak hour congestion at a road junction at the entrance to the zone. The purpose of the PDIE is to reduce the use of cars by encouraging employees to adopt a set of new practices (carpooling, cycling etc.). Congestion decreases, as do the GHG emissions linked to car usage by employees in the zone, and employees start to find commuting becoming more fluid.*

But practically, what would have happened if the PDIE had not been introduced? There are many possible options: continuation of an increasingly problematic situation (inaction), physical reorganization of the road junction, extension of an already existing tram line upstream of the zone to encourage the use of public transport instead of cars ... Identifying the "most probable" scenario in the absence of a PDIE is a highly complex and multi-faceted issue in this case.

A DIRECT LINK WITH EXTERNAL FACTORS

In the majority of cases, the same external factors operate on the action scenario and the baseline scenario.

In the frequent situation where the baseline scenario is described as the continuation of a historic situation, the description of the baseline scenario simply entails applying the external factors identified during Stage 4 to the historic situation.

When a baseline standard or control sample cannot be used - this is frequently the case for an *ex ante* or midway quantification - identifying and characterizing the factors external to the action is very useful in finally arriving at a correct description of the baseline scenario.

***> FOR EXAMPLE:** in the case of a financial incentive for the acquisition of condensing boilers, the historic situation is that of the market, i.e. the annual number of acquisitions of new boilers and the proportion of condensing boilers among them.*

The financial incentive (action) increases the proportion of acquisitions of condensing boilers (consequence of the action). Market growth during the observation period, i.e. the increase in the total number of acquisitions of new boilers (structural factor), together with the improvement in performance of non-condensing boilers (performance factor) also influence both the action scenario and the baseline scenario.

The baseline scenario is therefore defined as the change in the overall market volume and the proportion of sales of condensing boilers whilst taking into account the structural and performance factors: this is the continuation of the historic situation integrating these two external factors.

.../...

NB: the correspondence between external factors affecting the action scenario and external factors affecting the baseline scenario is not a systematic rule: in some cases, an external factor impacts the action scenario without having an impact on the baseline scenario and vice-versa.

*> **FOR EXAMPLE:** where a lighting system is connected to the electricity network, an action can consist of partially powering the lighting system by installing and using photovoltaic solar panels not connected to the network. The generation of electricity by solar panels depends on sunshine (climate factor) so, in the action scenario, the residual electricity consumption by the network (that is not supplied by the photovoltaic panels) is influenced by the weather. In the baseline scenario in which the lighting system remains exclusively powered by the classic electricity network, this same climate factor does not come into play.*

3 Determining the reliability score associated with Stage 5

The reliability score relating to the choice of baseline scenario is arrived at using two complementary criteria:

• the probability of occurrence of the baseline scenario selected;

• the quality of data available and used to describe this scenario.

This is then in line with the scale shown in the following table.

Reliability score

........**/4**

Probability that I have chosen the correct baseline scenario	Number of baseline scenarios reasonably possible	QUALITY OF DESCRIPTION OF THE SCENARIO(S)		
		Detailed description, integrating external factors if necessary	Average description	Rough description
> 90 %	1	**4/4**	**3/4**	**2/4**
50-90%	2	**2/4**	**1/4**	**0/4**
< 50%	3 or more	**1/4**	**0/4**	**0/4**

Figure 19: Reliability score scale for the choice of baseline scenario (Stage 5).

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	Sub-stage	Illustration
# 1	**Describing the potential baseline scenario(s)**	*Baseline scenario 1 - continuation of the historic situation integrating the external factors:* The four Tartempion employees continue to use their personal vehicles for commuting. However, they each purchased a new vehicle in 2015 due to the state of repair of their old ones. *Baseline scenario 2:* The same: without the provision by Tartempion of an electric vehicle, the four Tartempion employees organized themselves to carpool their own personal vehicles anyway. However, given the state of repair of their old vehicles, they all bought new ones in 2015.
# 2	**Choice of baseline scenario: why is this the most probable scenario?**	*Baseline scenario 1:* - as the employees' old vehicles were coming to the end of their life, their replacement was imminent (employee survey); - although carpooling might have been possible among the employees given the specific geographic location of Tartempion (near Lille, but relatively isolated), it was the provision of an electric vehicle by the employer that actually triggered the implementation of the action.
CONFIDENCE INDEX **Reliability score 1**		• *Probability:* after a survey among the employees concerned, it emerged that none of them would have considered carpooling without the provision of the shared vehicle by the company. Only one scenario was therefore reasonably possible. • *Data quality*: we have a precise description of the baseline scenario (the model of the employees' hypothetical "future" cars has been adapted to suit the characteristics of each - with/without children, need for long distances (or not) etc.), which takes account of the structural factor identified. **> Reliability score 1 = 4/4**

QUANTIFICATION PHASE

3.6 STAGE 6 DEFINING THE QUANTIFICATION SCOPE

ISSUE: why do it?

If the quantification is to be successful, the main characteristics of the action need to be retained whilst making the calculation possible. Here, this consists of specifying the types of greenhouse gases being taken into account, establishing time limits for the quantification and straight away limiting the GHG calculations to those of the tree consequences that are needed to achieve the aim of the quantification.

SUMMARY: what needs to be done

The user must establish the quantification scope, i.e. they must specify its geographic scope, timescale, the consequences of the action to be taken into account and the types of greenhouse gases to be considered.

	Sub-stage	Compulsory	Recommend-ed	Standard	Find out more
# 1	Indicate the types of GHG that are taken into account in the quantification	✓		✓	
# 2	Indicate the observation period, ensuring that it coincides with the consequence period of the action	✓			below
# 3	Exclude consequences with no impact on GHGs and consequences with a multiplier or indirect rebound effect	✓			p.58
# 4	Evaluate the theoretical order of magnitude of the impact on GHGs of each consequence that has an impact on GHGs		✓		p.58
# 5	Arrange the consequences in order of magnitude by absolute value		✓		p.60
# 6	Retain the consequences relating to the approach selected	✓			p.60
# 7	Retain additional consequences depending on the opportunity		✓		p.61
# 8	Determine the reliability score associated with the scope selected	✓			p.62

Table 12: Details of Stage 6 requirements and recommendations.

IN PRACTICE: how to do it

1 Define the timescale

The quantification timescale corresponds with the observation period of the action. In accordance with the principle of quantification relevance, **the observation period must be chosen to coincide with the consequence period of the action**.

Depending on the length of the consequence period of the action (defined during Stage 2), several approaches are possible.

> When the consequence period of the action lasts for a limited time, it is recommended that an observation period be chosen that corresponds with such consequence period. The observation start date is then chosen as the start date of the consequences of the action, which is also most often the start date of the implementation of the action.

In practice, a relevant observation period may for example be the lifetime of equipment (theoretical or actual), the duration of a chemical reaction (biological breakdown, nitrification/denitrification) or the duration of the effect of an awareness-raising/training campaign (known from socio-economic statistics) etc.

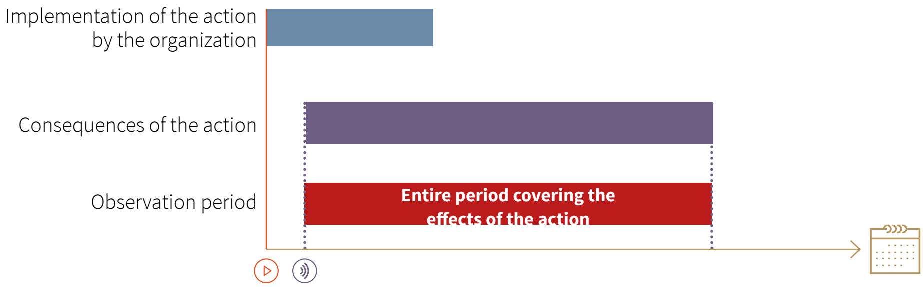


Figure 20: Observation period to be considered for an action with consequences of a limited duration.

> When the consequence period of the action is theoretically unlimited in time, the quantification of the impact on GHGs cannot generally proceed without a description of this impact over time.

***> FOR EXAMPLE**: in a very large company, an economic incentive to use cycles for commuting can have a growing impact year on year due to the time required for this incentive to be taken up, and conversely it may regress because people get tired of it, these two coupled consequences not necessarily being predictable.*

It should be noted that some actions can have an impact on GHG emissions well beyond the duration of the action itself, or on the other hand the consequences may only stabilize long after the end of the action.

***> FOR EXAMPLE**: if one stops burying organic waste, the organic waste buried previously will continue to emit methane and carbon dioxide for many years due to the continuation of the biological degradation processes. In the same way, changes in agricultural practices will have very long term consequences.*

It is vital that the observation period integrates all the significant theoretical long term consequences[11] because the observation period must be consistent with the consequence period of the action.

11. Insofar as they occur in the next 100 years, in line with the calculation methods prescribed by the UNFCCC.

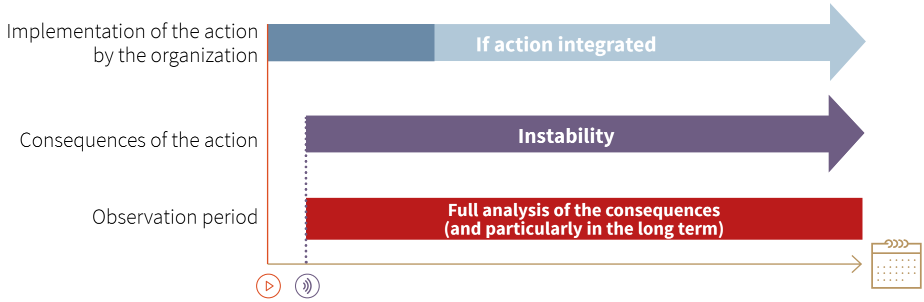


Figure 21: Observation period to be considered for an action with consquences of a theoretically unlimited duration.

> If the impact of the action on GHGs becomes static after a period of transition, one may opt to quantify this impact for a unitary period - in general one year. In this case, it may be more suitable to position the timescale within a period during which the impact of the action on GHGs is stable.

2 Selecting the consequences to be taken into account

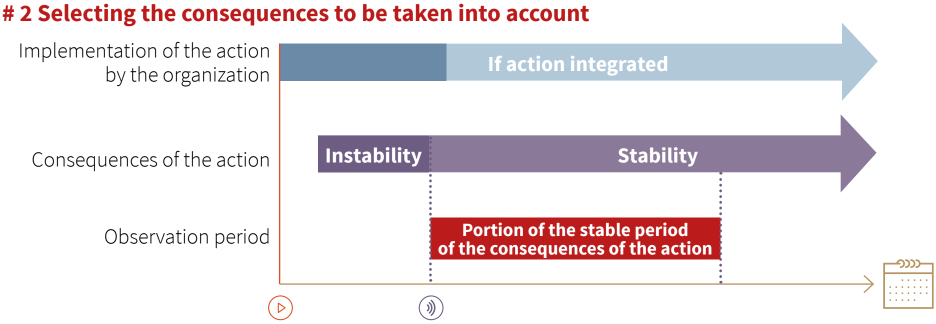


Figure 22: Observation period to be considered for an action with consquences of a theoretically unlimited duration, with a period of stability.

The creation of the consequence tree has enabled all the consequences of the action to be identified in a cascade in Stage 3. Those that will be taken into account in the quantification exercise should now be selected.

The consequences are selected in five successive steps, which we will describe in this section.

SELECTING THE CONSQUENCES FOR THE QUANTIFICATION SCOPE	
STEP 1	Theoretical exclusion
STEP 2	Estimation of |GHG|
STEP 3	Exclusion of ∑ |GHG|<5% depending on the opportunity
STEP 4	Selection according to the level of approach: • ∑ |GHG|> 60% in a simplified approach • ∑ |GHG|> 75% in an intermediate approach • ∑ |GHG|> 90% in an in-depth approach
STEP 5	Addition of other consequences depending on the opportunity

Figure 23: Summary of the consequence selection process in five steps.

STEP 1 Exclude theoretical consequences without an impact on GHGs, and indirect rebound and multiplier effect consequences.

Indirect rebound effect consequences are excluded insofar as one hypothesizes that such effects are independent of the manner in which the action is implemented. The evaluation of an indirect rebound effect is moreover a highly complex issue.

Multiplier effect consequences are excluded insofar as the realization of the multiplier effect will require the triggering of this multiplication by the proponent or third parties, which in itself constitutes one or more entirely separate other actions.

Naturally, the consequences of the tree with no impact on GHGs are also excluded.

Figure 24: Types of consequence to be systematically excluded from the quantification scope.

STEP 2 Evaluate the theoretical impact on GHGs of each consequence not excluded in Step 1.

This initial evaluation must be undertaken using the data and orders of magnitude that are available to the user at this stage: ideally, it should not give rise to any significant data collection work.

The impact of each consequence on GHGs is evaluated in absolute value.

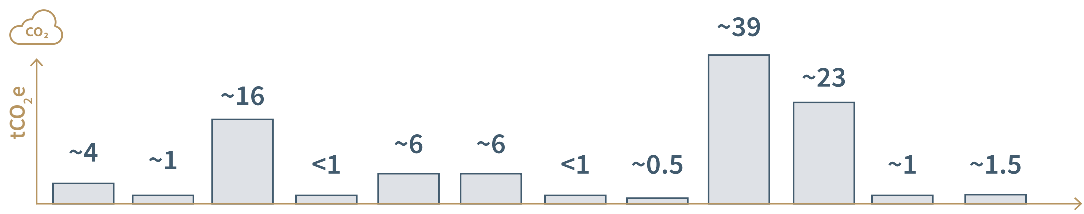


Figure 25: Example of a result of the theoretical evaluation of the impact on GHGs of consequences not excluded in Step 1.

CONSOLIDATION OF CONSEQUENCES THAT NATURALLY OFFSET EACH OTHER

When the tree shows two consequences that naturally offset each another (i.e. the impact on GHGs is the same order of magnitude in absolute value but of an opposing sign due to a displacement of the action or replacement of a good/service), then the user must consolidate these two consequences and treat them as a single consequence with an impact on GHGs obtained by subtracting the two initial values.

*> **EXAMPLE:** in the case of an action intended to insource production initially entrusted to a subcontractor, the modification of the production site will give result in a reduction in the subcontractor's workforce and an increase in that of the proponent of the action. The reduction in commuting by the subcontractor's employees (CSQ D in the diagram below) and the corresponding increase among those employed by the proponent of the action (CSQ C in the diagram below) must be consolidated in this consequence selection exercise under a single consequence description, "Change in commuting" (CSQ C+D in the diagram below), the impact of which on GHGs will be the algebraic sum of the impact on GHGs of the reduction in commuting on one hand and its increase on the other.*

WHY THIS SPECIFIC CASE?

If the two consequences are not consolidated into one, the sum of the absolute values of the impact on GHGs of the two consequences taken separately (a reduction on the one hand, an increase on the other) may be very high, whilst the impact on GHGs of the variation in these two consequences may at the same time be very low. The relative weight of these consequences treated separately may tend to mask other important consequences of the action and could lead to the exclusion of consequences whose relative weight would then be underestimated.

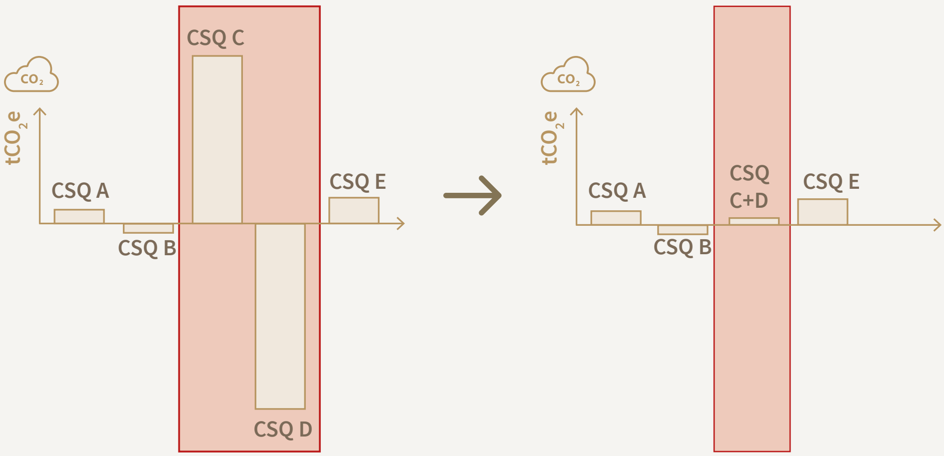


Figure 26: Example of consolidating consequences that naturally offset each other.

.../...

> ***EXAMPLE:** Following on from the example above, the overall impact on GHGs relating to the "Change in commuting" (CSQ C+D) may be very low, whereas the reduction in emissions connected with the reduction in this commuting by the subcontractor's employees (CSQ C) on the one hand and the increase in emissions linked with their increase among those of the proponent of the action (CSQ D) will both be very large in absolute value and could mask other significant consequences of the exercise.*

STEP 3 If the user so wishes, they may exclude any set of consequences whose impact on GHGs has a cumulative absolute value of less than 5% of the total.

This is to give the user the option of freeing themself from the precise quantification of consequences, the cumulative impact of which on GHGs is known to remain marginal, particularly when a large number of consequences manifestly constitute - including cumulatively - a very minimal part of the impact of the action on GHGs.

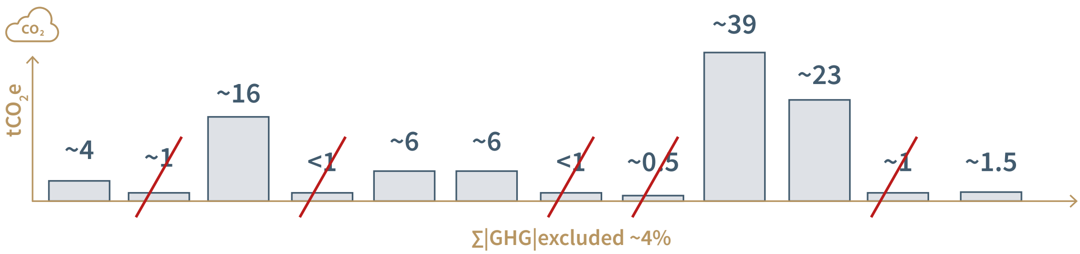


Figure 27: Example of exclusion of consequences with a marginal cumulative impact on GHGs (<5%).

STEP 4 Select in decreasing order of absolute value as many consequences as necessary for the accumulated absolute value to represent over 60% of the total in a simplified approach, over 75% in an intermediate approach and over 90% in an in-depth approach.

We have here selected the panel of consequences for which a finely detailed quantification will be undertaken. The objective is to integrate a sufficient number of consequences - beginning with those whose impact on GHGs is the greatest - so that their cumulative impact on GHGs is sufficiently representative of the actual impact of the action on GHGs, in line with the aim of the quantification exercise - the goal declared in Stage 1 by way of the level of approach chosen.

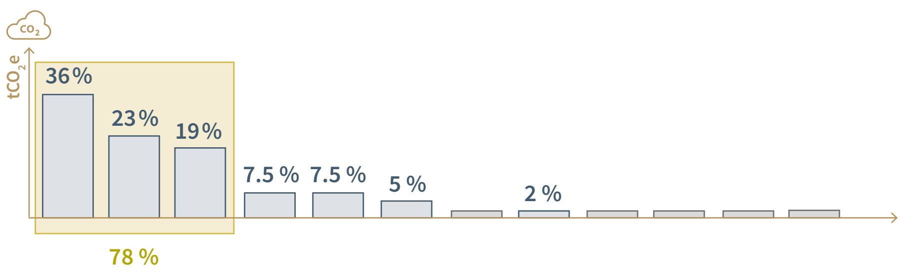


Figure 28: Example of selection of consequences the cumulative absolute value of whose impact on GHGs is sufficient to exceed the threshold required at the intermediate level of approach (75%).

NOTE

The representativeness of the consequences calculated as a percentage of the total cumulative impact on GHGs takes as a baseline all the consequences not excluded from the quantification scope at the end of the earlier Step 3. In other words, if no consequence is excluded during Step 3, the percentage obtained is 100% (*cf.* following section).

STEP 5 The user may add as many other consequences as they wish to the selection made in this way.

Step 5 enables the user to integrate additional consequences after exceeding the target threshold in Step 4. In fact, the calculation may be simple and the data available for some consequences whose impact on GHGs is not important. It would be a pity not to benefit from the quantification of these elements.

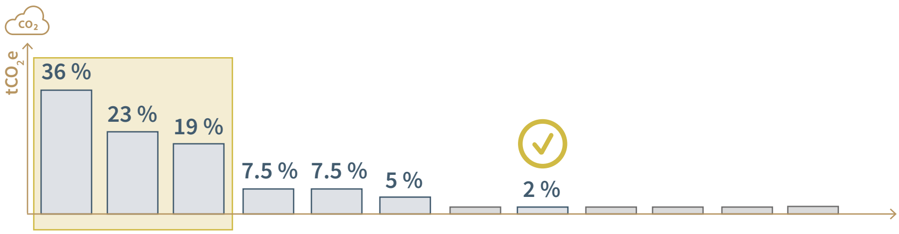


Figure 29: Example of the integration of a consequence whose impact on GHGs (2%) does not have the function of exceeding the required threshold.

NOTE

Given the rules to be applied in Steps 4 and 5, the selection of consequences undertaken according to a simplified level of approach can for example lead to the selection of consequences the sum of whose absolute values of impact on GHGs exceeds the threshold corresponding with the intermediate level of approach (75%), and possibly even the in-depth level of approach (90%). This is a most a favourable configuration for the user, and will enable them to increase the confidence index of the final result by the same amount (*cf.* following section).

3 Determine the reliability score associated with Stage 6

The reliability score associated with Stage 6 is directly linked to the representativeness of the cumulative impact on GHGs of the consequences included in the quantification scope relating to the actual impact of the action on GHGs.

This is in line with the scale shown in the following diagram:

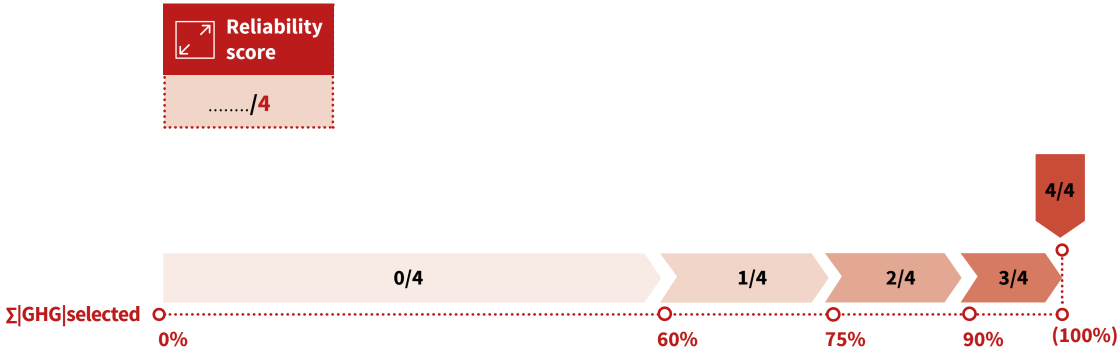


Figure 30: Reliability score scale associated with Stage 6.

APPLICATION TO THE main case study

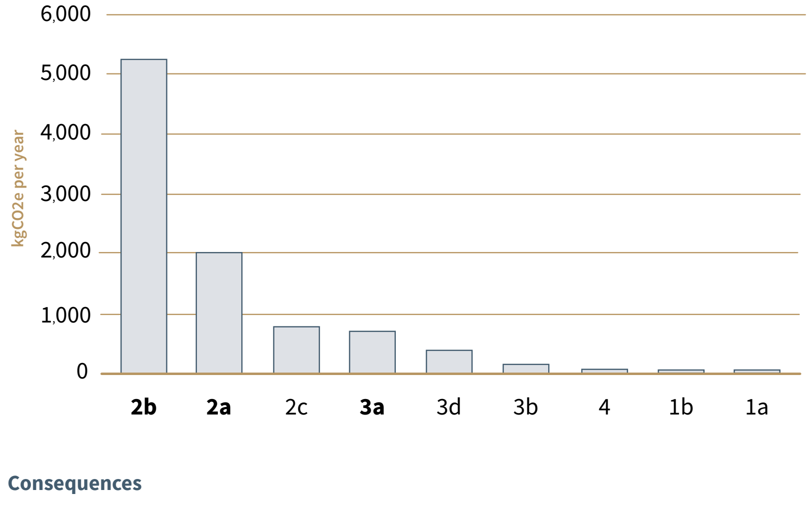
	Sub-stage	Illustration
# 1	**GHGs taken into account in the quantification**	All Kyoto GHGs
# 2	**Determined observation period**	It was decided to quantify the impact of the action on GHGs during its first year of implementation. The impact of the action on GHGs will be measured in tCO_2e per year. *Justification:* Tartempion's action is theoretically of unlimited duration. We hypothesize that the consequences of the action are stable from its launch onwards.
# 3	**Non-relevant consequences excluded**	Consequences 3c1 and 3c2 relating to "multiplier effects" are excluded from the quantification.

.../...

Sub-stages 4 & 5 – Theoretical evaluation in order of magnitude and ordering of consequences

	Weight of GHGs ($kgCO_2e$ per year)	Justification
1a	35 $kgCO_2e$	7 vehicles were tested: 5 hybrids and 2 electric over 60 km each. The hypotheses used to arrive at this order of magnitude are as follows: • 110 gCO_2e per km for the hybrid vehicles; • 20 kWh per 100 km and 82 gCO_2e per kWh for the electric vehicles.
1b	55 $kgCO_2e$	The charging station weighs about 30 kg (mostly plastic). We used the following upper bound hypotheses: • amortization period of 3 years; • emission factor of 5.5 $kgCO_2$ per kg (valid for a " machine tool").
2a	2,000 $kgCO_2e$ per year	4 vehicles will not be manufactured due to the action. It is considered, as an initial approximation, that the amortization of a vehicle is about 0.5 tCO_2e per year (valid for an amortization period of 10 years).
2b	5,250 $kgCO_2e$ per year	In total, the 4 vehicles cover an average of 35,000 km per year. An EF of 150 gCO_2 per km is used, which corresponds with the internal combustion engine vehicles that would have been bought in the baseline scenario.
2c	800 $kgCO_2e$ per year	According to a lifecycle analysis undertaken by ADEME, there are two orders of end-of-life GHG emissions: • recycling: 0.6 tCO_2e per vehicle; • emissions avoided through recycling: -2 tCO_2e per vehicle. All vehicles are deemed to have a lifetime of 7 years.
3a	683 $kgCO_2e$ per year	The production of the electric vehicle represents about 91 gCO_2 per km. The impact of the production of the electric vehicle is defined on the basis of the 7,500 km travelled per year.
3b	123 $kgCO_2e$ per year	Given the geographic location of the employees, the electric vehicle covers approx. 7,500 km per year. Consumption is deemed to be 20 kWh per 100 km and the EF, 82 gCO_2e per kWh.
3d	371 $kgCO_2e$ per year	According to a lifecycle analysis undertaken by ADEME, there are two orders of end-of-life GHG emissions: • recycling: 1.1 tCO_2e per vehicle; • emissions avoided through recycling: -3,7 tCO_2e per vehicle. The lifetime is considered to be identical to internal combustion engine vehicles (7 years).
4	105 $kgCO_2e$ per year	One of the employees comes to work by train and metro. This is deemed to be of the order of 15,000 km per year with an average EF of 7 gCO_2 per passenger km (order of magnitude valid for electric public transport).

Hence the following initial evaluation of the absolute value of the impact on GHGs, consequence by consequence:



Sub-stage 6 - Retaining the consequences

#	Weight of GHGs
2b	55.7%
2a	21.2%
2c	3.5%
3a	7.2%
3d	3.9%
3b	1.3%
4	1.1%
1b	0.6%
1a	0.4%

In Stage 1 - When defining the quantification objective, we opted for an intermediate level of approach.

We therefore needed to select at least all of the consequences in decreasing order, enabling us to obtain 75% of the total impact.

Thus, by taking into account the 2b consequences ("Reduction in the fuel consumption of internal combustion engine vehicles") and 2a ("Reduction in demand for new internal combustion engine vehicles"), we achieve the objective of 75% with almost 77% of the total impact.

However, with the data available for the 3a consequence ("Electric vehicle production") we make the choice to integrate it into the quantification in order to achieve 84% of the total impact and thereby improve the confidence index of our result.

Sub-stage 7 - Reliability score

Following the definition of the quantification scope, we reach a margin of 84% of the total impact of the action.

In line with the scale defined, the reliability score for this stage is 2/4.

Reliability score 2 = 2/4

3.7 STAGE 7
COLLECTING THE AVAILABLE DATA

ISSUE: why do it?

To produce a precise description of each of the two scenarios whereby GHG emissions change within the quantification scope by targeting the parameters of this description in such a manner that the data set relating to the baseline scenario on the one hand, and that relating to the action scenario on the other make it possible to describe the quantified change in GHG emissions in the corresponding scenario as faithfully and precisely as possible.

SUMMARY: what needs to be done

The user must list all the data they require to quantify the change in GHG emissions relating to each emission origin (sink or source) linked to a consequence of the action to be taken into account within the quantification scope - in the action scenario and the baseline scenario alike - then collect this descriptive data from the information sources they have identified.

	Sub-stage	Compulsory	Recommend-ed	Standard	Find out more
# 1	Identify the data required to quantify the emissions of each consequence taken into account in the quantification scope				p.66
# 2	Collect all this data				
# 3	For each item of data, specify whether it is linked to the baseline scenario or the action scenario.				
# 4	Determine the reliability score associated with the data quality				p.69

Table 13: Details of Stage 7 requirements and recommendations.

IN PRACTICE: How to do it

Data accessibility is crucial in an exercise to quantify the impact of an action on GHGs. The reliability and precision of the results obtained depend directly on the quality of data available. It is particularly vital that the data used for the quantification is valid over a geographic zone and period of time consistent with the quantification scope.

The data targeted, together with the skills to be mobilized to collect it, the inherent costs and time required to access it will vary from one case to another. The quantification suited to the situation and evaluation objectives should therefore be drawn up case by case.

The accessibility of data is linked to various elements:

• **the presence (or not) of statistical data** at entity level (region or organization) ;

• **the financial and human resources** available;

• **time**: at what point is the data required? How much time is available for searching for data?

We would here refer the reader to section 2.3, which specifically addresses the “project” dimension of the quantification exercise, and particularly the phase relating to the production of the data set for the quantification.

It should be noted that in practice Stages 7 and 8 are strongly interlinked inasmuch as preparing for the calculations helps to progressively identify the data to be collected in order for the calculations to be successful. For all that, once this preparatory work has been done, collection itself is a necessary stage and sometimes requires significant time before the launch of the calculation and the obtaining of the results.

Three main types of data are required to quantify the impact of an action on GHGs: action data, emission factors and (less systematically) various technical coefficients. These are described in the following sections.

1 Action data (AD)

By definition, action data is the data set that will help to describe the action under consideration.

Here are some examples of action data currently in use:

• **the total energy consumption of a system** (building, industry etc.) or facility. This is the total quantity of energy consumed by the system or facility. This quantity depends directly on the level of action and/or production;

• **the area of a building,** the staff working there every day, the sales of a company, the number of fleet vehicles attached to the action site;

• **energy intensity** or the consumption of specific energy:

- transport: fuel used per km, per passenger-km, per tonne-km of freight etc.;
- industry: total energy consumed (including electricity, natural gas and other fuels) per tonne of product manufactured;
- residential and services sectors: energy consumed to heat premises related to the unit of area (m^2) or volume etc.

The definition of each item of action data must be as precise as possible, its range and usage limits explained and its units of measurement described.

Obtaining the action data needed for the quantification calculation sometimes requires the use of calculation methods and expert tools involving specific techniques and processes relating to the action sector to which the action in question relates. This is often useful when there is no direct measurement of the data in question, which is generally the case for *ex ante* or midway quantification.

*> **FOR EXAMPLE:** if an action involves the implementation of biogas plants on a farm, both to treat the large volumes of organic waste produced and to provide a source of energy (biogas) to heat the farm buildings, this method will be of no assistance in calculating the volumes of biogas and digestate produced from the volumes of organic waste available. If there are no measurements, the user will need a tool that is able to model the methanization process such as the DIGES tool (Cemagref-ADEME), the results of which will serve as input data when using the method.*

In this sense, such "industry" tools and methods will prove complementary to the stage-by-stage process proposed by the quantification method described in this document, and also vital for obtaining a workable result.

Action data can vary greatly in quality when it comes to the need to describe the action in question. In the same way as for the BEGES, and depending on the quantification objectives, the types of data to be used are shown in the following table.

Type of data	Description	Examples	Reliability/ Precision
Primary data	Observed data, sampled from information systems and physical readings belonging to or used by the local authority or the business (or a company in its supply chain).	Actual consumption of fossil fuels.	✦✦✦✦
Secondary data	Generic data or average data from published sources, which represent the actions of the business or its products, or the local authority and its region.	Average national energy consumption of a petrol-powered car in an urban cycle.	✦✦
Extrapolated data	Primary or secondary data connected with a similar action that is adapted or customized to suit a new situation.	Energy consumption of a bank branch in a rural area in the Vosges adjusted for the climate of a similar branch in the Landes.	▯
Approximate data	Primary or secondary data connected with a similar action that can be used instead of representative data. This existing data is used directly, without adaptation.	Energy consumption of a bank branch in a rural area in the Vosges not adjusted for the climate of a similar branch in the Landes.	–

Table 14: Details of Stage 7 requirements and recommendations.

2 Emission factors (EF)

All the emission factors listed are available in the Base Carbone®[12], a public French database generated from the historic data of the Bilan Carbone®.

The emission factors used to quantify the impact of an action must:

- **be suited to the action data:**
  - Action data: tonnes of steel => EF in $kgCO_2e$ per tonne of steel.

12. www.basecarbone.fr

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- **be consistent with the consequences being studied:**
  - use of 50% recycled steel => EF of 50% recycled steel;
  - consumption of 10 kWh of electricity for heating => EF specific to the "heating" usage of electricity consumption (as opposed to the average EF for electricity).
- **be valid for the observation period and the geographic zone defined by the action:**
  - European recycled steel => historic average EF for European steel;
  - French recycled steel => historic average EF for French steel.
- **for each gas, use the latest Global Warming Potential in force, as published and updated by the IPCC[13].**

When the emission factors will not comply with these principles, the user must identify and qualify any bias and/or uncertainties generated.

*> **FOR EXAMPLE:** the change in the electricity generation energy mix influences the GHG content of the electric kWh produced. Also, the use of the historic electricity emission factor (i.e. that reflects past production capacities) to quantify the GHG emissions linked with the use of electricity over 10 years strongly reduces the relevance and reliability of the result.*

In the same way, applying a generic emission factor instead of a specific emission factor can lead to major errors in the results: it is not uncommon for a specific emission factor to differ, even by a different order of magnitude, from the corresponding generic emission factor.

*> **FOR EXAMPLE:** in the context of an action to insulate a building heated using electricity, a saving of 10 kWh on heating should have the EF relating to heating usage applied to it (EF = 0.209 kgCO_2e per kWh for 2014) and not the average electricity EF in France (EF = 0.82 kgCO_2e per kWh for 2014).*

ENSURING THE CORRECT COMPROMISE BETWEEN AVERAGE AND MARGINAL VALUES

An average emission factor is the relationship between the greenhouse gas emissions relating to a process and the action data describing the scale of the process (E.g.: tonnes of steel for a steel production process).

A marginal emission factor is the relationship between the variation in GHG emissions linked to a small variation in the action data and this small variation in the action data (E.g.: a small variation in the number of tonnes of steel produced).

A reduction action often results in a variation in the consumption of one (or more) specific types of material or energy, which will contribute to the impact of the action on GHGs. A variation in consumption is said to be "marginal" inasmuch as it only relates to a small part of the initial consumption concerned. The contribution of this variation in consumption to the impact of the action on GHGs is then calculated by applying a marginal emission factor (not an average emission factor) to this variation in the action data.

*> **FOR EXAMPLE:** let us take the case of a plant with a historic annual production of 1,000 tonnes of steel giving rise to the emission of 4,320 tCO_2e per year including infrastructure amortization (1,000 tCO_2e per year) and the consumption of the energy (820 tCO_2e per year) and raw materials (2,500 tCO_2e per year) required for this level of production. The emission factor for the production of one tonne of steel is therefore 4.32 tCO_2e.*

.../...

13. See website: www.ipcc.ch/publications/rapport du Working Groupe 1 "The Physical Science Basis"/Direct Global Warming Potentials

If plant management decides to reduce production from 1,000 to 900 tonnes of steel per year, this will not necessarily enable the removal of the basic emissions produced by the infrastructure, so the only emissions that can be taken into account in respect of the production of 100 tonnes per year are those relating to the reduction in the consumption of energy and raw materials. The marginal emission factor that is to be applied to calculate the impact of the reduction in these 100 tonnes of steel on GHGs is therefore (820 + 2,500 =) 3,320 tCO_2e per year and not 4,320 tCO_2e per year.

Using an average EF instead of a marginal EF to calculate a variation in consumption may give rise to a very different result.

So in the context of the inventory of data and emission factors necessary for calculating GHG emissions in the action scenario, the user must be sure to inspect each variation in consumption to which the action gives rise and, in this type of situation and as far as possible, collect or estimate the marginal EF rather than the average EF.

Note however that on the one hand, the marginal EF is frequently identical to the average value (this is the case when there is a linear relationship between consumption and GHG emissions) and on the other, even when the two values are different, it is often difficult to obtain (or even estimate) the marginal EF. EF databases such as the Base Carbone® can generally only provide average EFs.

Users may therefore be required to use an average EF where a marginal EF would be relevant: they must then take account of this variance in their evaluation of the reliability score for the stage.

3 Coefficients (C)

It will sometimes be necessary to use "coefficients", which are neither action data nor emission factors, to quantify an impact. These coefficients are used to compensate for the absence of the most suitable action data for quantifying the impact of the action.

***> FOR EXAMPLE:** when heating equipment is changed to more efficient equipment, if it is not possible to access the energy consumption after modification, one uses the energy consumption before modification and applies a consumption reduction coefficient to it.*

4 Determine the reliability score associated with Stage 7

The purpose of the reliability score associated with Stage 7 is to reflect the quality of the data used. In fact, the higher the data quality, the more the robust the result.

In order to obtain an overall score for all the data used to quantify the impact, it is necessary to proceed in several stages:

1. **Evaluate reliability by data type and allocate a "sub-score" for each consequence.**
   The impact of a consequence, whatever it may be, is arrived at through multiplication: AD x EF (x C). The reliability sub-score representative of the consequence will therefore be the lowest score of the AD, EF and C used to calculate the impact of this consequence on GHGs.

Reliability score	AD Action data	EF Emission factor	C Coefficients
0/4	Approximate or extrapolated data	Approximate	Experts' statements
2/4	Secondary data	Method	Constructors'/calculated data
4/4	Primary data	Specific to a source/sink	Measured/verified data

2. Estimate the overall reliability score for all the consequences.

In order to obtain an overall representative score for the quality of the data used to quantify all the consequences, the reliability score is defined as the weighted average of the sub-scores previously defined for each of the consequences, the weighting being carried out using their weight in the final result (strictly speaking, the calculation of the reliability score will therefore only be undertaken at the end of Stage 8, so that the relative weight of each of the consequences is known).

Weighted average = $\frac{\sum_{i=1}^{n} x_i c_i}{\sum_{i=1}^{n} c_i}$, with x_i the values, c_i the coefficients.

Reliability score

........./4

APPLICATION TO THE main case study

Sub-stages 1 & 2

Csq.	Type of data	Data	Useful for: baseline scenario/action scenario/both	Source
2a	AD	**Number of internal combustion engine vehicles bought**	**Baseline scenario**	Tartempion
2a	C	**Amortization period for an internal combustion engine vehicle**	**Baseline scenario**	Constructors' data
2a	EF	**Production of an internal combustion engine vehicle**	**Baseline scenario**	Lifecycle analysis - ADEME
2b	AD	**Distance travelled by each of the internal combustion engine vehicles**	**Baseline scenario**	Tartempion
2b	C	**Fuel consumption of each of the internal combustion engine vehicles**	**Baseline scenario**	Tartempion
2b	EF	**Fuel (diesel fuel at the pump)**	**Baseline scenario**	Base Carbone
3a	AD	**Number of electric vehicles bought**	**Action scenario**	Tartempion
3a	C	**Amortization period for an electric vehicle**	**Action scenario**	Constructors' data
3a	EF	**Production of an electric vehicle**	**Action scenario**	Lifecycle analysis - ADEME

Sub-stage 3 - Determine the reliability score associated with the data quality

	Csq. 2a	Csq. 2B	Csq. 3a
AD	4/4	4/4	4/4
C	2/4	-	2/4
EF	2/4	4/4	2/4
Sub-score selected	**2/4**	**4/4**	**2/4**

The reliability of the data used is evaluated for each consequence included in the quantification scope.

In order to obtain the overall reliability score associated with Stage 7, it is necessary to wait for the realization of the calculations in Stage 8 to obtain the weight of each of the consequences in the final result.

3.8 STAGE 8
QUANTIFY THE IMPACT OF THE ACTION ON GHGS

ISSUE: why do it?

This stage is the end of the exercise to quantify the impact of the action on GHGs.

SUMMARY: what needs to be done

The user must calculate the impact of the action on GHGs in relation to the quantification scope defined.

	Sub-stage	Compulsory	Recommended	Standard	Find out more
# 1	**For each consequence taken into account in the quantification, calculate the impact on GHGs through the difference between the two scenarios.**	✓			
# 2	**Add up the total to determine the full impact of the action on GHGs**	✓		✓	p.72
# 3	**Determine the confidence index of the final result**	✓			p.73

Table 15: Details of requirements and recommendations for Stage 8.

IN PRACTICE: explanations, illustrations and practical advice

1 Calculation rules and recommendations

The calculation of the impact of the action on GHGs is broken down consequence by consequence.
In accordance with the different standards and methods currently in existence, it is necessary to distinguish:

> **reductions (or increases) in emissions**, related to the fact that the action decreases (or increases) the GHG emissions from certain sources;

*> **FOR EXAMPLE:** following a reduction in consumption of natural gas or the use of raw materials with a smaller carbon footprint or the optimization of transport etc.*

> **emissions avoided**, either by recovering material or energy from waste or by producing renewable energy;

*> **FOR EXAMPLE:** energy production through methanization, which is a substitute for using combustible fossil fuel, or the production of raw material through recycling, which is a substitute for the production of virgin raw material.*

> **biogenic tCO_2**, linked to biogenic carbon emissions and capture.

*> **FOR EXAMPLE:** burning wood to fuel a biomass heating boiler emits biogenic CO_2.*

Ultimately, the **total impact** gives the overall sum of impacts in terms of GHG emissions.

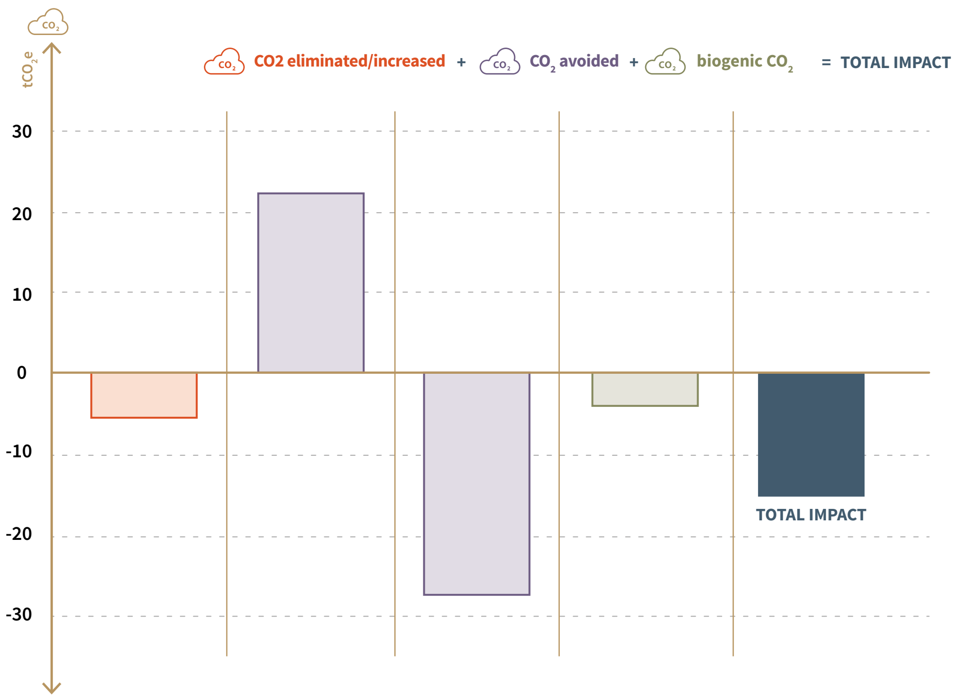

Figure 31: Graph showing the impact of an action on GHGs.

2 Undertake a specific calculation for each consequence included in the quantification scope

The impact of the action on GHGs within the quantification scope is the algebraic sum of the impact on GHGs of each consequence selected. This is of course valid insofar as the consequences selected do not interfere with each another (*cf.* p. 13). The calculations will therefore be undertaken consequence by consequence, then all the impacts obtained on GHGs will be totalled to obtain the final result.

3 Determine the confidence index for the result obtained

The confidence index for the final quantification result is calculated by multiplying the three reliability scores obtained in Stages 5, 6 and 7.

Reliability score		Reliability score		Reliability score		Overall score
......../4	X	......../4	X	......../4	=	......../64

The confidence index obtained conditions the use of the quantification result as a criterion for decision-making and in terms of communication (cf. Table 16).

4 Dissemination and development of the result obtained

Overall score	0 to 12/64	13 to 35 /64	6 to 64 /64
Confidence index	WEAK	CORRECT	OPTIMAL

Figure 32: Scale for the final confidence index for the quantification result.

By default, no weighting is advised between the reliability scores for the three stages (5, 6 and 7), which means that these three stages are seen as being of equal importance. However, in order to achieve the best possible match with the context in which the quantification exercise is being undertaken, the user can introduce a weighting between the three reliability scores if desired, on condition that they justify it and explain the method they have used.

Generally, an organization that communicates the results of the quantification of the impact of an action on GHGs must respect the principle of transparency relating to this method. The purpose of the elements present in this section is to encourage adherence to this principle.

> Presentation of results

The quantification of the impact of an action on GHGs is a complex exercise that requires clear, precise communication of the results.

There are four communication rules that will help to ensure the results are correctly transmitted:

1. **Define the outlines and scope of the communication** in line with the confidence index of the result (*cf.* Table 16)**;**
2. **Adapt the text and level of detail** to the target audience (decision-makers, liaison officers, employees/population);
3. **Make available to anyone wishing to consult them** all elements that will help them understand the quantification realized;
4. **Put the confidence index of the result obtained** in relation to the objective pursued (for example, have an initial idea of the potential of the action, monitor its effectiveness and performance etc.) to assess the match between them.

Lastly, it is recommended that all information that will help to properly understand the results be included in all communications, regardless of their target:
• the action name;
• the GHGs taken into account;
• the observation period (period to which the quantification relates);
• confidence index for the result.

TAKING THE OBSERVATION PERIOD INTO ACCOUNT WHEN COMMUNICATING RESULTS

If the nature of the action is such that the duration of its consequences is limited over time (E.g.: organization of a "Positive energy family" operation involving 50 families over three years), it is recommended that the quantification result be presented as the cumulative impact of all future exercises on GHGs, in tCO_2e.

If the nature of the action is such that the duration of its consequences is not limited over time, particularly when the action consists of a definitive change in the operation of the organization, it is recommended that the quantification result be presented as the annual impact of the action on GHGs in the future, in tCO_2e per year.

*> **NOTE:** In the case of a regulatory communication relating to BEGES or PCAET action plans, the principle of transparency involves specifying, for example, whether the reduced volume of emissions indicated corresponds with the total volume anticipated over the coming period between the two regulatory communications or failing that, to what other observation period it corresponds.*

A summary sheet format for a more formal "environmental reporting"-type presentation is given in Appendix 7. This picks up the quantification exercise and key elements in the reasoning in more detail: the consequence tree, the choice of scope and the baseline scenario.

> Extrapolation of results

It is essential to remember that this result relates to the action involved in the context of its own realization, with hypotheses drawn up for this quantification exercise. At this stage, the experiential feedback cannot be considered - even in the initial approach - to be representative of all the comparable actions.

In the same way, the user may be tempted to calculate performance ratios (tCO_2e per kg of material, tCO_2e per kWh etc.) to enable a better analysis and assimilation of the results. This is a means of communication that is widely and commonly used to put the results of a reduction action into perspective. However, here too, ADEME recommends that such ratios not be communicated: in the light of the weak experiential feedback currently available, one cannot consider that they are representative of the effectiveness of any similar action in a different context.

> Communication and use of results

The principles for communicating and using results are directly linked with the confidence index obtained, as summarized in the table below.

CONFIDENCE INDEX	INTERNAL COMMUNICATION	EXTERNAL COMMUNICATION	LANGUAGE ELEMENTS	INTEGRATION IN A DECISION-MAKING PROCESS
WEAK	With caution	No communication	"In order of magnitude" Only give one significant figure	Risky
CORRECT	Possible	With care	"About/Approx." Go up to a maximum of 2 significant figures	Conceivable
OPTIMAL	Possible	Possible	Free	Favourable

Table 16: Potential use of the quantification result depending on its confidence index.

Depending on the quantification objective set at the outset, it may therefore be necessary to repeat the exercise to make it more robust if this is indicated by the confidence index.

APPLICATION TO THE main case study

Sub-stages 1 & 2 – Calculating the impact of each consequence on GHGs

CONSEQUENCE 2A - REDUCTION IN DEMAND FOR NEW INTERNAL COMBUSTION ENGINE VEHICLES				
Type of data	**Data**	**Value Baseline scenario**	**Value Action scenario**	**Unit**
AD	**No. of internal combustion engine vehicles bought**	**4**	-	Vehicle
C	**Amortization period for an internal combustion engine vehicle**	**10**	-	Years
EF	**Production of an electric vehicle**	**3,757**	-	$kgCO_2$ per vehicle
Impact of consequence 2a = 4 x 3,757/10 = -1,503 $kgCO_2$ per year				

CONSEQUENCE 2B - REDUCTION IN FUEL CONSUMPTION				
Type of data	Data	Value Baseline scenario	Value Action scenario	Unit
AD	Distance travelled by vehicle 1	6,600	-	km per year
AD	Distance travelled by vehicle 2	6,600	-	km per year
AD	Distance travelled by vehicle 3	15,400	-	km per year
AD	Distance travelled by vehicle 4	6,600	-	km per year
C	Consumption of internal combustion engine vehicle 1	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 2	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 3	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 4	4	-	litres per 100 km
EF	Fuel used	3.17	-	$kgCO_2$ per litre

Impact of consequence 2b = - (6,600 x 5 + 6,600 x 5 + 15,400 x 5 + 6,600 x 4)/100 x 3,.17 = - 5,370 kgCO2 per year

CONSEQUENCE 3A - PRODUCTION OF AN ELECTRIC VEHICLE (INCL. BATTERY)				
Type of data	Data	Value Baseline scenario	Value Action scenario	Unit
AD	No. of internal combustion engine vehicles bought	-	1	Vehicle
C	Amortization period for an internal combustion engine vehicle	-	5	Years
EF	Production of an electric vehicle	-	6,634	$kgCO_2$ per vehicle

Impact of consequence 3a = 1 x 6,634/5 = 1,327 kgCO2 per year

Sub-stage 2 - Determining the total impact of the action on GHGs

Total impact on GHGs = Impact of consequence 2a + Impact of consequence 2b + Impact of consequence 3a

Total impact on GHGs = -5.5 tCO2 per year

Sub-stage 3 - Determining the confidence index for the final result

Before determining the confidence index for the final result, the calculation of the reliability score for Stage 7 must be finalized. One therefore reaches the weighted average of the sub-scores obtained for the data used for each of the consequences:

Csq.	Weight	Sub-score
2a	18%	2
2b	68%	4
3a	16%	2

Reliability score 3
= (2 x 18 + 4 x 68 + 2 x 16)/(18 + 68 + 16)
= 3.4/4

Reliability score
........**/4**

Hence, *ultimately*:

Reliability score	Reliability score	Reliability score	Final score
4/4	**2/4**	**3.4/4**	**27.2/64**

According to the scale defined by the method, **the confidence index for the result is correct.**

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4. CONCLUSION

It is important to remember that the quantification of emission reductions is an exercise that requires a certain length of time and must be carried out consistently with the objective sought, at the appropriate time. If it is unlikely to be possible to quantify "everything" the first time, it is vital that the exercise be undertaken with intellectual honesty whilst remaining aware of any limitations and/or bias introduced into the calculation.

Furthermore, **the purpose of quantification is not to compare several action plans with each another but rather to help with decision-making and measure one's own "performance"** within the more general context of managing one's greenhouse gas emissions. Also, as soon as it is part of such a context, it is crucial that this is the subject of real internal sponsorship within the organization, whatever it may be.

While the method may seem complicated at first reading for those who are less familiar with GHG accounting, the main case study and the collection of "Case Sheets" should enable each user to take it on board and improve their practical experience over time.

It is also in this spirit that ADEME invites each user to share their quantification exercises in order to **create a user community** and **exchange best practice** and experiential feedback whilst helping to raise the all-round level of skill.

Please introduce yourself through the Resource Centre forum
www.bilans-ges.ademe.fr, section "Bilan GES – Plan d'actions… en pratique".

APPENDICES

APPENDIX 1: TERMINOLOGY

The terminology presented below is intended to improve understanding of the document, establish a common language and provide technical assistance to liaison officers and other interested parties wishing to quantify the impact of their GHG emission reduction actions on GHGs.

Some terms and definitions provided below are inspired by standardization work undertaken at European level (CEN/CENELEC)[1] or international level (ISO/IEC)[2], together with previous work undertaken on behalf of ADEME.

ABBREVIATIONS

BEGES: greenhouse gas emissions assessment (France)

CO_2e: carbon dioxide equivalent

CSQ: consequence

DJU: unified day degree

EU-ETS: EUropean Emissions Trading System. EU system for trading greenhouse gas emission quotas

EF: emission factor

GHG(s): greenhouse gas(es)

IPCC: Intergovernmental group on climate change

PCAET: Regional plan for climate, air and Energy (France)

GWP: Global Warming Potential

tCO_2e: tonnes of carbon dioxide equivalent

1. EN 16212 - Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods - Edition: 2011-01-15
2. ISO/IEC JPC2/ FRANKFURT MEETING DRAFT N 111 - ISO/IEC CD 13273-1.2 - ISO/IEC TC JPC2/SC /WG 1 - Energy efficiency and renewable energy sources — Common international terminology — Part 1: Energy efficiency - Date: 2012-07-13

KEY DEFINITIONS

Consequence tree	**Schematic tree representing all the consequences of the action in a cascade, starting with** its direct consequences then iteratively listing the consequences of those consequences and so on.
Direct action	Action with the primary purpose of reducing the direct emissions in the BEGES of the proponent organization of the action. *E.g.: replacing its boiler, insulating its premises, changing its vehicle fleet etc.*
Indirect action	Action with the primary purpose of reducing the indirect emissions in the BEGES of the proponent organization of the action (E.g.: working with its suppliers, optimizing freight, reducing the energy consumption of products sold etc.) and/or emissions not appearing in this BEGES. Generally, the goal of an indirect action is to galvanize one or more third parties into action through an incentive or obligation. *E.g.: for a local authority, offering financial assistance to its ratepayers for the acquisition of a condensing boiler; for companies, committing their suppliers to an eco-responsible production charter.*
Greenhouse gas emissions assessment (BEGES)	ASSESSMENT OF THE TOTAL VOLUME OF GHGS EMITTED INTO THE ATMOSPHERE OVER ONE YEAR BY THE ACTIONS OF AN ORGANIZATION, EXPRESSED IN TONNES OF CARBON DIOXIDE EQUIVALENT.
Biogenic carbon	The terms “biogenic carbon“, “organic carbon“ and “biomass carbon“ refer to the carbon produced by living or recently dead organisms (this includes dead wood, but excludes fossil carbon, which is also derived from organic carbon hundreds of millions of years ago). Biogenic carbon differs from fossil carbon, which is not renewable in any way.
Emissions category	All GHG emission sources. Three emissions categories are distinguished: direct GHG emissions, indirect energy-related GHG emissions and other indirect GHG emissions. These categories are referred to as “scopes” in some international standards (cf. ISO 14064).
Consequence	Change caused by the implementation of the action.
Approximate data	Primary and secondary data connected with a similar action that can be used instead of data representative of the action concerned. This existing data is used directly, without adaptation. *E.g.: energy consumption data for a building in the Vosges not adjusted for the climate of a similar building in the Landes.*
Extrapolated data	Primary or secondary data connected with a similar action that is adapted or customized to suit a new situation. *E.g.: energy consumption data for a building in the Vosges adjusted for the climate of a similar building in the Landes.*
Primary data	Observed data, sampled from information systems and physical readings belonging to or used by the local authority or the business (or a company in its supply chain). *E.g.: actual consumption of fossil fuels.*
Secondary data	Generic data or average data from published sources, which represent the actions of the business or its products, the local authority and its region. *E.g.: average national energy consumption of a petrol-powered car in an urban cycle*
Displacement effect	The displacement effect occurs when the reduction in GHG emissions from a source obtained by the action necessarily results in the increase of GHG emissions from another source.

Multiplier effect	Draft definition of standard EN-16212: effect created by an incentive measure that remains after the measure ceases. Effect that translates the fact that the action, even once it is no longer being driven by the organization, continues to produce an impact on GHGs through the reproduc-tionof the same action. *E.g.: the training of employees in eco-driving will help to reduce the emissions connected with the vehicle fleet, but will also have an impact on emissions relating to employees' personal transport.*
Rebound effect	Draft definition for standard EN-16212: a variation in energy usage behaviour that produces an increase in service level and is the result of an action to improve energy efficiency. The rebound effect expresses the idea that an action targeting the moreefficient use of energy with the aim of reducing consumptionthereof, can lead to an increase in overall energy consumption or produce otherunforeseen emissions. *E.g.: in the case of an energy renovation of a home, an individual can either increase the temperature of their home because heating is less costly than before (direct rebound effect), or spend the money saved on their bill on other con-sumer goods (indirect rebound effect).*
indirect emission of greenhouse gases	GHG emissions resulting from the production of electricity, heat or steam imported and consumed by the organization or that are a consequence of the actions of an organization, but result from greenhouse gas sources belonging to or under the control of other organizations.
Direct greenhouse gas emissions	GHG emissions from greenhouse gas sources belonging to or under the control of the organization.
CO_2 equivalent (CO_2e)	Unit used to compare the radiative forcing of a GHG with carbon dioxide. Fact: to each GHG is attached the concept of "radiative forcing", which defines (in W/m^2) the additional energy that is returned to earth by a givenquantity of gas in the air.
Greenhouse gas emission or removal factor	Factor relating action data to corresponding GHG emissions or removals.
External factor	element external to the action and independent of its implementation that can influence its impact: structural factor, climate factor etc.
Greenhouse gas (GHG)	Gaseous component of the natural or anthropogenic atmosphere which absorbs and emits radiation with a specific wavelength of the infrared radiation spectrum emitted by the surface of the Earth, the atmosphere and clouds.
Impact on GHGs	Refers to changes to GHG emissions as a result of the action. Increases, reductions and the stabilization of emissions are all classified as changes in this context. The term "impact" is given preference over the term "effect" so as not to create confu-sion with certain types of consequences from the action, i.e. rebound, displacement and multiplier effects. The unit used to measure impact on GHGs is CO_2 equivalent (in tonnes, kilograms etc). It is widely accepted that the impact of an action on GHGs assumes a negative value when the action causes a reduction of GHGs in the atmosphere and a positive value when it causes an increase of GHGs in the atmosphere.
Non-GHG impact	Refers to changes caused by the action on categories of impact other than GHGs. These may be environmental (eutrophication, depletion of resources, water consump-tion, toxicity etc.) or societal (jobs, economy, safety, health, adaptation to climate change etc.).

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Origin of emissions	Processes and physical sources from which emissions result.
Quantification scope	Scope within which the impact of the action on GHGs is quantified. This includes the concept of temporal scope (the period during which the impact of the action on GHGs is observed), consequences taken into account in the quantification and the GHGs taken into account in the quantification.
Source of emissions	GHG EMISSIONS FROM HOMOGENOUS SOURCES OR TYPES OF SOURCE. A source of emissions can be treated as a sub-category. *E.g.: direct emissions from fixed sources of combustion, indirect emissions relating to electricity consumption, business travel etc.*
GHG sink	Physical unit or process removing one or more GHGs from the atmosphere. *E.g. a tree, a carbon storage centre etc.*
Baseline scenario	A baseline scenario is a short-, medium- or long-term modelling exercise that establishes what the greenhouse gas emissions would have been if the action had not been implemented, taking existing external factors into account as far as possible.
GHG source	Physical unit or process expelling one or more GHGs into the atmosphere. *E.g. an internal combustion engine, thermal boiler, cattle etc.*

APPENDIX 2: MAIN CHANGES TO THE METHODOLOGICAL GUIDE

The changes made to the Methodological Guide since the previous version are many, relating particularly to the form (more detailed accounts, reformulations, addition of examples and illustrations etc.), and are not therefore the subject of an exhaustive list.

The most significant changes, which for the most part constitute alterations to the method content, are presented in the table below.

Topic	Change to the method	Location in this document
Quantification of a package of actions	The recommendation relating to the quantification of a package of actions has been changed: a package of actions can be fully quantified by means of the method, insofar as any interference between consequences is correctly treated by the user.	§ 3.2.3, p.27
Quantification process	A detailed account of the methods of implementing a quantification process has been added.	§ 3.6, p.54
Format for presenting stages	The account relating to each of the eight stages of the method has been systematically structured into three parts: 1. ISSUE: why do it? 2. SUMMARY: what needs to be done 3. IN PRACTICE: explanations, illustrations and practical advice	§ 3.1 à § 3.8, p.19 to 78
Main case study	The action to which the main case study relates, which illustrates each stage with a practical application, has been changed, inspired by an actual case encountered.	§3.1 à § 3.8, p. 19 to 78 and Appendix 8
Consequence tree	Rules and practical advice on implementation have been added to better guide the user in creating the consequence tree.	§ 3.3
Baseline scenario	The process for selecting and describing the baseline scenario has been modified to improve the treatment of situations in which several baseline scenarios are theoretically conceivable.	§ 3.5
Selection of consequences	The process for selecting consequences has been modified and clarified to support the user step-by-step in the definition of their quantification scope.	§ 3.6
Confidence index for the result	The method incorporates the evaluation of a confidence index relating to the result using reliability scores determined in Stages 5, 6 and 7.	§ 3.5.3, p.53§ 3.6.3, p.62§ 3.7.4 p.70and § 3.8.2 p.73

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Format for presenting results	The format for presenting results as a summary has been modified in line with the update of the method and the collection of “Case Sheets” produced during the 2015 experiments.	§ 3.8.2, p.73 and Appendix 7
Use of results	The rules to be adhered to for the use of the results of the quantification are no longer dependent on the level of approach but rather on the confidence index for the result.	§ 3.8.3, p.73
Performance ratio for an action	The method recommends not communicating elements that can be treated as a performance ratio ofor the action so as to avoid the extrapolation of such a ratio to similar actions in a different context.	§ 3.8.3.2, p.74
Referral to external references	Various types of external referrals have been added to provide more practical assistance for the user: Reference documents/Case sheets from the 2015 experiments/Useful sources of data	Appendix 4, Appendix 5 and Appendix 6

APPENDIX 3: TYPES OF ACTION

PHYSICAL ACTIONS	Change in equipment or systems *These actions are generally linked to an investment*
Technology	Use relevant and appropriate equipment or technology, reducing energy consumption and/or GHG emissions. *Examples: Replacement of an oil-fired boiler with a gas boiler, high efficiency motors, electronic speed variation system for induction motors, solar dryer etc.*
Infrastructure	Develop relevant, appropriate infrastructure to reduce GHG emissions. *Examples: Multimodal platform, navigation channel, peri-urban parking, cycleways etc.*
Process	Optimize the company's industrial production processes. *Examples: Change the organization of a production chain, modify the temperature of a chemical reaction etc.*
ORGANIZATIONAL ACTIONS	**Change in organizational processes.** ***Altering the way things are done***
Sustainable/Long-term procurement policy	Incorporate "sustainable development" criteria into the organization's procurement policies. *Examples: specific GHG requirements when defining a need, specifications, execution conditions etc.*
Research & development	Research, develop and experiment with products, practices, materials and technologies reducing GHG emissions in their production methods and/or use. *Examples: ecodesign, simplified cultural techniques, no-till sowing etc.*
Development strategey	Reposition or develop a business or region in markets or actions helping to reduce GHG emissions. *Example: expand a range of local shops accessible using "soft" transport, expand an offering of ecodesigned products, increase availability of positive energy housing etc.*
Flow optimization	Optimize/reduce flows of materials, people and merchandise with a view to decreasing the grey or direct energy relating thereto. *Examples: using "non-road" modes of transport, optimization of journeys, loads, goods transport in built-up areas, reduction of raw material offcuts, suiting working hours to public transport timetables etc.*

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BEHAVIOURAL ACTIONS	Change in day-to-day behaviour
Information and awareness-raising	Inform and raise awareness among employees, customers, suppliers, users and the general public to make the adoption good habits more widespread. *Examples: information campaigns, B2B information, promotion of best practice, public transport timetables.*
Commitment or voluntary agreement	Convert the voluntary reduction of emissions into a contractual commitment. *Examples: reduce greenhouse gas emissions from public buildings by 50% in 10 years (Circular of 16/01/2009), "Grenelle" agreement Hospital federation status*
Training	Enable different protagonists to assimilate best practices that promote energy savings. *Example: training personnel in eco-driving*
REGULATORY ACTIONS	**Changes to rules**
Obligation/prohibition	Implement rules and regulations promoting the decrease of GHG emissions. *Examples: GHG reporting obligation with action plans, energy audit, use of train for a trip of under three hours.*
Taxation	Introduce tax penalties/incentives for certain practices to encourage the use of alternative solutions. *Examples: implement a carbon tax, urban toll system, tax on air tickets (may be internal to a company) etc.*
Market mechanisms	Limit emissions by specific sources/sectors by allocating permits or quotas, possibly tradable, corresponding with maximum authorized emission levels. *Examples: Clean Development Mechanism, joint implementation, European Emissions Trading System (EU ETS), California Cap-and-Trade Program etc.*
Economic incentive	Offer financial incentives to encourage the adoption of best practice and/or the use of efficient technologies. *Examples: energy savings certificates (ESCs), reimbursement of "soft" transport receipts, motor bonus/penalty system, drop in insurance premiums etc.*

Table 1: Types of emission reduction action.

APPENDIX 4: REFERENCE DOCUMENTS

[1] *ISO14064-2: 2006, Greenhouse gases – Part 2: Specifications and guidelines at project level for the quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements* (International Standards Organization, 2006)

[2] *Policy and action standard – Accounting and reporting standard to evaluate the effects of policies and actions on greenhouse gases* (World Resources Institute – GHG Protocol, 2014)

[3] *Clean Development Mechanism methodology* booklet, 7th edition (United Nations Framework Convention on Climate Change, 2015)

Quantifying the impact of an emission reduction action on GHGs - Collection of "Case Sheets" - 2015 edition (ADEME, 2015):
www.ademe.fr/sites/default/files/assets/documents/quantifier_impact_ges_action_reduction_emissions_exemple_8738.pdf

[5] *Application of the ADEME methodology for quantifying the impact of one or more waste prevention actions on greenhouse gases* (I Care/ADEME, 2015)
www.ademe.fr/application-methodologie-ademe-quantification-limpact-gaz-a-effet-serre-dune-action-a-actions-prevention-dechets

APPENDIX 5: PRACTICAL CASES FROM THE "2015 CASE SHEETS"

Below is the list of "Case Sheets" produced as part of the experimentation with the method in 2015. Please note that the web links relating to the following table refer directly to the detailed Excel files of the sheets and not the collection itself.

Case	Title of "Case Sheet"
001	HQE process applied to the construction of a new store
002	External insulation of laboratory buildings
003	Introduction of 15 NGV (natural gas for vehicles) vehicles as a substitute for 15 diesel vehicles
004	Optimization of public lighting systems
005	Connection of the South/East wing of the "Gironde" building to the pre-existing Mériadeck geothermal network
006	Drop in the temperature of hot mix
007	Improvement in the energy performance of 1,000 social housing units in the City of Paris
008	Deployment of a community travel scheme in the Val d'Ille region
009	Installation of a bamboo phytoremediation system to treat process wastewater
010	Implementation of an adiabatic cooling system in a machine room at the Bastille station
011	Change from teabags with staples to compostable teabags without staples (with knots)
012	Reduction in the use of natural gas to produce steam by using steam produced using biogas
013	Lightening 125 ml HDPE Betadine bottles by 12%
014	A one-kilometer tramway extension in Paris
015	Installation of a system for optimizing cutting
016	Implementation of a cooling system linked to a heat recovery system at the RATP building
017	Installation of a system to detect faults prior to cooking and reinsertion of scraps into the process

018	Replacement of a natural gas boiler with a wood boiler in an agrifood factory
019	Change in pill machine material: from a fossil PE to a sugar cane-based PE
020	Optimization of palletizable cardboard packaging - reduction in “dead space”
021	Re-establishment of rail freight between S and O
022	Ecodesign action for a garment model: change in raw material
023	Change to paperless institutional communication resources: greeting card, CAPI review, digital satchel
024	Deployment of a combination of three evidence-based potato cultivation practices
025	Development of alternative cultural techniques for green beans being cultivated on 1 ha. in Nord Picardie
026	Increase in web- and tele-conferences
027	Introduction of a “Simplycité” urban distribution platform, green deliveries in the built-up area
028	School meals: change in the source of protein based on the complementary use of organic soya and beef
029	Recovery of the Departement’s retired goods via an online auction platform
030	Recovery of recyclable products discarded in a restaurant
031	Support for the development of collective composting in private spaces
032	Support for the development of individual composting
033	Agreement with the La Glanerie recycling depot
034	Agreement to recover computers retired by local government
035	Insourcing the manufacture of Betadine unidoses at the Mérignac site
036	Introduction of a system of reusable plates at the Rio Loco festival
037	Introduction of a digital system to broadcast debates
038	Introduction of packaging shuttles
039	Change in the road freight transport mode vs. motorways of the sea
040	100% organic and if possible, local, products in school canteens in the town’s elementary schools
041	Use of demolition concrete as a infill material
042	Use of water carafes for local government events (Protocol Department)

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043	Use of materials from roadworks as resources on other local authority sites
044	Energy recovery from late mowing remnants using methanization
045	Establishment of CEP departments in nine municipalities in the region
046	Introduction of a CO_2 savings account for Group employees
047	Moveco: Car-sharing and carpooling service using electric vehicles
048	Onboard eco-driving training for CASE agents
049	Implementation of a “Positive energy family” challenge
050	Implementation of a plan to combat food waste in a school complex
051	Raising awareness and distributing “NO-SPAM”
052	Support for occupants when undertaking energy-efficiency improvements in their homes

APPENDIX 6: SOURCES OF USEFUL DATA

We have drawn up a (non-exhaustive) list of potentially useful resources for users in Stage 7: these resources may help to enrich the data set required for calculations, particularly in respect of emission factors and average data.

ADEME Resource Centre for greenhouse gas assessments

www.bilans-ges.ademe.fr/fr/accueil

This ADEME Internet portal provides free access to databases and documents on GHG assessments, and more generally to material useful for GHG accounting.

It includes a number of useful resources:

- **the Base Carbone®**: the benchmark database in France for emission factors and source (or average) data. Its use is subject to signature of a free licence by the user;
- **the library**: sectoral guides for GHG assessments: these guides - the purpose of which is to explain how to apply the GHG assessment methods to given action sectors - include emission factors and average data for most of the sectors concerned;
- **the collection** of "Case Sheets" relating to the application of this method for quantifying the impact of the action on GHGs. This provides a summary of the calculations undertaken, which use some average data that may - subject to all the appropriate precauations - be reused by a reader dealing with a comparable action.

Sectoral databases on emission factors

- **The ADEME Car Labelling database**, listing the GHG emissions of vehicles per kilometer (gCO_2 per km): *carlabelling.ademe.fr*
- **The environmental and health database for construction materials.** Amongst a wider range of information, this includes the emission factor for most of the materials present: *www.base-inies.fr/inies/Consultation.aspx*

Lifecycle analysis databases

These multi-criteria databases all include impact on climate change, and the impact factor for each element in the database corresponds with the emission factor of that element.

NB: the understanding and initial manipulation of these databases (even the free ones) may be time-consuming due to the wealth of material they contain.

- **The Base Impacts®** is an ADEME database with free access: *www.base-impacts.ademe.fr*
- **The European Life Cycle Database** is a Joint Research Center database with free access: *eplca.jrc.ec.europa.eu/ELCD3/*
- **The Ecoinvent database** is a commercial pay database: *www.ecoinvent.org*
- **The Gabi database**is a commercial pay database: *www.gabi-software.com/france/index*

Databases containing statistical data of all types

- **The database of the French Institut National de la Statistique et des Études Économiques (INSEE)** includes a database of regional data: *www.insee.fr/fr/bases-de-donnees*
- **The Service de l'Observation et des Statistiques (SOeS) website of the French Ministry of the Environment, Energy and the Sea (MEEM)**: *www.statistiques.developpement-durable.gouv.fr*
- **The Eurostat** database of the European Commission: *ec.europa.eu/eurostat/fr/data/database*

Other sources containing data on climate and energy

- "Les Chiffres-clés du climat. France et monde" – 2016 edition, MEEM, 2015: *www.statistiques.developpement-durable.gouv.fr/publications/p/2369/1072/chiffres-cles-climat-france-monde-edition-2016.html*
- "Les Chiffres-clés Climate / Air / Energy" – édition 2015, ADEME, 2016: *www.ademe.fr/climat-air-energie-edition-2015*

Other sources containing data on waste

- "Déchets: Chiffres-clés" – Edition 2015, ADEME, 2015: *www.ademe.fr/dechets-chiffres-cles*
- "Bilan national du recyclage 2003-2012", ADEME, 2015: *www.ademe.fr/bilan-national-recyclage-2003-2012*

Distance calculators

- Example of a distance calculator for road and air journeys: *calculerlesdistances.com*
- Example of a distance calculator for maritime transport: *www.sea-distances.org*
- Example of a distance calculator for international and multimodal freight (including rail): *www.uic.org/dium*

APPENDIX 7: EXAMPLE OF A RESULT SUMMARY SHEET

Car-sharing, carpooling service using electrical vehicles

Organizational **ACTION**

PROPONENT OF THE ACTION	Tartempion

THE ACTION

OBJECTIVE:

Reducing the impact on the environment and the nuisance represented by vehicles in the village, whilst enabling the staff concerned to make savings.

START DATE: March 2015

SOURCES OF EMISSIONS TARGETED:

Source 23 – Commuting

NATURE: Indirect

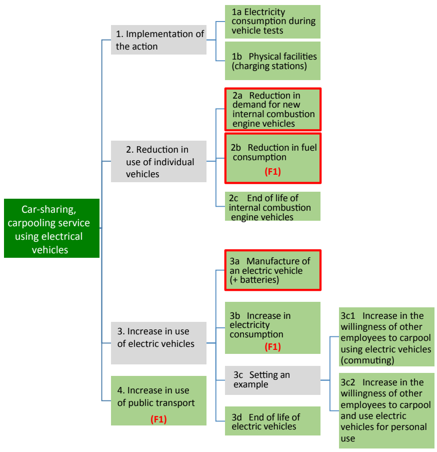
DURATION OF ACTION: Unlimited, action integrated over the long term

LEVEL OF APPROACH	STATUS OF THE ACTION	QUANTIFICATION POINT
Intermediate	Currently being deployed	Midway

DESCRIPTION OF THE ACTION

Providing the company's employees with a car-sharing/carpooling service using electric vehicles, via a subscription system. The vehicles are rented.
The priority target is the commute.
For the moment, only one car is involved (4 people), but there is potential for 28 vehicles within the company.

CONSEQUENCE TREE FOR THE ACTION



Consequence with an impact on GHG (green box)

Consequence header or no impact on GHG (grey box)

(F1) *External factor 1 applies*

Consequence taken into account in the quantification (red-outlined box)

The quantification scope for the action

CREATING THE TREE	HYPOTHESIS 1	When defining the action, we have not included any sub-leasing of the vehicle to local residents during the day (times when the vehicles are not used by employees), which is currently only an idea.
	HYPOTHESIS 2	Inasmuch as the vehicles were parked in an underused public car park, the potential consequence "Reduction in parking spaces required" has not been included in the tree. These are GHG emissions relating to the downtime of the car park (the reduction in the number of vehicles reduces the spaces needed for parking).
	HYPOTHESIS 3	
	HYPOTHESIS 4	
	HYPOTHESIS 5	
	EXTERNAL FACTOR 1	**Structure:** The annual number of kilometers changes from one year to the next, which influences the impact of the action on GHGs > **Taken into account**
	EXTERNAL FACTOR 2	
	EXTERNAL FACTOR 3	
	EXTERNAL FACTOR 4	
	EXTERNAL FACTOR 5	
	CONSEQUENCES NOT TAKEN INTO ACCOUNT	- Energy consumption during vehicle tests - Physical facilities (charging stations) - Increase in use of public transport - Increase in electricity consumption - Increase in the willingness of employees to carpool using electric vehicles - Increase in the willingness of employees to use electric vehicles for personal use

BASELINE SCENARIO

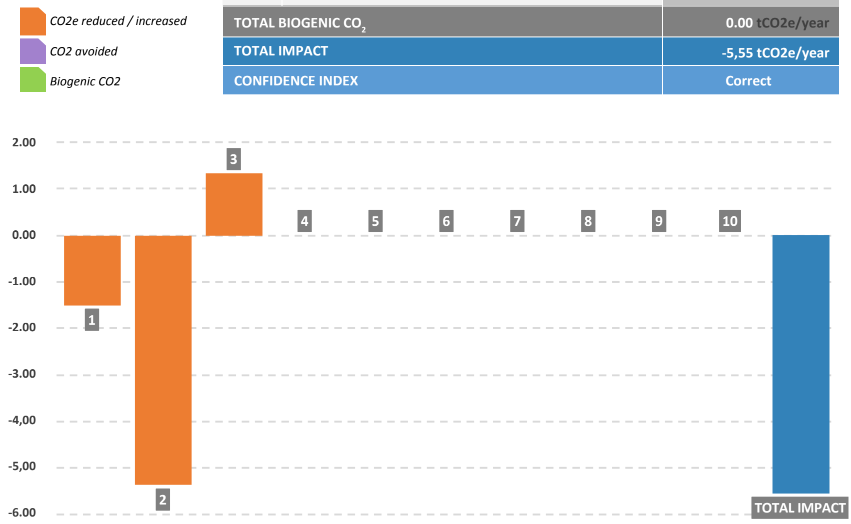
Continuation of the historic situation integrating the external factors
The four Tartempion employees continue to use their personal vehicles for commuting. However, given the state of repair of their old vehicles, they all bought new ones in 2015.

Explanations:
- as the employees' old vehicles were coming to the end of their life, their replacement was imminent (employee survey);
- although carpooling might have been possible among the employees given the specific geographic location of Tartempion (near Lille, but relatively isolated), it was the provision of an electric vehicle by the employer that actually triggered the implementation of the action.

IMPACT OF THE ACTION ON GHGs

GHG taken into account: fossil CO2	Start date of observation:	March 2015	Length of observation period:	1 year

1	Reduction in demand for new internal combustion engine vehicles	-1.50 tCO2e/year
2	Reduction in fuel consumption	- 5.37 tCO2e/year
3	Manufacture of an electric vehicle (+ batteries)	1.33 tCO2e/year
4	-	0.00 tCO2e/year
5	-	0.00 tCO2e/year
6	-	0.00 tCO2e/year
TOTAL CO_2 REDUCED/INCREASED		-5,55 tCO2e/year
7	-	0.00 tCO2e/year
8	-	0.00 tCO2e/year
TOTAL CO_2 AVOIDED		0.00 tCO2e/year
9	-	0.00 tCO2e/year
10	-	0.00 tCO2e/year
TOTAL BIOGENIC CO_2		0.00 tCO2e/year
TOTAL IMPACT		-5,55 tCO2e/year
CONFIDENCE INDEX		Correct



CONFIDENCE INDEX FOR THE RESULT

Confidence index for the result: Correct

Confidence index per stage:

Baseline scenario: **High**
Quantification scope: **Correct**
Data quality: **High**

INDEX	COMMUNICATION	DECISION-MAKING
Weak	Internal: with caution Exernal: none	Integration in a decision-making process: risky
Correct	Internal: possible External: with caution	Integration in a decision-making process: conceivable
Optimal	Internal: possible External: possible	Integration in a decision-making process: favorable

APPENDIX 8: MAIN CASE STUDY IN FULL

This semi-fictitious case was inspired very largely by action 47 implemented by Pocheco for which the quantification exercise was undertaken during the 2015 experiments using the ADEME method.

The earlier exercise has been changed to enable it to correspond completely with the changes made in this second version and provide a comprehensive example.

3.1 STAGE 1 DEFINE THE QUANTIFICATION OBJECTIVE

	Sub-stage	Illustration
# 1	Give the quantification point	Midway
# 2	Give the quantifica-tion objective	Monitoring the effectiveness of the action
# 3	Give the level of ap-proach selected	Intermediate

3.2 STAGE 2 DEFINING THE ACTION TO BE QUANTIFIED

	Sub-stage	Illustration
# 1	Give the proponent of the action	(Organization) Tartempion
# 2	Give the name of the action	Car-sharing and carpooling service using electric vehicles
# 3	Give the status of the action	Currently being deployed
# 4	Give the nature of the action	Indirect
# 5	Give the type of action	Organizational action
# 6	Give the geographic location of the action	Organization's site

# 7	**Give a description of the action**	Providing the company's employees with a car-sharing/carpooling service using electric vehicles, via a subscription system. The vehicles are rented. The priority target is the commute. For the moment, only one car is involved (4 people), but there is potential for 28 vehicles within the company.
# 8	**Give the main objective of the action**	Reducing the impact on the environment and the nuisance represented by vehicles in the village, whilst enabling the staff concerned to make savings.
# 9	**Origin of the GHG emissions targeted by the action**	Fuel consumption by vehicles with internal combustion engines
# 10	**Sources of emissions targeted for an Organizational BEGES**	Source 23 - Commuting
# 11	**Sources of emissions targeted for a Regional BEGES**	-
# 12	**Background prior to the realization of the action**	Prior to realization of the action, each employee came to work in their own internal combustion engine vehicle. At the end of 2014, a number of employees were faced with the issue of renewing their ageing personal vehicles (main use: commuting). It was decided to establish a vehicle rental service for employees.
# 13	**Greenhouse gas(es) targeted by the action**	CO_2
# 14	**Implementation start date**	March 2015
# 15	**Length of implementation period**	Action integrated over the long term (no end scheduled).
# 16	**Consequence start date**	March 2015
# 17	**Length of consequence period**	*Theoretically unlimited*
# 18	**Give the main action sector to which the action relates**	-
# 18	**Any elements identified as documenting the action**	-
# 20	**Provide any other useful information**	-

3.3 STAGE 3
CREATING THE CONSEQUENCE TREE FOR THE ACTION

Sub-stage 1: consequence tree for the action

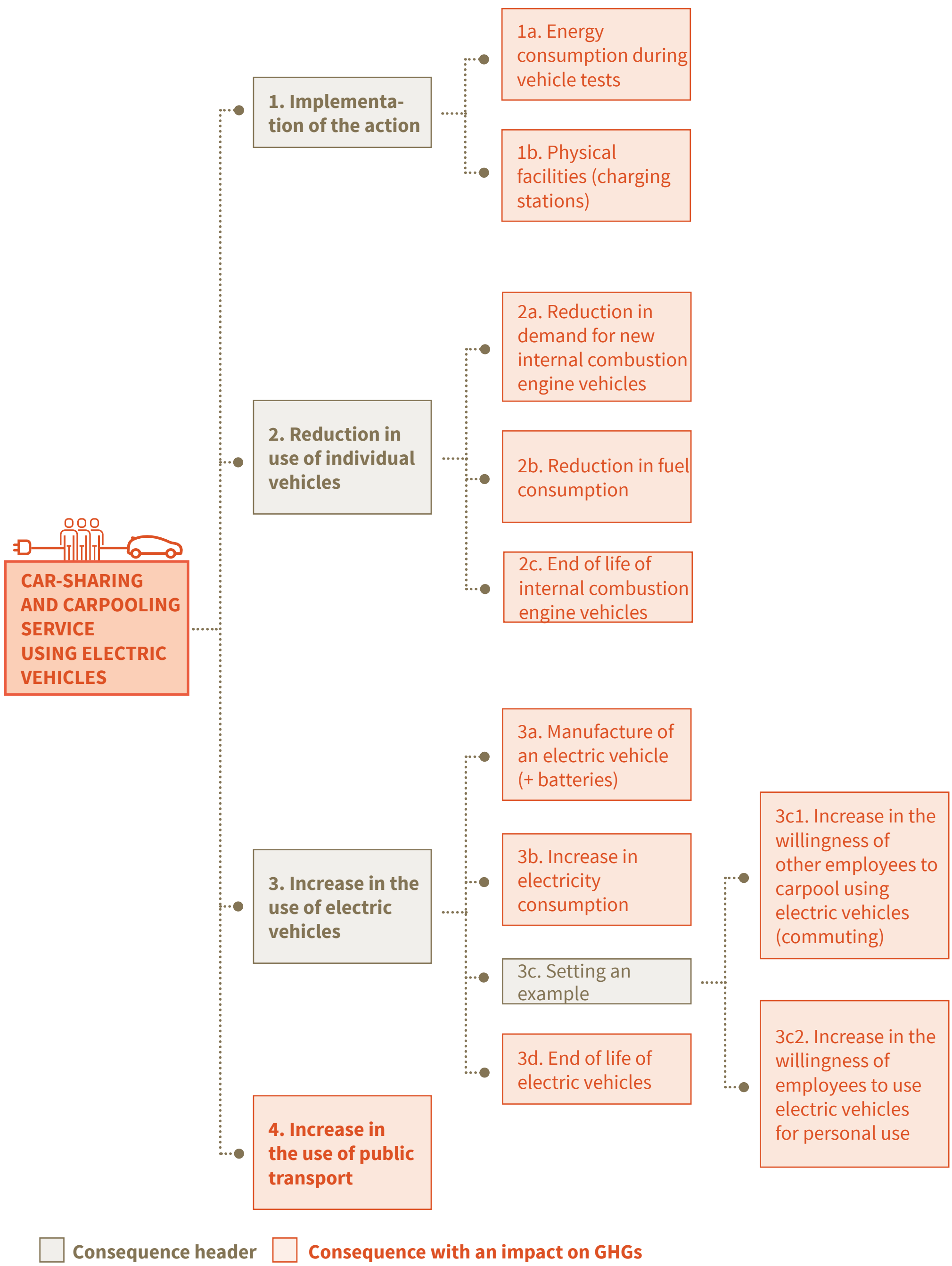


Figure 17: Consequence tree for the main case study.

Sub-stage 2: hypotheses used to create the tree

	Hypotheses
# 1	We will not include in the definition of the action any sub-leasing of the vehicle to local residents during the day (times when the vehicles are not used by employees), which is currently only an idea.
# 2	Inasmuch as the vehicles were parked in an underused public car park, the potential consequence “Reduction in parking spaces required” has not been included in the tree. These were GHG emissions relating to the downtime of the car park (the reduction in the number of vehicles reduces the spaces needed for parking).

Sub-stages 3 and 4: Description of consequences and identification of the origin of the emissions targeted (if necessary)

Consequence	Description	Origin of emissions
1	-	-
1a	The choice of vehicle was made after one day testing a number of vehicles	EV for test journeys
1b	Manufacture and installation of the charging station	Manufacture of the station and installation work
2	-	-
2a	Non-replacement of new private vehicles	Production of vehicles
2b	Reduction in fuel requirements due to car-sharing and carpooling using electric vehicles	Production and combustion of fuel by employees’ vehicles - commuting
2c	Reduction in emissions relating to vehicles’ end of life	Collecting and processing materials
3	-	-
3a	Manufacture of the EV and its battery	Manufacture of the EV and its battery
3b	EV for commuting	Electricity consumption of the vehicle
3c	Positive feedback could lead to a scaling up of the action	-

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3c1	Other carpooling teams could be created internally at Tartempion	Same origin as the consequences of consequence headers 1 and 2 and for consequences 3a and 3b
3c2	Externally, employees persuaded by this initiative (carpooling and/or electric vehicles) could apply it to their personal travel	Same origin as the consequences of consequence headers 1 and 2 and for consequences 3a and 3b
3d	Collecting and processing the electric vehicle at the end of its life	Collecting and processing materials
4	One of the carpoolers (the one who lives furthest away) will use public transport to come closer to the others	Production and energy consumption of public transport

3.4 STAGE 4 IDENTIFYING EXTERNAL FACTORS AFFECTING THE ACTION

	Sub-stage	Illustration
# 1	**Identifying and describing each eternal factor**	**Structural factor:** the number of kilometres travelled annually can be caused to change (employee moves home, prolonged absence etc.)
# 2	**Explaining how they are taken into account**	In the context of this exercise, one of the four employees involved in carpooling has just moved to a village further away, changing from 8,000 km per year to 15,400 km per year. To keep a constant scope between the baseline scenario and the action scenario, we will use the employee's new location, so the annual distance travelled will be 15,400 kilometers in both in the baseline scenario and the action scenario.
# 3	**Indicating the consequence(s) of the tree on which each external factor operates**	The structural factor operates on consequences 2b, 3b and 4.

3.5 STAGE 5
CHOOSING THE BASELINE SCENARIO

	Sub-stage	Illustration
# 1	**Describing the potential baseline scenario(s)**	*Baseline scenario 1 - continuation of the historic situation integrating the external factors:* The four Tartempion employees continue to use their personal vehicles for commuting. However, they each purchased a new vehicle in 2015 due to the state of repair of their old ones. *Baseline scenario 2:* The same: without the provision by Tartempion of an electric vehicle, the four Tartempion employees organized themselves to carpool their own personal vehicles anyway. However, given the state of repair of their old vehicles, they all bought new ones in 2015.
# 2	**Choice of baseline scenario: why is this the most probable scenario?**	*Baseline scenario 1:* - as the employees' old vehicles were coming to the end of their life, their replacement was imminent (employee survey); - although carpooling might have been possible among the employees given the specific geographic location of Tartempion (near Lille, but relatively isolated), it was the provision of an electric vehicle by the employer that actually triggered the implementation of the action.
CONFIDENCE INDEX **Reliability score 1**		• *Probability:* after a survey among the employees concerned, it emerged that none of them would have considered carpooling without the provision of the shared vehicle by the company. Only one scenario was therefore reasonably possible. • *Data quality*: we have a precise description of the baseline scenario (the model of the employees' hypothetical "future" cars has been adapted to suit the characteristics of each - with/without children, need for long distances (or not) etc.), which takes account of the structural factor identified. **> Reliability score 1 = 4/4**

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3.6 STAGE 6
DEFINING THE QUANTIFICATION SCOPE

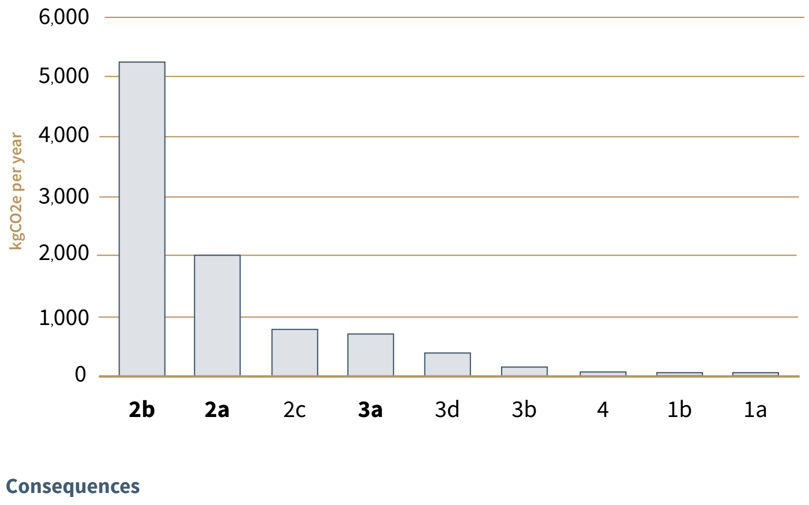
	Sub-stage	Illustration
# 1	**GHGs taken into account in the quantification**	All Kyoto GHGs
# 2	**Determined observation period**	It was decided to quantify the impact of the action on GHGs during its first year of implementation. The impact of the action on GHGs will be measured in tCO_2e per year. *Justification:* Tartempion's action is theoretically of unlimited duration. We hypothesize that the consequences of the action are stable from its launch onwards.
# 3	**Non-relevant consequences excluded**	Consequences 3c1 and 3c2 relating to "multiplier effects" are excluded from the quantification.

Sub-stages 4 & 5 – Theoretical evaluation in order of magnitude and ordering of consequences

	Weight of GHGs ($kgCO_2e$ per year)	Justification
1a	**35 $kgCO_2e$**	7 vehicles were tested: 5 hybrids and 2 electric over 60 km each. The hypotheses used to arrive at this order of magnitude are as follows: • 110 gCO_2e per km for the hybrid vehicles; • 20 kWh per 100 km and 82 gCO_2e per kWh for the electric vehicles.
1b	**55 $kgCO_2e$**	The charging station weighs about 30 kg (mostly plastic). We used the following upper bound hypotheses: • amortization period of 3 years; • emission factor of 5.5 $kgCO_2$ per kg (valid for a " machine tool").
2a	**2,000 $kgCO_2e$ per year**	4 vehicles will not be manufactured due to the action. It is considered, as an initial approximation, that the amortization of a vehicle is about 0.5 tCO_2e per year (valid for an amortization period of 10 years).
2b	**5,250 $kgCO_2e$ per year**	In total, the 4 vehicles cover an average of 35,000 km per year. An EF of 150 gCO_2 per km is used, which corresponds with the internal combustion engine vehicles that would have been bought in the baseline scenario.
2c	**800 $kgCO_2e$ per year**	According to a lifecycle analysis undertaken by ADEME, there are two orders of end-of-life GHG emissions: • recycling: 0.6 tCO_2e per vehicle; • emissions avoided through recycling: -2 tCO_2e per vehicle. All vehicles are deemed to have a lifetime of 7 years.
3a	**683 $kgCO_2e$ per year**	The production of the electric vehicle represents about 91 gCO_2 per km. The impact of the production of the electric vehicle is defined on the basis of the 7,500 km travelled per year.

3b	**123 kgCO_2e per year**	Given the geographic location of the employees, the electric vehicle covers approx. 7,500 km per year. Consumption is deemed to be 20 kWh per 100 km and the EF, 82 gCO_2e per kWh.
3d	**371 kgCO_2e per year**	According to a lifecycle analysis undertaken by ADEME, there are two orders of end-of-life GHG emissions: • recycling: 1.1 tCO_2e per vehicle; • emissions avoided through recycling: -3,7 tCO_2e per vehicle. The lifetime is considered to be identical to internal combustion engine vehicles (7 years).
4	**105 kgCO_2e per year**	One of the employees comes to work by train and metro. This is deemed to be of the order of 15,000 km per year with an average EF of 7 gCO_2 per passenger km (order of magnitude valid for electric public transport).

Hence the following initial evaluation of the absolute value of the impact on GHGs, consequence by consequence:



Sub-stage 6 - Retaining the consequences

#	Weight of GHGs
2b	55.7%
2a	21.2%
2c	3.5%
3a	7.2%
3d	3.9%
3b	1.3%
4	1.1%
1b	0.6%
1a	0.4%

In Stage 1 - When defining the quantification objective, we opted for an intermediate level of approach.

We therefore needed to select at least all of the consequences in decreasing order, enabling us to obtain 75% of the total impact.

Thus, by taking into account the 2b consequences ("Reduction in the fuel consumption of internal combustion engine vehicles") and 2a ("Reduction in demand for new internal combustion engine vehicles"), we achieve the objective of 75% with almost 77% of the total impact.

However, with the data available for the 3a consequence ("Electric vehicle production") we make the choice to integrate it into the quantification in order to achieve 84% of the total impact and thereby improve the confidence index of our result.

Sub-stage 7 - Reliability score

Following the definition of the quantification scope, we reach a margin of 84% of the total impact of the action.

In line with the scale defined, the reliability score for this stage is 2/4.

Reliability score 2 = 2/4

3.7 STAGE 7 COLLECTING THE AVAILABLE DATA

Sub-stages 1 & 2

Csq.	Type of data	Data	Useful for: baseline scenario/action scenario/both	Source
2a	AD	Number of internal combustion engine vehicles bought	Baseline scenario	Tartempion
2a	C	Amortization period for an internal combustion engine vehicle	Baseline scenario	Constructors' data
2a	EF	Production of an internal combustion engine vehicle	Baseline scenario	Lifecycle analysis - ADEME
2b	AD	Distance travelled by each of the internal combustion engine vehicles	Baseline scenario	Tartempion
2b	C	Fuel consumption of each of the internal combustion engine vehicles	Baseline scenario	Tartempion
2b	EF	Fuel (diesel fuel at the pump)	Baseline scenario	Base Carbone
3a	AD	Number of electric vehicles bought	Action scenario	Tartempion
3a	C	Amortization period for an electric vehicle	Action scenario	Constructors' data
3a	EF	Production of an electric vehicle	Action scenario	Lifecycle analysis - ADEME

Sub-stage 3 - Determine the reliability score associated with the data quality

	Csq. 2a	Csq. 2B	Csq. 3a
AD	4/4	4/4	4/4
C	2/4	-	2/4
EF	2/4	4/4	2/4
Sub-score selected	**2/4**	**4/4**	**2/4**

The reliability of the data used is evaluated for each consequence included in the quantification scope.

In order to obtain the overall reliability score associated with Stage 7, it is necessary to wait for the realization of the calculations in Stage 8 to obtain the weight of each of the consequences in the final result.

3.8 STAGE 8
QUANTIFY THE IMPACT OF THE ACTION ON GHGS

Sub-stages 1 & 2 – Calculating the impact of each consequence on GHGs

CONSEQUENCE 2A - REDUCTION IN DEMAND FOR NEW INTERNAL COMBUSTION ENGINE VEHICLES				
Type of data	**Data**	**Value Baseline scenario**	**Value Action scenario**	**Unit**
AD	**No. of internal combustion engine vehicles bought**	**4**	-	Vehicle
C	**Amortization period for an internal combustion engine vehicle**	**10**	-	Years
EF	**Production of an electric vehicle**	**3,757**	-	$kgCO_2$ per vehicle
Impact of consequence 2a = 4 x 3,757/10 = -1,503 $kgCO_2$ per year				

CONSEQUENCE 2B - REDUCTION IN FUEL CONSUMPTION				
Type of data	**Data**	**Value Baseline scenario**	**Value Action scenario**	**Unit**
AD	Distance travelled by vehicle 1	6,600	-	km per year
AD	Distance travelled by vehicle 2	6,600	-	km per year
AD	Distance travelled by vehicle 3	15,400	-	km per year
AD	Distance travelled by vehicle 4	6,600	-	km per year
C	Consumption of internal combustion engine vehicle 1	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 2	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 3	5	-	litres per 100 km
C	Consumption of internal combustion engine vehicle 4	4	-	litres per 100 km
EF	Fuel used	3.17	-	$kgCO_2$ per litre
Impact of consequence 2b = - (6,600 x 5 + 6,600 x 5 + 15,400 x 5 + 6,600 x 4)/100 x 3,.17 = - 5,370 kgCO2 per year				

CONSEQUENCE 3A - PRODUCTION OF AN ELECTRIC VEHICLE (INCL. BATTERY)				
Type of data	**Data**	**Value Baseline scenario**	**Value Action scenario**	**Unit**
AD	No. of internal combustion engine vehicles bought	-	1	Vehicle
C	Amortization period for an internal combustion engine vehicle	-	5	Years
EF	Production of an electric vehicle	-	6,634	$kgCO_2$ per vehicle
Impact of consequence 3a = 1 x 6,634/5 = 1,327 kgCO2 per year				

Sub-stage 2 - Determining the total impact of the action on GHGs

Total impact on GHGs = Impact of consequence 2a + Impact of consequence 2b + Impact of consequence 3a

Total impact on GHGs = -5.5 tCO2 per year

Sub-stage 3 - Determining the confidence index for the final result

Before determining the confidence index for the final result, the calculation of the reliability score for Stage 7 must be finalized. One therefore reaches the weighted average of the sub-scores obtained for the data used for each of the consequences:

Csq.	Weight	Sub-score
2a	18%	2
2b	68%	4
3a	16%	2

Reliability score 3
= (2 x 18 + 4 x 68 + 2 x 16)/(18 + 68 + 16)
= 3.4/4

Reliability score
......../4

Hence, *ultimately*:

Reliability score	Reliability score	Reliability score	Final score
4/4	2/4	3.4/4	27.2/64

According to the scale defined by the method, **the confidence index for the result is correct.**

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CLÉS POUR AGIR

QUANTIFYING THE IMPACT OF AN EMISSION REDUCTION ACTION ON GHGS

Whether they be for PCAET or BEGES, these processes are based on action plans to reduce GHG emissions, and are part of a process of quantified evaluation. ADEME therefore now proposes a METHOD TO QUANTIFY THE IMPACT OF A REDUCTION ACTION ON GHGs.

This sequential methodology consists of 8 stages and is divided into three approaches - simplified, intermediate, in-depth - depending on the objective of the exercise on the one hand and the target confidence index on the other.

This guide is VERSION 2 of the ADEME quantification method.

It has been updated using experiential feedback from users and is intended to be more robust and operational.

Next document update: 2020.

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