Fact-finding study in support of the development of an EU strategy for freight transport logistics

Lot 3: Introduction of a standardised carbon footprint methodology

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Glossary

Abbreviation	Explanation
3PL	Third-party logistics provider
CF	Carbon footprint(ing), relates to GHG emissions of a transport service
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EC	European Commission
EU	European Union
EU-27	The 27 EU Member States before Croatia became a member of the Union on 1 July 2013
GHG	Greenhouse gas
GVW	Gross vehicle weight
GWP	Global Warming Potential defined by the Intergovernmental Panel on Climate Change: 25 g CO_2/g CH_4 and 298 g CO_2/g N_2O
MRV	Monitoring, reporting and verification. A proposed policy instrument of the European Commission to reduce the GHG emissions of shipping.
ISO/TR	ISO Technical Report: "An informative document containing information of a different kind from that normally published in a normative document."[1]
ISO/TS	ISO Technical Specification: "A normative document representing the technical consensus within an ISO committee."[2]
Level 1	A Level 1 methodology for carbon footprinting uses performance-based default values (g/tkm per vehicle type) (see Section 2.3.1 for a more complete definition)
Level 2	A Level 2 methodology for carbon footprinting uses vehicle-based default values (g/km per vehicle type) (see Section 2.3.1 for a more complete definition)
Level 3	A Level 3 methodology for carbon footprinting uses real-world measured fuel consumption data (company-specific) (see Section 2.3.1 for a more complete definition)
N_2O	Nitrous oxide
pkm	Passenger-kilometre
TEU	Twenty feet Equivalent Unit
tkm	Tonne-kilometre
WTW (=TTW+WTT)	Well-to-wheel (LCA typology for cradle-to-grave approach)
TTW	Tank-to-wheel (emissions resulting from vehicle operation)
WTT	Well-to-tank (emissions resulting from the fuel production, processing and delivery)

[1] http://www.iso.org/iso/home/standards_development/deliverables-all.htm?type=tr

[2] http://www.iso.org/iso/home/standards_development/deliverables-all.htm?type=ts

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Abstract

Carbon footprinting is a method to generate data about the GHG emissions of transport services. Availability of such information is regarded as one means to limit the emissions and improve the efficiency of transport.
However, the existence of many standards, initiatives and calculation tools makes different carbon footprints mutually incomparable, thus hampering the potential of this measure.

The main problem addressed in this study is therefore the inability to benchmark transport services on GHG emissions. This is due by two intermediate problems. Firstly, many companies do not report their carbon footprints. Secondly, the carbon footprints that are available are often neither accurate nor comparable.

To harmonize carbon footprinting and to allow benchmarking of transport services, four policy options were identified. The options address increased reporting on the one hand and the level of harmonization of calculation methods on the other.

The study concludes that a methodology representing real-world fuel consumption data scores highest on improving the accuracy and reliability of the carbon footprints, and consequently has the best cost/benefit ratio for GHG reduction. This option, however, is perceived as realistic only for voluntary reporting.

The research made in the study identified an important role of the EU in the carbon footprinting harmonisation process.

Abstrait

La mesure de l'empreinte carbone est une méthode qui permet de produire des données sur les émissions de GES des services de transport. La diffusion de cette information est considérée comme un moyen de limiter les émissions et d'améliorer l'efficacité du transport.
Cependant, l'existence de nombreuses normes, initiatives et outils de calcul rend les différentes mesures de l'empreinte carbone incompatibles et non comparables, entravant ainsi le potentiel de ces mesures.

Par conséquent, l'incapacité à fournir un repère précis sur l'émission des GES des services de transport constitue le principal problème abordé dans cette étude. Deux problèmes intermédiaires en sont la cause. Tout d'abord, de nombreuses entreprises n'établissent aucun rapport concernant l'empreinte carbone issue de leur activité. Deuxièmement, les mesures de l'empreintes carbone qui sont disponibles ne sont souvent ni exactes ni comparables.

Afin d'harmoniser les méthodes de calcul de l'empreinte carbone et de permettre une analyse comparative des services de transport, quatre options stratégiques ont été identifiées. Les options envisagées concernent l'augmentation de rapports d'un côté, et le niveau d'harmonisation des méthodes de calcul de l'autre.

L'étude conclut que la méthodologie représentant les données de la consommation mondiale réelle en carburant permet une amélioration de l'exactitude et de la fiabilité des données concernant l'empreinte carbone, et obtient par conséquent le meilleur rapport coût/bénéfice en matière de réduction des GES. Cependant, cette option n'est considérée comme réaliste que sur la base de l'établissement de rapports volontaires.

La recherche menée dans cette étude a identifié un rôle important que doit jouer l'UE concernant la procédure d'harmonisation du calcul de l'empreinte carbone.

Summary

Carbon footprinting
Carbon footprinting of transport services is a methodology for providing information about the GHG emissions associated with performance of those services. Availability of such information is regarded as one means to reduce transport GHG emissions, on both the demand and supply sides of the market. Transport users (i.e. shippers and passengers) can include GHG efficiency as a criterion in their transport decision, while transport operators, can in turn reduce their emissions to improve their competitive position. This may create a win-win situation, since companies will be incentivised to implement GHG reduction measures, lowering in consequence costs of the transport/logistic operations.

In recent years carbon footprinting has become increasingly popular, as evidenced by the growing number of operators who report their footprint as well as by the multiplicity of carbon footprinting initiatives and tools now available. However, the existence of so many initiatives, each with its own methodology and data, makes the available carbon footprints mutually incomparable and unsuitable for benchmarking different transport operators. Attempts to harmonise carbon footprint calculations in the transport sector were therefore initiated several years ago by developing standards and guidelines for such calculations.

The European Commission has taken the initiative to contributing to the development of harmonised carbon footprinting standards for passenger and freight transport. As a first step, they have commissioned the present study, which has the overall objective of providing a preliminary assessment of the impacts to be expected under different policy options for promoting the development of harmonised carbon footprinting measures in the EU. The results of each of the main steps in this study are summarised below.

Problem definition
The main problem addressed in this study is that transport decision-makers are presently unable to benchmark available transport services with respect to GHG emissions. This is due by two intermediate problems. Firstly, many companies do not report their carbon footprint, as they regard carbon footprinting as complex, time-consuming and revealing sensitive business information. This is compounded by a lack of incentives to do so, as shippers/passengers do not generally ask for carbon footprint information. Secondly, the carbon footprints that are available are often neither accurate (i.e. do not represent real-world emissions) nor comparable. This is due, on the one hand, to many of the available tools being based on default values, such as the average fuel consumption of a particular vehicle type, rather than on the measured fuel consumption of a particular vehicle and, on the other, to the fact that the various tools employ different methodologies and assumptions. This lack of comparability is in itself also a disincentive for the market to report, request or use carbon footprints.

The identified problems prove to be less severe for passenger transport, as carbon footprinting of transport services is already carried out by several large passenger transport providers and as the calculations are easier to harmonise. It is for this reason that the present study focuses mainly on freight transport.

Policy objectives

It is to be anticipated that in the absence of suitable policy the number of available initiatives will continue to grow without being significantly harmonised. This limits the ability of shippers, passengers and decision-makers to effectively use the information for transport decisions and benchmarking.

To improve the harmonisation, accuracy and application of carbon footprinting, four specific goals have been defined:
- calculations must become consistent and comparable;
- calculations must become reliable and accurate;
- for application in business practice, carbon footprinting must be simplified and facilitated;
- the awareness of shippers, 3PLs and hauliers must be increased.

Policy options

In pursuit of these policy objectives, a long list of policy options has been assembled in this study. As shown in Table 1, the options are aimed towards harmonisation and accuracy of carbon footprinting and also its increased application (i.e. reporting of carbon footprints). The 10 basic options identified can be applied to passenger transport, freight transport, or both, resulting in a long list of 30 options. Four of these options have been selected for impact analysis, based on criteria including sufficient coverage of the full spectrum of options, practical feasibility and contribution to achieving the defined objectives.

Table 1 Overview of selected policy options

Increased reporting / Harmonisation	Voluntary reporting	Mandatory reporting
No EU harmonisation efforts	Baseline scenario	
Voluntary guidelines for CF methodology	Option 1 (mild)	Option 3 (medium)
Mandatory CF methodology Level 1		
Mandatory CF methodology Level 2		Option 4 (strong)
Mandatory CF methodology Level 3	Option 2 (medium)	

Note: The methodologies are described in detail in Section 2.3.1. A Level 1 methodology uses performance-based default values (g/tkm per vehicle type), a Level 2 methodology vehicle-based default values (g/km per vehicle type), a Level 3 methodology real-world measured fuel consumption data (company-specific).

As can be seen in the table above, Options 1 and 3 leave the choice for a particular methodology open to the market, whereas Options 2 and 4 oblige operators to use a particular methodology for calculating their carbon footprint.

Analysis of impacts

The two options with mandatory reporting (Option 3 and 4) will obviously result in a significant increase in the use of carbon footprinting. On the other hand, only Option 2, with mandatory Level 3 methodology (using real-world company-specific fuel consumption data), significantly improves the accuracy and reliability of the information provided. This, in turn, allows the market to make a fair comparison.

Altogether, Options 1 and 3 (both with voluntary use of methodologies) are expected to lead to only limited GHG emission reductions, as positive impacts on market functioning will be negligible as long as methodologies are not well harmonised and reported carbon footprints are incomparable.
Option 4 has the dual advantage of a single, harmonised methodology being used, with all transport operators under *obligation* to report their carbon footprint according to this method. At the same time, though, it has the limitation that the reported carbon footprints will still be based partly on fixed default values, e.g. for vehicle fuel efficiency. Consequently, the footprints calculated will not be a true reflection of real-world GHG performance and will not incentivise some of the key reduction measures, such as more fuel-efficient vehicles, significantly limiting effectiveness.

Option 2 has the major advantage of ensuring that all carbon footprints reported can be compared, and at the same time provide a good indication of real-world emissions. It will incentivise the full range of emission reduction measures, moreover, and bring an end to the market being given incomplete and incomparable carbon footprints. However, as this approach is more complex, it needs to be further developed in a stepwise approach involving all relevant stakeholders. The share of the market reporting carbon footprints will therefore remain limited, at least in the short term. The majority of transport operators are SMEs, which are unlikely to adopt complicated carbon footprinting practices. In the long run uptake should increase, though, as carbon footprints become recognised as a valuable and reliable means for benchmarking transport services with respect to GHG emission performance.

All four policy options result in relatively higher administrative costs for the market and the Commission, varying depending on the level of complexity of the calculations and the level of mandatory reporting. Options 1 and 2 are associated with relatively low costs compared with the other options, Options 3 and 4 with the highest cost, owing to the mandatory reporting requirements.

In comparison with the ‘baseline scenario’, the GHG emission reduction under Option 1 is anticipated to be zero, because of the multiplicity of methodologies permitted. Option 3 requires mandatory reporting, but allows diverse methodologies as well. This option is therefore also expected to result in a very limited GHG reduction. The estimated reduction is greatest for Options 2 and 4, which both prescribe a single, detailed, mandatory methodology.

Illustrative calculations performed for the road haulage sector indicate that although the estimated GHG reduction is comparable (2.1 and 2.7 Mton for Options 2 and 4, respectively[3]), the costs of implementing Option 2 are estimated to be significantly lower than for Option 4.

Comparison of options and recommendation
Comparison of the four policy options with respect to their overall effectiveness in contributing to the aforementioned four objectives, their efficiency (i.e. cost-effectiveness) and their coherence with other EU policies shows that Option 2 scores relatively highest (followed by Option 4).
This option is therefore recommended. While Options 2 and 4 yield broadly similar benefits in terms of expected GHG emission cuts, Option 2 brings with it a significantly lower administrative burden. Moreover, Option 2 is consistent with the environmental footprint schemes currently being rolled out for

[3] Average values for a minimum and a maximum scenario. See Section 6.10.

products and organisations, which are likewise voluntary and based on measured data. A specific added value of carbon footprinting compared with existing policy instruments is that it allows transport buyers to contribute to realising a more GHG-efficient transport system, by selecting the most GHG-efficient transport service provider. Furthermore, Option 2 aligns with the strong preference of stakeholders for a Level 3 methodology.

It is recommended that policy Option 2 is implemented in phases, given that carbon footprinting of transport services is not currently common practice, especially not with a Level 3 methodology. In addition, there are still a number of unresolved issues, including emission allocation across clients and reporting in non-road sectors, for example.

Against this background, the following stepwise approach is therefore recommended:
1. Develop guidelines, software systems and reporting for a Level 3 methodology, or support the industry in going so. This should also cover definition of default factors for translating fuel consumption into emissions and other such key issues, as well as a standardised allocation method, taking into due account the existing EU framework and, in particular, the method currently applied for Product and Organisational Environmental Footprints[4].
2. Conduct small-scale testing of these Level 3 methodological guidelines, both in road and non-road sectors, to ensure the data are reliable/accurate and comparable within homogeneous segments.
3. Adjust the guidelines as necessary.
4. Publish and promote the guidelines, with voluntary use by market actors.
5. Implement a framework prescribing use of this Level 3 methodology, *if* carbon footprinting is performed.

Besides the steps outlined above, issues of confidentiality also need to be taken into account, as a Level 3 methodology may reveal sensitive operator information. Additionally, it is recommended that the footprinting system is developed in such a manner that interim data (on fuel consumption and vehicle load factors, for example) are validated by authorised verifiers, to guarantee the quality and reliability of the reported data. The level of automation will need to be very high, as transport services are regularly sub-contracted, requiring significant data transfer.

It is also recommended to investigate whether the outlined policy option should be implemented at the EU-level, or whether the Commission should work to encourage uptake of a *global* benchmarking scheme, this being deemed more useful by stakeholders in an increasingly globalised industry.

4 For more information on OEF/POF, see Section 2.2.2.

Résumé

Empreinte carbone
Le calcul de l'empreinte carbone des services de transport est une méthodologie qui permet de fournir des informations sur les émissions de gaz à effet de serre associées à l'exécution de ces services. La diffusion de cette donnée est considérée comme un moyen permettant de réduire ces émissions dans le transport, tant du côté de la demande que de l'offre sur le marché. Les usagers des transports (c'est-à-dire les expéditeurs et les passagers) peuvent inclure le critère de l'efficacité des gaz à effet de serre dans leur choix de transport, tandis que les opérateurs peuvent, à leur tour, réduire leurs émissions afin d'améliorer leur position concurrentielle.

Au cours de ces dernières années, l'empreinte carbone est devenue de plus en plus populaire, comme en témoignent le nombre croissant d'opérateurs qui rendent cette information publique ainsi que l'ensemble des initiatives et des outils disponibles en la matière. Cependant, il existe tellement d'initiatives, chacune étant caractérisée par sa propre méthodologie et ses propres données, qu'il est impossible de comparer les empreintes carbone disponibles entre elles et de réaliser un étalonnage concurrentiel des différents opérateurs de transport grâce à celles-ci. Il y a plusieurs années, on a donc tenté d'harmoniser les calculs de l'empreinte carbone dans le secteur des transports en développant des normes et des lignes directrices.

La Commission européenne a pris l'initiative de contribuer à l'élaboration de normes harmonisées en matière d'empreinte carbone pour le transport de passagers et de marchandises. Dans un premier temps, ils ont commandé la présente étude, qui a pour objectif général de fournir une évaluation préliminaire des impacts possibles dans le cadre des différentes options politiques envisagées pour promouvoir le développement de mesures harmonisées concernant l'empreinte carbone au sein dans l'UE. Les résultats de chacune des principales étapes de cette étude sont résumés ci-dessous.

Définition du problème
Le problème central abordé dans cette étude est l'incapacité actuelle des décideurs du domaine des transports à comparer les services de transport disponibles en fonction de leurs émissions de gaz à effet de serre.
Deux problèmes intermédiaires en sont la cause. Tout d'abord, de nombreuses entreprises ne déclarent pas leur empreinte carbone, car elles considèrent que cette information est complexe, qu'il faut du temps pour la calculer et qu'elle est sensible à révéler. De plus, elles ne sont pas vraiment incitées à le faire car les expéditeurs ou les passagers ne demandent généralement pas ce genre d'informations. Deuxièmement, la plupart du temps, les empreintes carbone disponibles ne sont ni exactes (c'est-à-dire qu'elles ne représentent pas les émissions réelles) ni comparables. Ce phénomène est dû, d'une part, au fait qu'un grand nombre des outils disponibles utilisent des valeurs par défaut, comme la consommation moyenne de carburant d'un type de véhicule donné plutôt que la consommation réelle d'un véhicule en particulier, et, d'autre part, au fait que les différents outils se basent sur diverses méthodologies et hypothèses. Cette difficulté à établir des comparaisons exerce en soi également un effet dissuasif sur le marché qui ne se sent pas contraint de déclarer, exiger ou utiliser l'empreinte carbone.

Les problèmes identifiés se révèlent moins graves dans le cadre du transport de passagers puisque l'empreinte carbone des services de transport a déjà été évaluée par plusieurs grands fournisseurs et que les calculs sont plus faciles à harmoniser. Voilà pourquoi la présente étude se concentre principalement sur le transport de marchandises.

Objectifs politiques

Il est à prévoir qu'en l'absence d'une politique appropriée, le nombre d'initiatives va continuer à croître mais qu'elles ne seront pas vraiment harmonisées. Cette situation contraint les expéditeurs, les passagers et les décideurs à ne pas pouvoir utiliser efficacement l'information dans leur choix de transport et leur étalonnage concurrentiel.

Pour améliorer l'harmonisation, l'exactitude et l'utilisation de l'empreinte carbone, quatre objectifs spécifiques ont été définis:

- les calculs doivent devenir cohérents et comparables;
- les calculs doivent devenir fiables et précis;
- pour une utilisation en entreprise, l'empreinte carbone doit être simplifiée et facilitée;
- la sensibilisation des expéditeurs, des entreprises 3PL et des transporteurs doit être accrue.

Options politiques

Afin de réaliser les objectifs précités, une longue liste d'options politiques a été dressée dans le cadre de cette étude. Comme le montre le Table 1, les options visent une certaine harmonisation et une certaine précision dans le calcul de l'empreinte carbone, une utilisation plus fréquente de celle-ci (c'est-à-dire la publication d'un rapport concernant son empreinte carbone), voire les deux. Les dix options de base identifiées peuvent être appliquées au transport de passagers, au transport de marchandises, ou aux deux, et forment donc une longue liste de trente options. Quatre de celles-ci ont été sélectionnées pour réaliser l'analyse d'impact sur la base de critères tels qu'une couverture suffisante de l'ensemble des options, la faisabilité pratique et la contribution à la réalisation des objectifs définis.

Tableau 2 Vue d'ensemble des options politiques choisies

Augmentation des rapports / Harmonisation	Rapport volontaire	Rapport obligatoire
Aucun effort d'harmonisation de l'UE	Scénario de base	
Lignes directrices volontaires pour la méthodologie d'empreinte carbone	Option 1 (légère)	Option 3 (moyenne)
Méthodologie d'empreinte carbone obligatoire de niveau 1		
Méthodologie d'empreinte carbone obligatoire de niveau 2		Option 4 (forte)
Méthodologie d'empreinte carbone obligatoire de niveau 3	Option 2 (moyenne)	

Remarque : Les méthodologies sont décrites en détail dans la section 2.3.1. Une méthodologie de niveau 1 utilise des valeurs par défaut basées sur le rendement (g/tkm par type de véhicule), une méthodologie de niveau 2 des valeurs par défaut basées sur le véhicule (g/km par type de véhicule), une méthodologie de niveau 3 des données de consommation de carburant mesurées dans la réalité (spécifiques à l'entreprise).

Comme on peut le remarquer, les options 1 et 3 permettent au marché de choisir une méthodologie alors que les options 2 et 4 obligent les opérateurs à utiliser une méthodologie particulière pour calculer leur empreinte carbone.

Analyse des impacts

Les deux options imposant un rapport obligatoire (option 3 et 4) vont sans aucun doute entraîner une utilisation considérablement plus élevée de l'empreinte carbone. D'autre part, seule l'option 2, imposant une méthodologie obligatoire de niveau 3 (utilisant des données de consommation de carburant basées sur la réalité et spécifiques à l'entreprise), améliore significativement la précision et la fiabilité des informations fournies.
Le marché pourra alors réaliser une comparaison équitable.

En tout, seules les options 1 et 3 (les deux basées sur une utilisation volontaire de méthodologies) devraient conduire à une réduction limitée des émissions de gaz à effet de serre étant donné que les effets positifs sur le fonctionnement du marché resteront négligeables tant que les méthodologies ne seront pas bien harmonisées et que les empreintes carbone déclarées resteront incomparables.

L'option 4 présente le double avantage d'avoir recours à une seule méthodologie harmonisée et d'*obliger* tous les opérateurs de transport à déclarer leur empreinte carbone selon celle-ci. Cependant, dans le même temps, elle présente une limitation car les empreintes carbone déclarées seront toujours, en partie, basées sur des valeurs fixes par défaut, en matière d'efficacité énergétique des véhicules par exemple. Par conséquent, les empreintes calculées ne reflèteront pas parfaitement les émissions de gaz à effet de serre dans la réalité et n'encourageront pas à respecter certaines des mesures de réduction clés, telles que l'utilisation de véhicules plus économes en carburant, ce qui limite considérablement l'efficacité.

L'option 2 présente l'avantage majeur d'assurer une comparaison entre toutes les empreintes carbone déclarées et, en même temps, elle permet de disposer d'une bonne indication des émissions réelles. De plus, elle stimulera le respect de l'ensemble des mesures de réduction des émissions et mettra fin à l'utilisation d'empreintes carbone incomplètes et incomparables sur le marché. Cependant, étant donné que cette approche est plus complexe, elle doit encore être développée en une approche progressive impliquant toutes les parties prenantes pertinentes. La part du marché déclarant son empreinte carbone restera donc faible, au moins à court terme. La majorité des opérateurs de transport sont des PME, qui sont peu susceptibles d'adopter des pratiques complexes pour réduire l'empreinte carbone. Sur le long terme, leur intérêt devrait néanmoins augmenter puisque l'empreinte carbone acquiert la réputation de constituer un moyen très utile et fiable pour réaliser une analyse comparative des services de transport en fonction de la performance des émissions de gaz à effet de serre.

Les quatre options politiques entraînent des coûts administratifs relativement plus élevés pour le marché et la Commission, variant en fonction du niveau de complexité des calculs et du fait que le rapport soit obligatoire ou pas.
Les options 1 et 2 sont associées à des coûts relativement bas par rapport aux options 3 et 4 dont le coût est le plus élevé en raison des exigences liées au rapport obligatoire.

En comparaison avec le « scénario de base », il est prévu que la réduction des émissions de gaz à effet de serre sous l'option 1 reste nulle en raison de la multiplicité des méthodologies autorisées. L'option 3 exige un rapport obligatoire, mais autorise également diverses méthodologies. On s'attend donc à ce que cette option se solde aussi par une réduction très limitée des émissions de gaz à effet de serre. La réduction semble plus importante dans le cadre des options 2 et 4, qui imposent toutes deux une méthode unique, détaillée et obligatoire.

Des calculs illustratifs réalisés pour le secteur du transport routier indiquent que même si la réduction estimée des émissions de gaz à effet de serre s'avère comparable (2,1 et 2,7 mégatonnes pour les options 2 et 4, respectivement[5]), les coûts de mise en œuvre de l'option 2 semblent nettement plus faibles que pour l'option 4.

Comparaison des options et recommandations

La comparaison des quatre options politiques en fonction de leur efficacité globale dans leur contribution aux quatre objectifs mentionnés ci-dessus, de leur rendement (c'est-à-dire le rapport coût-efficacité) et de leur cohérence avec les autres politiques de l'UE indique que l'option 2 produit des résultats relativement plus élevés (elle est suivie par l'option 4). Cette option est donc recommandée. Bien que les options 2 et 4 produisent des résultats fortement similaires en matière de réductions prévues des émissions de gaz à effet de serre, l'option 2 entraîne des tâches administratives considérablement plus réduites. En outre, l'option 2 est compatible avec les programmes d'empreinte écologique actuellement mis en place pour les produits et les organisations, qui sont également volontaires et basés sur des données mesurées. Par rapport aux instruments politiques existants, l'empreinte carbone présente le grand avantage de permettre aux chargeurs de contribuer à la création d'un système de transports plus performant en matière de gaz à effet de serre en sélectionnant le fournisseur de services de transport le plus performant dans le domaine des émissions. En outre, l'option 2 répond à la grande préférence des parties prenantes pour une méthodologie de niveau 3.

Il est recommandé de mettre l'option politique 2 en œuvre progressivement, étant donné que l'empreinte carbone des services de transport ne constitue pas une pratique courante actuellement, et certainement pas l'utilisation d'une méthodologie de niveau 3. De plus, un certain nombre de questions restent encore en suspens, notamment la répartition des émissions entre les clients et les rapports dans les secteurs non routiers.

Dans ce contexte, il est recommandé d'agir par étapes de la manière suivante:

1. Élaborer des lignes directrices pour une méthodologie de niveau 3 ou soutenir l'industrie dans l'élaboration de celles-ci. Ces lignes directrices devraient inclure la définition des facteurs par défaut permettant de convertir la consommation de carburant en émissions et d'autres éléments clés, mais également une méthode de répartition uniforme, tenant compte du cadre de l'UE existant et, en particulier, de la méthode actuellement appliquée en matière d'empreinte écologique des produits et des organisations[6].

5 Valeurs moyennes pour un scénario minimal et un maximal. Voir la Section 6.10.

6 Pour en savoir plus sur l'EEP et l'EEO, consulter la Section 2.2.2.

2. Effectuer des tests à petite échelle de ces lignes directrices méthodologiques de niveau 3, tant dans les secteurs routiers que non routiers, afin de s'assurer que les données sont fiables/précises et comparables au sein de segments homogènes.
3. Ajuster les lignes directrices si nécessaire.
4. Publier et promouvoir les lignes directrices pour que les acteurs du marché puissent les utiliser de manière volontaire.
5. Mettre en place un cadre prescrivant l'utilisation de cette méthodologie de niveau 3 *si* l'empreinte carbone est calculée.

Outre les étapes décrites ci-dessus, des questions de confidentialité doivent également être prises en compte, étant donné qu'une méthodologie de niveau 3 peut révéler des informations sensibles au sujet de l'opérateur. De plus, il est recommandé que le système d'empreinte soit développé de manière à ce que les données provisoires (concernant des facteurs comme la consommation de carburant et la charge du véhicule par exemple) soient validées par des vérificateurs agréés afin de garantir la qualité et la fiabilité des données communiquées. Le niveau d'automatisation devra être très élevé puisque les services de transport sont régulièrement exécutés en sous-traitance, une situation qui nécessite un transfert de données important.

Il est également conseillé de vérifier si l'option politique choisie doit être mise en œuvre au niveau de l'UE ou si la Commission doit plutôt encourager l'adoption d'un programme de benchmarking au niveau *mondial*.
Cette deuxième possibilité est, en effet, considérée comme plus utile par les parties prenantes d'une industrie de plus en plus mondialisée.

1 Introduction

1.1 Background

The European Union has set a very ambitious target for reducing its domestic greenhouse gas (GHG) emissions, aiming to reduce them by 80-95% by 2050 compared with the 1990 level. As the transport sector is responsible for almost a quarter of the EU's GHG emissions, it can play an important role in achieving this target.

In March 2011 the European Commission adopted the Transport White Paper presenting its vision for the future of the EU transport system and defining a policy agenda for the coming decade, and route to the ambitious goal of a 60% reduction in transport GHG emissions by 2050 (EC, 2011). To this end, a list of objectives was announced in the White Paper, including carbon-free inner-city distribution, lowered vehicle fuel consumption and a modal shift towards non-road transport over larger distances. The White Paper sets out several initiatives that can assist the EU in achieving these goals, one of which is the harmonisation of carbon footprinting practices.

Initiative 29 from the Transport White paper **(EC, 2011)**:
"Encourage business-based GHG certification schemes and develop common EU standards in order to estimate the carbon footprint of each passenger and freight journey with versions adapted to different users such as companies and individuals. This will allow better choices and easier marketing of cleaner transport solutions."

With carbon footprinting, data is generated about the GHG emissions of transport operations. This can be done for both passenger and freight transport and can be accomplished on an aggregated (e.g. a company) or more detailed level (e.g. a trip or a transport service). By providing this information, transport users may evaluate and change their behaviour and/or the transport service provider may reduce the carbon intensity of the offered services to obtain a better competitive position. As such, carbon footprinting can help reduce the carbon intensity of transport.

By paying an increased attention to the energy efficiency of the vehicle fleet, operational behaviour and the optimization of logistical networks, the companies may reduce costs of the transport/logistic operations. This may create a win-win situation on the market. Positive effects of carbon footprinting are widely recognised by the stakeholders, what has been clearly confirmed by the means of the public consultation performed in the framework of this study.

Over the years, many carbon footprinting initiatives have been developed. In the passenger transport sector, several public transport and aviation companies provide their customers information on the GHG emissions of their services. Likewise, several tools are available for comparing the GHG emissions of various transport modes. Also in the freight transport market carbon footprinting initiatives have become increasingly popular. The most notable initiative was implemented in 2013 in France, where national legislation was adopted requiring all transport operators to report their CO_2 emissions.

This legislation covers all transport activities departing from or arriving in France and includes both passenger and freight transport.

With the growing number of initiatives, each with its own underlying methodology and data, there is a clear risk of incomparability. Differences in scope, default data and calculation methods have a significant impact on the results of carbon footprinting. However, as the essence of carbon footprinting is to enable benchmarking between different operators, it is highly important that two carbon footprints can be readily and fairly compared. If one carbon footprint is based only on Tank to Wheel (TTW) emissions, while another also includes the upstream, Well to Tank (WTT) emissions of the transport service, for example, comparison becomes inherently difficult if not impossible for the average user.

The difficulty of comparing the GHG performance of different transport services is one of the reasons that carbon footprinting is still not in widespread use (with other reasons including the low importance often attached to GHG emissions by decision-makers). In light of the significant challenges faced by the EU's transport sector in reducing its CO_2 emissions by 60% compared with the 1990 level, there is a growing call for harmonisation of carbon footprinting. Although some efforts have bene devoted to improving the consistency and comparability of carbon footprints, the European CEN 16258 standard published in January 2013 being the most important (CEN, 2012), these are not in themselves sufficient to guarantee comparability of carbon footprints from different sources. Further efforts in this area are therefore required.

In this respect, the Commission has decided to contribute to the development of harmonised carbon footprinting standards for passenger and freight transport. As a first step, they commissioned this study to assess possible approaches, which may be applied at the EU-level.

1.2 Objectives of this study

The overall objective of this study is to carry out a preliminary analysis of the impacts that may be expected with different options for the EU for (contributing to) the development of harmonised carbon footprinting measures for both freight and passenger transport services in Europe.
More specifically, the objectives of the study are:
- to provide an overview of state-of-the-art carbon footprint calculators and methodologies and related concepts and to carry out a comparative analysis of these tools;
- to define minimum requirements and guidelines carbon footprint calculators should meet to be reliable and consistent;
- to define and validate the main problem and underlying problem elements with respect to the wide variety of carbon footprint calculators available;
- to define and validate the general, specific and operational objectives with respect to a potential future Commission initiative to promote the harmonisation of carbon footprint calculators;
- to develop concrete policy options to meet these objectives;
- to assess the mobility/logistic, economic, social, environmental, and other impacts of these policy options;
- to provide a clear comparison between the various policy options and to provide the Commission clear policy recommendations;

– to assist the Commission in preparing and conducting a stakeholder consultation.

1.3 Scope

The term 'carbon footprint' has become tremendously popular over the last few years and is now widely used by businesses and consumers. For this study, the definition of Wiedmann Minx (Wiedman & Minx, 2008) has been adopted. After reviewing a large number of studies, he developed the following general definition:
"The carbon footprint is a measure of the exclusive total amount of GHG emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."

Carbon footprinting can be performed with different scopes and different objectives, as shown in Table 3.

Table 3 Different objectives (columns) and scopes (rows) of carbon footprinting

Scope	Objectives		
	Internal use	Annual report	(Potential) product/service information
Company level	X	X	X
Product group, business unit or market segment	X	X	X
Client level	X		X
Delivery level			X

As this study has been launched in order to assess the impacts of harmonised carbon footprinting on logistics and modal choices in freight and passenger transport, its focus is on the red-circled objective of providing product and service information. In other words, in this study the term 'carbon footprint' refers to the *GHG emissions at the level of passenger or freight transport services*. Carbon footprints that are merely used internally or for annual reports (e.g. to shareholders) are therefore beyond the scope of the present study[7].

Although this study covers both passenger and freight transport, the focus in the analysis and report has been on the latter. This can be explained with two reasons:

– The share of the total transport volume that is provided by service operators to users is much larger in the freight than in the passenger transport market, where the bulk of the transport distance covered is accomplished by users themselves (e.g. by car).
– The incomparability of various carbon footprinting methodologies is much less of an issue in the passenger than in the freight transport market. In passenger transport, the impact of consumer demand on a particular vehicle movement or even on the services provided is usually negligible

7 Note that if carbon footprinting is performed solely for internal use, harmonisation of methodologies is irrelevant, as there is no inter-company comparison. On the other hand, when footprinting is carried out in the context of annual reporting, methodological harmonisation may become relevant, as the annual reports of different companies may be used for benchmarking by transport users.

(e.g. fixed time schedules), while it is very significant in the freight transport market. Therefore, carbon footprints based on average GHG emissions are generally sufficient for passenger transport, while freight transport services require more specific estimates to enable meaningful comparisons.

Wherever passenger transport differs significantly from freight transport, this has been pointed out in the report.

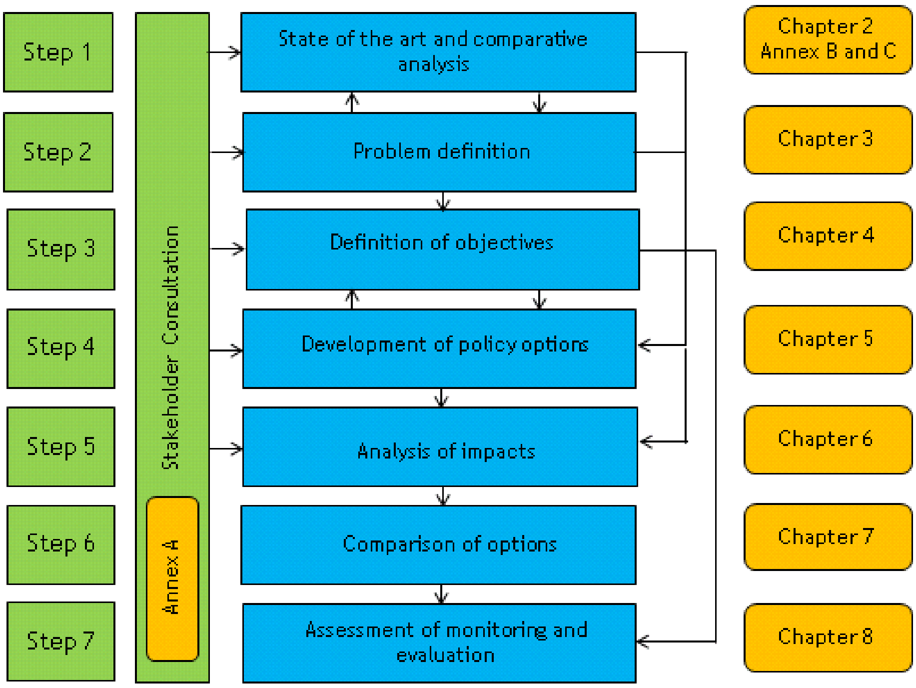
Finally, this study does not discuss available methods to calculate aggregated transport emissions from a country (e.g. IPCC or national emissions inventory methodologies).

1.4 Project overview

Considering the objectives of the study and given that its results may later be used in developing a possible Commission initiative, the approach taken in this report followed the 2009 (EC, 2009) general impact assessment guidelines of the European Commission (Steps 2 to 7 in Figure 1). To assess the impacts of harmonisation of carbon footprinting, an additional step was necessary: analysis of the different methodologies currently available and review of existing (state-of-the-art) carbon footprinting practices.

Figure 1 summarises this overall approach, showing the various steps that have been taken (blue boxes in the middle), the main interlinks between them and the chapters of this report in which the results of these analyses can be found (orange boxes on the right). As can be seen, the steps are highly inter-related.

Figure 1 Approach for this project



As indicated in Figure 1, stakeholders were asked to contribute to subsequent steps of the project, with their responses being fed back into the process, which is in line with the impact assessment guidelines (EC, 2009).

The stakeholder consultation comprised two dedicated workshops, an online questionnaire and in-depth interviews. A summary of the results of the stakeholder consultation can be found in Annex A.

1.5 Outline of the report

The remainder of this report is structured in line with the respective steps of the impact assessment guidelines (as shown in Figure 1). First, Chapter 2 elaborates on the current state of carbon footprinting at the level of transport services. Chapter 3 deals with the detailed problem definition, being then the basis to determine the relevant policy objectives (as presented in Chapter 4). Chapters 5 develops the applicable policy options, which, as a subsequent step, are subject to analysis of impacts, performed in Chapter 6. In Chapter 7 the options are compared using criteria formulated in line with the policy objectives. Chapter 8 provides a post-implementation framework for monitoring of implemented policy options. Finally, in Chapter 9 the conclusions and recommendations are presented.

2 Carbon footprinting in practice

The analyses summarised in this chapter are based mainly on an extensive literature review. More detailed information on existing standards and initiatives can be found in 0.

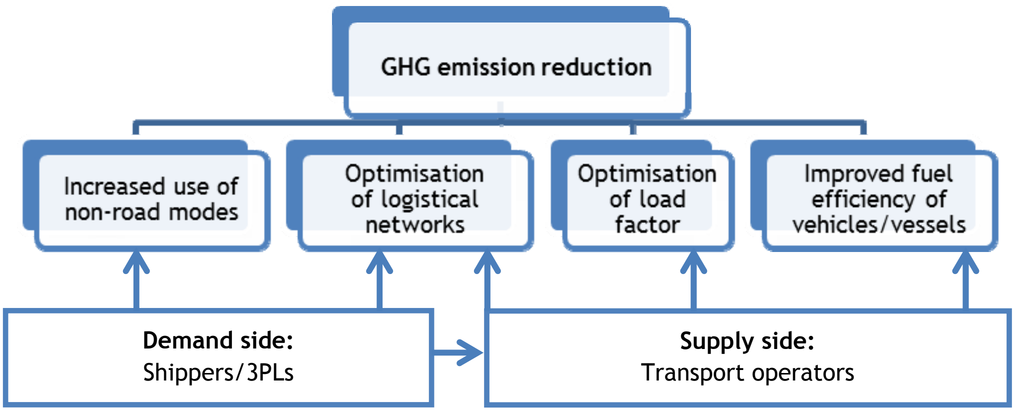
2.1 Introduction

This chapter provides important background information on carbon footprinting, which is needed as input for the subsequent analysis of impacts. Firstly, the mechanisms behind the contribution of carbon footprinting to GHG emission reduction are described in Section 2.2. Section 2.3 then outlines the main approaches that can be used to generate a carbon footprint. Finally, Section 2.4 briefly summarises the existing, state-of-the-art, carbon footprinting standards and initiatives.

2.2 Carbon footprinting and GHG emission reduction

As summarised in Figure 2, the GHG emissions of freight transport operations can be reduced by two main groups of players in the transport market:
– the shippers and third party logistics providers (3PLs) that arrange transport with actual operators (i.e. the demand side); and
– the transport operators actually performing the transport activity (i.e. the supply side).

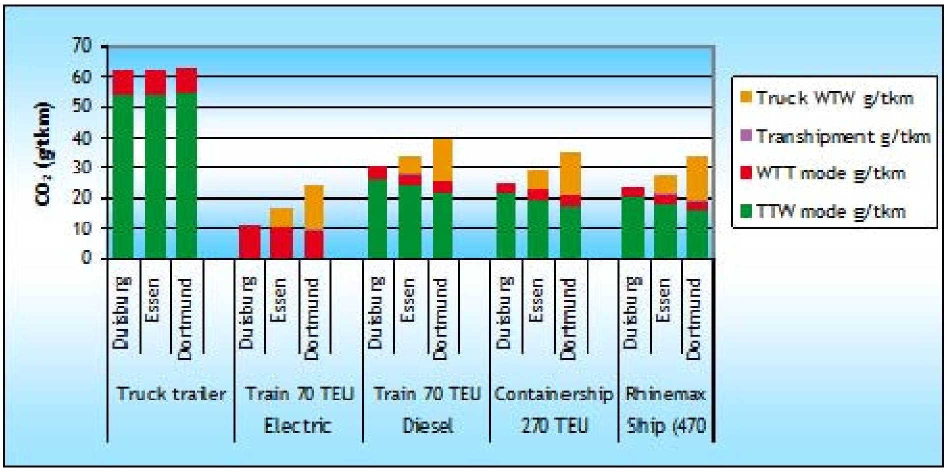
Figure 2 Main groups of GHG emission reduction measures and actors



As Figure 2 shows, four main groups of GHG emission reduction measures can be distinguished, although these are not all available to each actor.

On the demand side, greater use can be made of non-road modes, since non-road transport is generally associated with lower GHG emissions per transported unit than road-only transport (IFUE ; Öko-Institut ; IVE/RMCON, 2011); (CE Delft, 2011), as shown graphically in Figure 3. Although such GHG emission figures are subject to a wide range of assumptions, such as load factors, technologies used, fuel type, density of networks, the need for pre- and end-haulage, empty running, and transhipment and storage, GHG emissions will, as a rule, be reduced by a switch to non-road modes.

Figure 3 **Comparison of GHG emissions per mode for container transport between Rotterdam and Duisburg**



Source: (CE Delft, 2011).

The other three groups of measures shown in Figure 2 can improve the GHG emissions within one mode. These measures are further detailed below:

– optimisation of logistical networks (e.g. better route planning, transporting in less congested time slots, etc.);
– optimisation of the load factor (e.g. reduce empty running, increase loads per truck/wagon/vessel; improve product and package design);
– improved fuel efficiency of the vehicle/vessel by adopting:
    - fuel saving measures (e.g. low rolling resistance tires, trailer side skirts, etc.);
    - energy carriers with lower carbon content (e.g. natural gas, electricity);
    - eco-driving.

Note that shippers can only take the first measure directly themselves. They can, however, try to encourage/oblige the transport operator they work with to implement the latter groups of measures.

In the passenger transport market, the types of GHG emission reduction measures are similar to freight transport. However, the influence of the demand side on the transport operators is usually more indirect here. In case of private car transport, vehicle owners have full control of all options.

2.2.1 Incentives provided by carbon footprinting

Carbon footprinting enables benchmarking between different services in terms of GHG emission performance. As such, reporting of this kind of information can provide an incentive to change the behaviour of shippers and 3PLs (demand side), as well as of operators (supply side).

With the increased use of carbon footprinting for different type of operations and when assuming the reported GHG emissions represent the real world situation, shippers can evaluate the various transport modes and operators on their GHG emission performance. Shippers can then use carbon footprints for selecting the best performing transport mode and operator in terms of GHG emissions, on top of usual criteria like costs and quality. In addition, carbon footprinting of transport services provides an incentive to transport operators for changing their own behaviour in order to reduce their GHG emissions and outperform their competitors. Arguments to change the behaviour may include the need to increase revenues, reduce costs and limit risks (legal requirements and license to operate) as well as the altruistic reasons. Transport operators can adopt a full range of measures that were presented in Figure 2.

The same applies to passenger transport. Travellers could include the GHG emissions performance in their decision process when choosing a transport mode and transport operator. This in turn would stimulate transport operators to improve their GHG emission performance and to become the best in class.
Hence, carbon footprinting is an instrument that targets the decision-making process of consumers and shippers when purchasing transport services from transport operators and encourages operators to improve their performance. This limits the effectiveness of the instrument in two ways. Firstly, carbon footprinting is mainly effective when buying a transport service from another actor. However, in the passenger transport market, the bulk share of the transport volume is performed by travellers driving their own vehicle. It is only in certain specific parts of the passenger transport market that travellers purchase transport services from operators (e.g. public transport, aviation, ferries, coaches). Only in those segments, carbon footprinting may change behaviour. In the freight transport market, on the other hand, the bulk share of transported volume is accomplished by transport operators on demand of shippers and 3PLs.

Secondly, the effectiveness of carbon footprinting is highly dependent on the number of alternatives available and on the importance the traveller/shipper attaches to GHG emission performance. Logically, travellers/shippers not interested in GHG emissions are not likely to change their behaviour even having an opportunity to compare different carbon footprints[8]. However, for those that are interested in reducing their GHG emission impact, the availability of these alternatives is an important precondition to go green.

2.2.2 Interactions between carbon footprinting and other instruments

As explained in the previous sub-section, carbon footprinting is one of the available options for improving the GHG efficiency of transport by providing relevant information. However, carbon footprinting does not stand on its own; there are many other factors driving improvements in the GHG efficiency of both passenger and freight transport (EEA, 2013). Thereby, information provisioning is particularly effective when it is supported by other policies, such as standards or pricing.

This has for example been shown with the CO_2 labelling of cars and vans, which also is a means of providing information to consumers. Evaluation studies have shown that this instrument is particularly effective as a supplementary measure to other policies such as CO_2 standards for new cars and vans (and in the longer perspective potentially also for HDVs). With this combination, the standards provide the incentive for manufacturers to improve the average fuel efficiency of new vehicles, while the CO_2 label

8 Although buyers may not be directly interested in GHG emission reduction, they are strongly incentivised by the costs reduction, which is closely related to fuel/energy savings.
It demonstrates that a business strategy driven by the cost efficiency may result in a lower carbon footprint.

assists them in promoting the most fuel-efficient vehicles, as it provides incentives for consumers to include GHG efficiency in their purchasing decisions. By a similar logic, information provisioning can also support pricing measures, such as differentiated vehicle taxes.

Standards and pricing measures have proven to be effective instruments in improving the GHG efficiency of transport. Many other instruments can reduce the GHG emissions from transport such as green public procurement, infrastructure subsidies, speed policies, traffic management, etc. Combining information provision with such measures will increase awareness of consumers and their ability to better take GHG emissions into account when making their transport decision.

Last but not least, carbon footprinting from transport services can also be seen as a complementary measure to the EU product and organisation environmental footprint (POF/OEF) initiative, which is further described in the following text box.

Product and Organisation Environmental Footprint (PEF/OEF)

Both the Organisation Environmental Footprint (OEF) and the Product Environmental Footprint (PEF) provide a life-cycle approach to quantify the environmental performance of products and organisations. One of the reasons for the development of the policy was to respond to the proliferation of methods in the Single Market and the variability in these methods leading to different results of calculation, which is a problem across the board for the measurement of environmental impacts.

The methodology has been developed by the Joint Research Centre of the European Commission and DG Environment. It is the aim of the PEF and OEF methods to move towards comparability of results through the development of product- and sector-specific rules (Product Environmental Footprint Category Rules – PEFCRs and Organisation Environmental Footprint Sector Rules – OEFSRs). It is a cross-cutting objective to ensure comparability and set benchmarks per product group and sector, where appropriate.

The methods encompass 14 life cycle impact categories, including GHG emissions. Already existing methods, like the International Reference Life Cycle Data System (ILCD) Handbook, ISO 14040-44, PAS 2050, and the GHG protocol have been used as a starting point.

The final methodology was published in an Annex of the Commission Recommendation **(EC , 2013)** on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. Transport is part of the PEF/OEF.

The recommendation states that the vehicle type, load factor, empty running, allocation, fuel production, infrastructure, and additional resources and tools (e.g. cranes) should be taken into account. However, it does not include a set of formulas to be used for these analyses.

PEF/OEF has a broader scope than benchmarking GHG emissions of transport services, since it focuses on the entire life cycle chain of products and also has a broader coverage than only GHG emissions.

There is a pilot phase in place which tests the process for developing PEFCRs and OEFSRs, approaches to verification and communication for 25 product groups and 2 sectors. Transport is part of all of the pilots as an activity related to products or sectors and it is expected that a consistent approach across pilots is applied.

The pilot phase will finish at the end of 2016 and will be followed up by an evaluation and peer review. Based on this, relevant policy proposals will be formulated for the further implementation of PEF, OEF, PEFCRs and OEFSRs.

For more information see: http://ec.europa.eu/environment/eussd/smgp/

Table 4 provides an overview of other relevant policies and their impacts on the GHG emissions of transport.

Table 4 **Current policies with significant impacts on GHG emissions from transport services**

Policy	Impacts that have an effect on GHG emissions
Fuel efficiency standards for cars and vans	Increase fuel efficiency
CO_2 strategy for HDVs, including estimating and reporting the fuel efficiency of new vehicles (adopted May 2014)	Increase fuel efficiency
CO_2 incentives in vehicle taxes	Increase fuel efficiency
Vehicle registration tax	Improve vehicle utilization/modal shift
Annual vehicle tax	Improve vehicle utilization/modal shift
Fuel taxation	Improve vehicle utilization/modal shift, increased fuel efficiency, transport demand
Distance based road charging	Modal shift, transport demand
Product and Organisation Environmental Footprint	Increased efficiency
Infrastructure policies (TEN-T)	Modal shift/fuel efficiency/alternative drivetrains
Subsidies & R&D	Fuel efficiency/alternative drivetrains, modal shift

2.3 Main approaches for carbon footprinting

Section 2.3.1 discusses the main methodologies that can be used to generate a carbon footprint with different accuracy levels. The following Section 2.3.2 then outlines several approaches for allocating an aggregated carbon footprint to the service level, i.e. to a single shipment, passenger, etc.

2.3.1 Methodologies for calculating the amount of GHG emissions

There is a broad range of methodologies for calculating the GHG emissions resulting from transport services, each with varying levels of accuracy and detail.

In this study we distinguish three main types of approaches. They are listed in Table 5. While the examples shown in the table focus on the road transport, the methods indicated there can also be applied to other transport modes in a broadly similar fashion. The right hand column presents an overview of the incentives provided by the respective methods.

It is important to note that although a high level of accuracy and detail (level three) results in more reliable estimations of GHG emissions, it also requires a significant amount of real-world data. Hence, there is a trade-off between the accuracy of the measurement method and its simplicity and user-friendliness.

Table 5 Three basic methods for transport carbon footprint calculations

Accuracy level	Description	Required data	Incentive provide by the methodology
1	Default performance-based emission factors (g/tonne-km)	– Transport performance [tkm] – Vehicle class[9] – Default values[10] [g GHG/tkm] specified for vehicle classes	Modal shift Reduced tonne-km
2	Default vehicle emission factors (g/vkm)	– Transport distance [km] – Vehicle class – Vehicle class specific loading [kg] (per client) – Default values for emission factors [g GHG/km] based on load-dependent energy consumption and specified for vehicle classes	Reduced km (full and empty) Modal shift Increased load factors
3	Measured vehicle energy consumption (litre, kg, kWh, NM^3)	– Transport distance [km] – Vehicle class – Measured energy consumption [MJ/km] per vehicle class with respective load factor – Vehicle loading (per client) between stops	Improved vehicle energy efficiency Fuel-efficient driving Reduced km (full and empty) Modal shift Increased load factors

These three basic methods for calculating carbon footprints of transport are described in more detail below.

Default performance based emission factors (Level 1)
A calculation of GHG emissions with default performance based emission factors is relatively simple and requires limited data. The emissions of a transport service can be calculated with the following formula:

$$F = W * D * E$$

Where:
F GHG emission [g]
W Actual cargo weight [t]
D Actual transportation distance [km]
E Specific GHG emission [g CO_2 eq./tkm]

When using this method, transport operators only need to provide information on their transport performance, i.e. on the transport distance for a specified cargo weight. The specific GHG emission factors are obtained from public or licensed databases or studies.

9 E.g. truck trailer (> 40 t), solo truck (12-14 t).

10 Available in public/licensed databases.

The specific CO_2 emission factor is based on a large number of variables, such as:
- load factor;
- share of empty running;
- goods density;
- share of different road types (urban/non-urban/motorway);
- route profile.

These variables may be based on national and/or industry sector-specific averages. The CO_2 emission factors can be aggregated by using weighted averages based on a country's vehicle class mix, or more specifically, taking account of different sub-sectors. Non-CO_2 GHGs can be added by applying their Global Warming Potential (based on IPCC datasets)[11].

The quality of the carbon footprints generated by this method is highly dependent on the quality of the underlying database. In certain countries there are databases, such as the STREAM dataset in the Netherlands, with data on both passenger and freight transport. As yet, though, a comprehensive and harmonised EU-wide database with (comparable) default values for all transport modes is still lacking. One example of a mode-specific database is that established by the Clean Cargo Working Group (CCWG)[12] for ocean container ships.

However, even if such a general database becomes available, the default emissions factors used in this method will be still based on certain assumptions about the average variables for a country/vehicle class. Therefore, the emission factor used for the calculations may deviate from the transport operator's real world data. These divergences can be reduced when a differentiated set of average emission factors is used, e.g. per vehicle type (weight classes), country and type of application (urban deliveries, long haul, etc.). The higher the aggregation level of the default values used, the less accurate and realistic the carbon footprint of a specific operator will be. Either way, the use of average default values is the main drawback of using this method for the carbon footprint calculation, which is further illustrated with the example given in the following text box.

An example of a Level 1 calculation

Consider two road freight transport operators, delivering the same amount of goods from A to B with their truck-trailer. Company A has implemented several operational (e.g. eco-driving courses, improved logistics to increase load factors) and technical (e.g. side skirts) measures to reduce the emissions from the vehicles used. Company B operates the same truck-trailer, but has not implemented these measures.

As these companies have the same vehicle type, they use the same default emission factor (g/tkm). Considering that they operate on the same route with the same load (i.e. with the same amount of tkms), the calculated carbon footprint (tkms multiplied with the emission factor per tkm) that results is the same for both companies, while in practice, company A will have caused lower emissions than company B. A comparison between these two transport companies with this calculation method is pointless therefore.

11 The Global Warming Potential (GWP) of methane and nitrous oxide is 25 and 298 times higher than that of CO_2, per unit of mass.

12 For more information on CCWG, see Section 2.4.

The main advantage of this method is the simplicity and straightforwardness of the approach. It requires relatively low input levels and is therefore not very time-consuming. In addition, there is little if any data exchange between shippers and hauliers, implying that this method is least subject to issues of business sensitivity. Furthermore, the method still allows for a comparison of different transport modes, bearing in mind the different average GHG performance values respectively for air, inland waterway, maritime, rail and road transport.

Default vehicle emission factors (Level 2)
The calculation of the carbon footprint with default vehicle emission factors (Level 2) also uses default values. However, whereas the Level 1 method uses one emission factor (g/tkm) per vehicle type, country and/or type of application, the Level 2 calculation uses two (g/km of an empty vehicle and g/km of a fully loaded vehicle). This method thus requires more data than the Level 1 method, but also generates a more accurate outcome as it takes account of the actual load factors. The formula used with this method is the following:

$$F_{vehicle} = D * [(E_{max} - E_{empty}) * W\% + E_{empty}]$$

Where:

$F_{vehicle}$	GHG emission [g] of vehicle (possibly for several shipments/clients)
D	Actual vehicle distance [km] (both loaded and empty kms)
E_{max}	Specific GHG emission of a vehicle with maximum load [g GHG/km]
E_{empty}	Specific GHG emission of an empty vehicle [g GHG/km]
W%	Actual load factor based on weight

Default values based on energy consumption of the vehicles (litre or MJ per km) instead of emission factors of the vehicles (in gCO_2 per km) are common as well. An example of a commonly used database for such default emission factors for road vehicles is the Handbook for Road Transport Emission Factors (HBEFA). Also, national datasets are used. Like for the Level-1 calculations, no comprehensive and harmonised EU-wide dataset exists.

The outcome of this formula will generally result in the GHG emissions of the vehicle. These emissions can then be allocated to different shipments/ tonnages in order to take vehicle loads with various clients into account. This will be further explained in the next sub-section.

As this method uses company-specific information on the average load factor and share of empty runs, comparison between two relatively similar transport operators becomes more meaningful than with a Level 1 calculation. However, this method still uses default values for energy consumption, and hence, company-specific measures such as eco-driving or technical improvements in this case are not reflected by the carbon footprint result.

Measured vehicle energy consumption (Level 3)
The third method uses vehicle-specific measured energy consumption and therefore captures divergences in energy efficiency of different trucks and drivers. As the method uses actually measured, company-specific data, this method is by far the most reliable. Unlike with the Level 1 or 2 calculations described above, this method also captures emission reduction measures taken by operators. As such, this method provides an incentive for the energy efficient driving and the adoption of fuel-saving technologies, like side skirts.

This method offers the most realistic carbon footprints, but does require a large amount of data. In this case, the carbon footprint is calculated with the following formula:

$F_{vehicle} = D * G * Q$

Where[13]:

$F_{vehicle}$	GHG emission [g] of vehicle (possibly for several shipments/clients)
D	Actual vehicle distance [km] (both loaded and empty kms)
G	Specific energy consumption (e.g. l/km or MJ/km)
Q	Conversion factor (g GHG/l diesel)

The outcome of this formula results in the GHG emissions of the vehicle. These emissions can then be allocated to different shipments/tonnages. This will be further explained in the next sub-section.

As this method does not use default emission factors, a transport operator needs to collect data on energy consumption of its vehicles. This can be accomplished with two main measurement methods, as is shown specifically for road transport in Table 6. This calculation method can also be translated to other modes.

Energy consumption can be measured in different ways. Refuelling statistics are generally most reliable, but data from on-board computers may be easier to use from an administrative point of view.

Table 6 Measurement of energy consumption (road transport)

Way for measuring energy consumption	Comments
Real time, by using on-board computers	– Requires fleet investments. Operator cannot directly influence the investments/ equipment of partners and sub-contracted transport services – Deviations from actual refuelling statistics and measured consumption have been reported, although this varies with the installed on-board equipment and technology – Very detailed and consistent measurement over time (if the same on-board technology is used)
Fuelling statistics per individual vehicle Fuelling statistics per category of vehicles	– Requires company documents on the refuelling of vehicle(s) (e.g. gas receipts) and on relevant vehicle distance data (covering loaded and empty trips) for an adequate sample

13 The description focuses on diesel, which is the most used transport fuel. However, the same method can be followed for other energy carriers (e.g. gas, electricity).

2.3.2 Complexity of carbon footprinting at the service level

There are several complexity issues with carbon footprinting, especially when aggregated emissions need to be allocated to the service level (e.g. to different clients).

First of all, calculating carbon footprints at the service level requires specific allocation of vehicle emissions (e.g. emissions per shipment, consignment, shipper or passenger) since only this approach can be useful for the decision-makers comparing carbon footprints from different services. Therefore, in case of groupage transport, where multiple shipments are transported at once, the shipper is not interested in the total emissions generated by this operation, but only in the emissions that can be allocated to his shipment. In the case of the relatively rough Level 1 approach, this topic is irrelevant, as emissions are already expressed per unit or transport performance (see previous sub-section). However, if more accurate and reliable data are needed and the carbon footprint is calculated with the Level 2 or Level 3 methodology, the GHG emissions figure will be aggregated at the level of vehicles, vessels or aircrafts. In this case, allocation of emissions to services (or clients) becomes an important and sometimes complex issue.

Likewise, auxiliary and location-related processes and emissions might need to be allocated to the single service level as well. Examples for which the allocation of total emissions to the service level is relevant are shown in Table 7. For each of these, a harmonised allocation methodology would be needed in order to guarantee the comparability of carbon footprints provided by different companies.

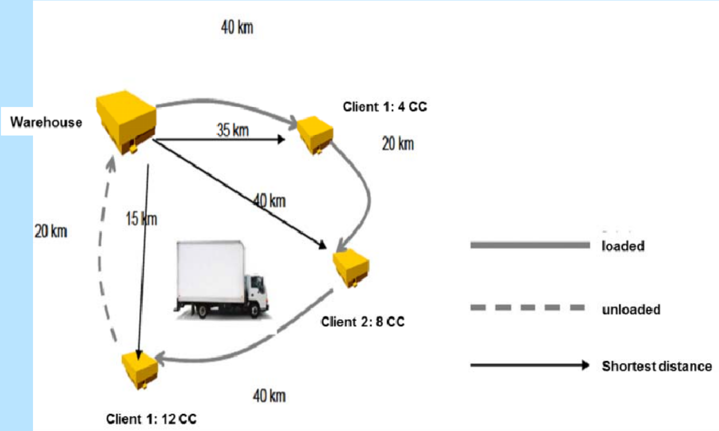
Table 7 Relevant situations for allocating emissions to the service level

	Mode	Sector
Less than full truck loads (LTL)	Road	Freight
Collection and distribution round trips	Road	Freight
Belly freight	Air	Freight, passenger
Single wagon traffic	Rail	Freight
Container shipping	Water	Freight
Ferry transport	Water	Freight, passenger
Bus, metro, train trip	Road, Rail	Passenger
Empty trips for vehicle provision	Road	Freight, passenger
Empty trips for repositioning of wagons, containers	Road, rail, water	Freight, passenger
Shunting processes	Rail	Freight, passenger
Transshipment, storage, picking & packing	All	Freight

The following textbox illustrates different allocation methods for groupage road transport. It makes clear that the influence of the allocation method is very high: different allocation methods may result in very different carbon footprints.

Example: allocating vehicle emissions resulting from groupage transport

Consider a truck transporting 24 standardised containers that are used for the transport of plants (i.e. Danish trolleys: CCs). The distribution trip requires 3 delivery stops at the clients' sites on a roundtrip of 120 km from and to the warehouse. This in turn requires 31 litres of diesel, which can be converted to approximately 100 kg CO_2e[14].



Source: (Duoinlog & Panteia, 2014).

The allocation of this 100 kg CO_2 eq. to the service level (i.e. per delivery of CC) can be done in different ways:

1. Allocation based on the shortest distances and transported CC (proposed by EN 16258 for roundtrips and optional in the GHG protocol):
   - Total CCkm: 4CC * 35 km + 8CC * 40 km + 12CC * 15 km = 640 CCkm
   - Share in total CCkm per client:
     - client 1: (4 CC * 35 km) /640 CCkm = 140 /640
     - client 2: (8 CC * 40 km) /640 CCkm = 320 /640, etc.
2. Allocation based on driven km and performance (optional in GHG protocol):
   - Total CCkm: 4CC * 40 km + 8CC * 20 km + 12CC * 40 km = 800 CCkm
   - Share in total CCkm per client:
     - client 1: (4 CC * 40 km) /800 CCkm = 160 /800
     - client 2: (8 CC * 20 km) /800 CCkm = 160 / 800, etc.

The results of both allocation methods are as follows:

Allocation method	CF for client 1	CF for client 2	CF for client 3
1	~22 kg CO_2e	~50 kg CO_2e	~28 kg CO_2e
2	~20 kg CO_2e	~20 kg CO_2e	~60 kg CO_2e

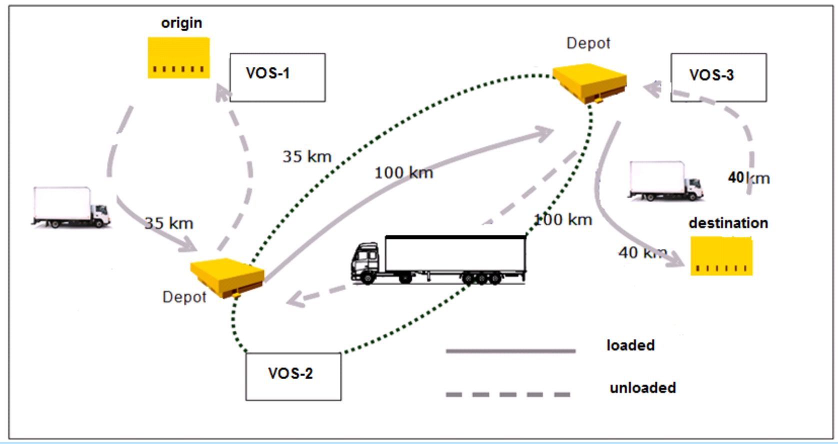
The example shows that the chosen allocation method has a significant impact on the allocation of total vehicle emissions to the different clients.

Note that the example assumes that all delivered goods are comparable in weight and volume/size. This will often not be the case in reality, but without this simplification the allocation of emissions to individual shipments becomes more difficult. In this case, a common allocation principle (e.g. tonnes or used floor surface) that reflects the relative use of the vehicle's loading capacity and fuel consumption is necessary. This however, is difficult to define.

Besides the allocation of emissions to the service level, also collecting all data for shipments in a (multi-modal) network can make carbon footprinting a complex exercise with high data requirements. This is illustrated in the following text box.

[14] With 3.24 kg CO_2e/l diesel (see Table A.1 - Transport fuels: density, energy factor and GHG emission factor in EN 16258:2012) (CEN, 2012).

Example: allocating emissions from a shipment moving in a logistical network
With logistical networks, single shipments can be subject to pre-haulage, long distance groupage transport and distribution transport, and can be stored in between these processes.



Note: VOS refers to vehicle operating system, referred to in EN 16258: consistent set of vehicle operations established by the user.
Source: (Duoinlog & Panteia, 2014).
To calculate the emissions resulting from the shipment shown in the figure above, a tremendous amount of data needs to be collected:
Main-haulage (one stop):
- size of the shipment for all single items loaded [amount, weight, volume, …]
- distance travelled with a loaded vehicle[km]
- distance travelled with an empty vehicle [km]
- vehicle fuel consumption [l diesel/km]

Pre- and end-haulage:
- Size of the shipment for all single items loaded [amount, weight, volume, …]
- Distance travelled with a loaded vehicle[km]
- Distance travelled with an empty vehicle [km]
- Vehicle fuel consumption [l diesel/km]
- Shortest distance from clients to DC [km]

Ideally, any emissions resulting from storage and transhipment should also be included, but in practice this is very uncommon due to lacking methods and data. The same applies to emissions resulting from cooling (some of the) shipments. The following data would be needed:
- Size of the shipment for all single items and total [amount, weight, volume, …]
- Total warehouse energy consumption [kWh]

The sum of all allocated emissions in the different stages of the logistical network is the total carbon footprint of a shipment. However, as shown by the large amounts of data required, this is a time-consuming, expensive and complex process.

2.4 Existing carbon footprinting tools, standards and programmes

There exists a broad range of initiatives on carbon footprinting on the transport and logistics market. Looking at their type, purpose and applicability, we can split them in the following categories:
- standards for prescribing and/or harmonising carbon footprinting methodologies;
- programmes and other initiatives within the transport market for promoting, supporting or harmonising carbon footprinting;
- tools for calculating or comparing the carbon footprint of transport services.

In this section, we produce a short overview of the most important existing standards and programmes within the freight and passenger transport market. A more detailed description hereof can be found in Annex B.2 and B.6, respectively.

Table 8 Summary of the most relevant carbon footprinting standards for transport services

Standard	Short description	Developed by	Year of publication
Standard EN 16258	A European standard that provides a methodology for the calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)	CEN	2012
Decree 2011-1336	French legislation obliging service providers of both passenger and freight transport to report their GHG emissions. The legislation is based on EN 16258	French government	2011, but came into force since 2013
Corporate value chain (Scope 3) standard of the GHG protocol	Standard for GHG emission calculation developed by the Green House Gas Initiative, a multi-stakeholder partnership of industry, non-governmental institutions and administration led by the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD)	WBCSD	2011

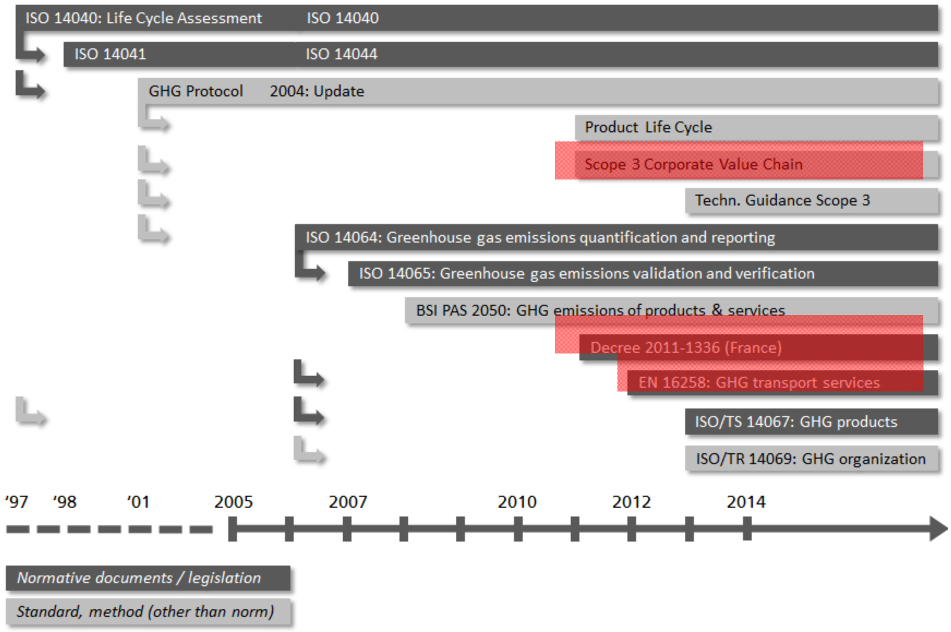
Evaluation of the available carbon footprinting tools is performed in Section 2.5.

2.4.1 Available standards and normative documents for carbon footprinting

The development of standards for carbon footprints of consumer products and of organisations has already started since the 1990s (as shown in Figure 4). As from 2004, there is special focus on GHG emissions with the development of the GHG protocol and ISO 14064. Other standards with a similar focus were developed shortly hereafter, such as the Publicly Available Specification (PAS) 2050 and, with a broader scope, the Product and Organisation Environmental Footprint (PEF/OEF). Some of these standards, in addition to GHG emissions, focus on other environmental impacts. OEF/PEF (as mentioned in Section 2.2.2) deserve particular attention as they are the result of a European Commission initiative to harmonise industry initiatives regarding information on the environmental performance of products and organisations.

Standards specifically aimed at carbon footprinting of transport services have been developed only recently. The most relevant standards for transport services have been marked red in the figure below and are summarised in Table 8 above.

Figure 4 **Development of standards and normative documents for the calculation of greenhouse gas emissions over the years**



A detailed description of the development and contents of each of the standards shown in Figure 4 can be found in 0. A closer look at the available standards shows that although the number of standards that explicitly include transport-related services has increased over the years, they do incorporate different ways of calculating and allocating emissions. Moreover, the available standards apply different boundaries and use multiple sources of default and real world data.

When specifically looking at standards that also include transport services, it appears that a large share of the available standards do not consider the entire logistic operation or all transport elements of the supply chain (the EN 16258 standard does not cover terminals for example). Moreover, the currently available carbon footprinting standards do still give room for many different methodologies and default data sets. Consequently, carbon footprints meeting these standards may still be incomparable.

Further standardisation efforts may help to harmonise the calculations made. Especially, allocating emissions to clients in case of complex logistics operations may need to be addressed, to make calculations comparable (see also Section 2.3.2 and Section 3.4.1)[15].

2.4.2 Available programmes within the transport sector

In addition to the standards and normative documents that have been developed by standardisation bodies and public institutions, the transport sector itself has also initiated different market driven initiatives to promote and/or support the calculation of carbon footprints in a harmonised way. Table 9 summarises the most relevant and best-known examples.

[15] At the level of initiatives covering GHG emissions at a broader range of environmental impacts, the Product and Organisation Environmental Footprints aim to reduce variability already at the level of the general method; and it strives to enable comparability where feasible and appropriate through the development of Product Environmental Footprint Category Rules (PEFCRs) and Organisation Environmental Footprint Sector Rules (OEFSRs).

Table 9 Examples of carbon footprinting programmes in the transport sector

Initiative	Short description	Year of initiation
Network for Transport Measures Environment (NTM)	A non-profit organisation initiated in Sweden which aims to establish a common methodology and database of values with which the environmental performance of transport services can be assessed and improved. Several tools have been developed to do so.	1993
Clean Cargo Working Group (CCWG)	A business-to-business initiative which focusses on improving the environmental performance of marine container transport globally. Several tools have been created which maritime freight carriers can use to measure, evaluate and report the environmental performance of their businesses. They can also collaborate with other stakeholders to improve this environmental performance and influence the development of tools, standards and methodologies.	2003
SmartWay USA	Public-private partnership in the USA. Part of this program was the SmartWay Transport Partnership in which freight carriers and shippers have committed themselves to benchmark their operations, to track fuel consumption and to improve fuel efficiency annually.	2003
Lean and Green	A Dutch public-private network for sustainable mobility (now also extended to other countries). The program aims to stimulate logistical companies to reduce their transport-related emissions. Companies which can prove to have reduced their emissions by 20% in five years receive a 'Lean and Green Star'. In later years, the program was extended to cover personal mobility as well.	2008
Logistics Carbon Reduction Scheme (LCRS)	A voluntary, industry-driven approach endorsed by the UK government to monitor, report and reduce CO_2 emissions from road freight transport. Members have committed to reduce the carbon intensity of the sector by 8% in 2015 compared to 2010.	2009
Green Freight Europe (GFE)	Industry-driven initiative started by several multinational companies (both shippers and transport operators). The programme aims to establish a pan-European system to collect, analyse and monitor GHG emission from road freight transport. Additionally, the initiative aims for best practice sharing, access to verified green technologies and a future certification of green transport service providers.	2009
Green Logistics	A German industry based R&D-project funded by the German Federal Ministry for Research and Education with the objective to provide a standardised methodology with which users can comprehensively determine the ecological effects of logistics systems and processes.	2010

A detailed description of the development and contents of each of the initiatives summarised in Table 9 be found in 0. A closer look at these initiatives shows that these are mainly focussed on knowledge and methodology development, self-assessment and on co-operation between shippers and carriers. The exchange of operational GHG performance data is uncommon due to the sensitivity of business to share this type of information. Smartway USA is an exception and as such is the only initiative that focusses on benchmarking logistical carriers within certain market segments. Although the market coverage of the initiatives differs, it is considered to be generally limited. Based on the discussions with the stakeholders, the market coverage for the best performing initiatives is estimated at approximately 20%. However, this does not mean that 20% of the market reports comparable carbon footprints as most initiatives do leave (most) methodological choices open to the market or focus on self-assessment. Furthermore, the initiatives are mainly joined by large companies, as small companies lack experienced personnel and cannot (or are not willing to) pay the fees charged .

2.5 Evaluation of available carbon footprinting tools

As part of this study, the most relevant carbon footprinting tools currently in use were reviewed in order to assess their quality and comparability.
The extent to which carbon footprinting can have an impact on GHG emissions, depends, amongst other aspects, on the level of harmonisation of the available methodologies, as this results in comparable footprints that can be used for benchmarking. Section 2.3 explained the different methodological approaches for determining the carbon footprint of logistical services. When approaches are harmonised, carbon footprinting can play a more significant role in the decision-making processes of shippers and passengers.
This section presents a summary of the results of this analysis and outlines the future steps required to harmonise the existing tools. A complete overview of this assessment can be found in Annex C.
Four issues have been identified as relevant for obtaining harmonised carbon footprints that can readily be used for benchmarking in the future:
- comparability of system boundaries and scope;
- comparability of calculation methodology;
- transparency and declaration rules;
- credibility and usability.

Where possible, earlier work under the EU research project COFRET (see Annex B.5) has been considered, updated and integrated into these analyses.

2.5.1 Assessment of the tools on the four issues identified

As a general issue, it is important to point out that the focus of this study is on carbon footprinting at the *service level*. For freight transport this is a complex topic, however, and there are consequently only a few tools that can be used to allocate emissions across individual clients. For passenger transport this is much easier and most tools therefore allocate emissions to the service level.

Comparability of system boundaries and scope

Generally speaking, the scope of the footprinting tools was found to differ widely. While some cover all relevant transport modes, others focus on one specific mode, making comparison of different modes very difficult.
For freight transport, most tools cover both TTW and WTW emissions, while in the case of passenger transport most are limited to TTW emissions. In some tools (both passenger and freight-related), the methodological description is unclear about the inclusion of upstream emissions being an important factor for fair comparison across modes. This problem in particular occurs in tools covering single modes.
Most of the freight tools cover all GHG emissions, with only a few focusing only on CO_2 emissions. Their geographical scope varies widely and is related to the default data used. As far as the passenger tools are concerned, they rather focus on a specific country, including international emissions only for transboundary modes (air, rail).

Comparability of calculation methodology

Most of the tools are based on the CEN standard or the GHG protocol, which goes some way to increasing comparability. Even when based on the same standard, however, the calculation methods still differ significantly. All three methodological levels identified in Section 2.3 have been incorporated in at least some tools, while each uses different vehicle fuel consumption databases, vehicle classes and default values. The deviations are particularly large for the non-road transport modes.
In some of the tools, the actual distance travelled is used as an input value, while in others (especially those that focus on passenger transport) calculate

the distance and routing with integrated navigation systems. This can also lead to differences among the various tools.

Transparency and declaration rules

In some cases a clear and full description of the methodology and assumptions is lacking. The passenger tools are generally more transparent than their freight counterparts and do provide a description of the calculation methodology employed.

Reflection of real-world emissions

One main point of criticism about the carbon footprints of transport services has been the insufficient reflection of real-world emissions. All of the tools evaluated use at least some default data, or in some cases use defaults as a back-up option. This is due to the limited availability of real-world data, which is especially problematic for non-road modes. At the same time, most tools incorporate the same datasets (for example, for road freight transport, HBEFA 3.1 and DEFRA are the only databases used). However, variant modes of interpretation and aggregation (vehicle classes, road types, gradients) can still lead to divergences in calculation outcomes.

2.5.2 Requirements for harmonisation of carbon footprinting tools

Improving the comparability and reliability of carbon footprinting is mainly a matter of ensuring that the definitions, methodologies and assumptions are used in the same way in the calculations. Further in this section, we illustrate the areas where alignment is needed.

In the first place however, we have created an indicative list of minimum requirements, which should be considered while discussing the harmonisation of carbon footprinting tools (relevant aspects of these minimum requirements were already mentioned in the main carbon footprinting approaches, presented in Section 2.3).
Minimum requirements for harmonisation of carbon footprinting tools:

- calculations should be made on the well-to-wheel (WTW) basis, in order to make a fair comparison between modes and energy chains;
- non-CO_2 emissions and indirect impacts need to be included, especially in case of air transport and unconventional fuels[16];
- empty trips need to be taken into account;
- the assumptions and data underlying the calculations should be fully transparent (at least for the purpose of verification);
- all energy burned in the transport processes needs to be taken into account[17];
- the methods used need to reflect as much as possible the benefits of measures taken to reduce the carbon footprint[18].

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16 The overall contribution of air transport to climate change is about two times higher than one would expect on the basis the GHGs emitted only (NO_X, cirrus clouds). This is acknowledged by the IPCC. Non CO_2 emissions (methane, nitrous oxide) are relatively important for the climate impact of biofuels.

17 Discussion about the responsibility for emissions (e.g. as a result of congestion) should not result in a less than full allocation of all the relevant GHG emissions.

18 More operators will be interested in increasing carbon efficiency of their services, if the methodology allows for reflection of more optimisation measures to be implemented in business practice.

In addition to these minimum requirements, alignment is needed in several areas, further described below.

System boundaries, calculation methodology and scope

With respect to the scope and methodology of carbon footprints, decisions need to be made on the in- or exclusion of:

- geographical area;
- transport modes;
- routing methodologies implemented in navigation software;
- logistics operations and logistics chain elements covered, i.e.:
  - transport processes;
  - auxiliary and location-related processes;
  - administration, business travel, commuting.
- phases of the life-cycle:
  - production, maintenance, and end-of-life phase of equipment (e.g. means of transport, transhipment technologies) and facilities (e.g. warehouses).
- verification requirements when company-specific calculations and real-world data are exchanged;
- up-to-date use of a particular default datasets for the complete carbon footprint, depending on the calculation level chosen;
- integration of Scope 1 to 3 processes according to the GHG Protocol[19]
- an allocation method with satisfying rules for:
  - modes;
  - services (e.g. passenger vs. freight, mass vs. volume goods), loading units, shipments;
  - roles within supply chains (e.g. responsibility for empty runs);
  - allowances concerning the usage of renewable energy and material, recycling processes;

Transparency

Besides the verification and validation of calculated carbon footprints (e.g. by external parties), the interpretation and possible comparison of results requires a significant level of transparency of the carbon footprints.
Any future methodology should, therefore, be accompanied with a generally accepted set of declaration rules for carbon footprint calculations covering issues such as:

- applied scope of carbon footprint;
- data used;
- allocation rules used;
- assumptions and simplifications made.

Credibility and usability

The process of harmonisation and development of a generally accepted carbon footprint methodology for logistics services should, furthermore, aim at the following aspects:

- consensus of relevant stakeholders:
  - companies along the supply chain (shippers and logistics/transport service providers);
  - government and standardisation organisations;
  - science and non-governmental organisations.

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[19] The GHG protocol differentiates between own account emissions (scope 1) and emissions of hired transport operations (scope 3). For carbon footprinting, no difference should be made between those.

- applicability independent of company size:
  - global players such as large logistics service providers;
  - small and medium sized enterprises.
- harmonised implementation of a method within calculators, e.g.:
  - specification of minimum criteria;
  - auditing scheme for tools.
- Accessible availability of methodology and guidance, dependent on:
  - target group/stakeholder;
  - language.
- sufficient frequency of actualisation.

3 Problem definition

The results of the analysis presented in this chapter are based on a review of available literature, stakeholder input and our own analysis of existing carbon footprinting tools.

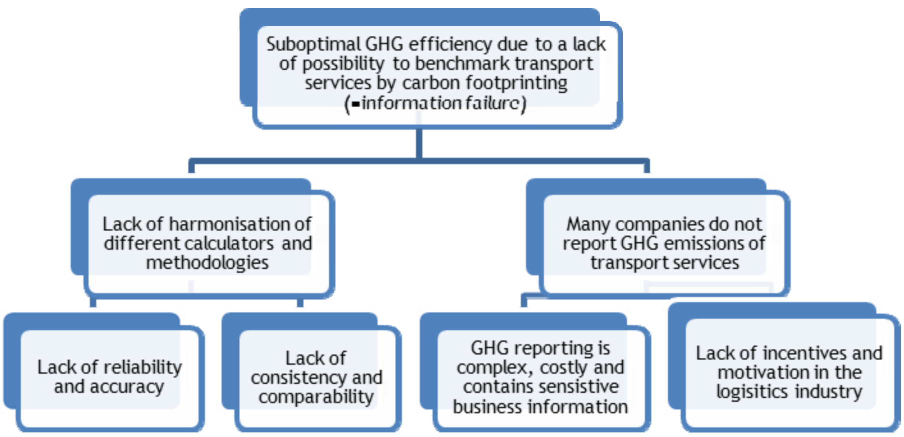
3.1 Introduction

This chapter describes the main problem, its constituent elements and their root causes. The problem definition is formulated first for freight transport, the prime focus of the present study. Later in the chapter, differences between freight and passenger transport are identified and explained in relevant level of detail. Section 3.2 provides a basic overview of the central problem, which is then followed by more in-depth description and analysis, produced in Section 3.3. The two intermediate problems and their root causes are discussed in Sections 3.4 and 3.5. In Section 3.6 we highlight specific issues with respect to the problem definition for passenger transport. Finally, Section 3.7 addresses the subsidiarity principle.

3.2 Overview of the problems and causes (freight transport)

On the basis of an extensive literature review, stakeholder consultation and the knowledge available within the Consortium, the main problem can be formulated as 'the suboptimal GHG efficiency of transport services resulting from the lack of the possibility to benchmark'.
The analysis has been structured in a problem tree (Figure 5) showing the causal relationships between the central problem, two intermediate problems and the root causes of these.

Figure 5 Problem definition for the suboptimal GHG efficiency of transport services



3.3 Definition of the main problem

Available studies show that several barriers exist for improving the GHG performance of logistics, such as a lack of resources, risk aversion of entrepreneurs, split incentives[20] and information asymmetries with respect to the advantages of fuel saving technologies (CE Delft, 2011a). Another important barrier is the inability of those demanding the transport service (e.g. shippers, third party logistics providers (3PLs)) to benchmark the available services on GHG emissions (DLR, 2011). This problem is supported by the stakeholders that have been consulted for this project; almost 70% of the respondents to the online questionnaire agree with the existence of this main problem.

COFRET – Carbon footprint of freight transport
COFRET, A FP7 financed project, focusing on the harmonisation of the methodology for carbon footprint calculations in freight transport, conducted a detailed review of existing carbon footprint tools. This project also consulted stakeholders to investigate user needs and state-of-the-art practices with respect to methods, tools and data for the calculations.
The results, which can be downloaded from the COFRET website, demonstrated that a truly harmonised framework for carbon footprinting is missing.
More information: Annex B and www.cofret-project.eu/

This lack of information in the market results in suboptimal choices in terms of the GHG efficiency of transport. Decision-makers cannot effectively include the GHG of a transport service in their choice for a particular service provider. In most cases they make their decisions based on other factors, such as price, speed and quality.

If reliable and comparable carbon footprints were generated in the logistical market, shippers and 3PLs could easily benchmark various transport operators offering the service and take the GHG emissions into account in their purchase decision alongside with the most obvious factors mentioned in the paragraph above. This, in turn, would incentivise the operators to enhance efficiency of their services and improve their GHG performance.

The information failure on GHG emissions in the market is considered to derive from two intermediate problems. Firstly, information about the carbon footprint of transport services is generally not reported by service providers. Secondly, if any information is reported, in most cases the figures published are neither reliable nor comparable due to different underlying methodologies and assumptions.

The two intermediate problems briefly mentioned above are further discussed in the following sections:
- lack of harmonisation of different calculators and methodologies (Section 3.4);
- many companies do not report GHG emissions of transport services (Section 3.5).

[20] If a vehicle owner is not the operator, there is a split incentive for implementing measures. The owner needs to make investments, while the operator receives the benefits.

3.4 Intermediate problem 1: Lack of harmonisation

The rationale of benchmarking carbon footprints is to *compare* the GHG performance of service providers. It is therefore crucial that footprints can be compared fairly i.e. that differences between them are explained solely by differences in *performance* rather than differences *in applied methodologies and data*. In the second place, they must properly reflect the real-world situation, i.e. calculated footprint must approximate the actual emissions of the operator.

Chapter 2 showed a large number of tools, standards, programmes and market initiatives currently available for carbon footprinting; each incorporating its own specific approaches and datasets. This makes the calculation results incomparable (see Section 2.3.1 for details)[21].

The results from the FP7 project COFRET confirm the lack of harmonisation and evidence that the comparability and accuracy of methodologies and calculators are limited. The COFRET project has identified several methodological gaps, such as a different coverage of the supply chain. Furthermore, COFRET concluded that the possibility of data adjustment (e.g. with respect to load factors/vehicle types/empty trips) between different tools, to better reflect the actual transport conditions, is very limited at the moment (DLR, 2011).

The Massachusetts Institute of Technology Centre for Transportation & Logistics has studied the lack of alignment between existing tools and methodologies (MIT, 2013). MIT has identified several factors that hinder harmonised carbon footprints of transport services. They conclude that tools and methodologies vary in:
- the scope of activities and number of modes included (breadth);
- the range of direct and indirect emissions included in the measurement (depth);
- the level of detail provided by the measurement (precision);
- the degree with which measurements can be compared (comparison);
- the degree of assurance in the results and methodology (verifiability).

To sum up, the intermediate problem of a lack of harmonisation can be explained by two main root causes (defined in detail in the text box below):
1. Lack of comparability and consistency.
2. Lack of reliability and accuracy.

It is important to emphasise that there exists a trade-off between both causes. An accurate methodology requires the application of detailed company-specific data, thus being relatively complex. Such an approach may be therefore more difficult to standardise. On the other hand, a standardised approach that is consistent and comparable but not sufficiently accurate, may lack incentives for (some) GHG reduction measures (e.g. as a result of default vehicle energy consumption data).

Both root causes are described in more detail in the next sub-sections.

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21 As an example: one tool can use TTW emission factors while another one uses WTW emission factors.

Definitions used

Consistent and comparable CF calculations

Consistent and comparable calculations are based on an agreed set of common principles and calculation rules. Part of this common ground could be a set of standardised default emission factors, or the rule that carbon footprints should be based on measured fuel consumption only. Consistent and comparable Carbon footprints ensure that differences between generated footprints are solely the result of differences in performance and not of differences in the tools and methodologies used. This is a precondition for benchmarking.

Reliable and accurate CF calculations

Reliable and accurate CF calculations reflect real world emissions. This requires among other aspects that calculations are based on measured fuel consumption and shipment of goods/passengers. Reliable and accurate CF calculations ensure that the impacts of all type of GHG reduction measures are reflected in the carbon footprint. In this case, transport operators get an incentive to apply any kind of GHG emission reduction option.

Source: own analysis.

3.4.1 Root cause 1: Lack of comparability and consistency

One of the causes explaining the lack of harmonisation in carbon footprints is the fact that the tools and methodologies do not use a set of common principles for making carbon footprint calculations. Underlying (default) data, methodologies, boundaries and definitions differ. Several studies confirm this cause, described in more detail below.

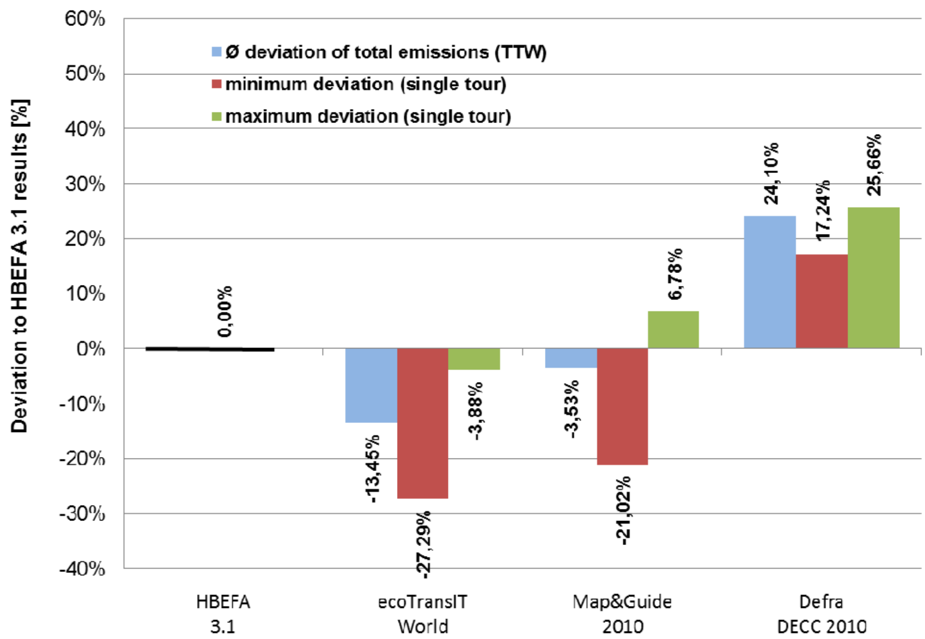
Findings from previous studies

The R&D project Green Logistics[22], executed a comparative calculation to investigate the existing methodological and data-technical diversity that persists in the databases and tools that are available today (Fraunhofer IML, 2012). To this end, the project's partners (Deutsche Post DHL, UPS and Schmidt Gevelsberg) provided data on twelve different round tours, e.g. the vehicle classes used, the respective load factors and tour kilometres (as annual average) [23]. Hereafter the Consortium modelled the GHG emissions from these tours with different tools and data sets. Their results are shown in Figure 6.

22 http://www.green-logistics-network.info/.

23 The observed transport performances of the project partners Deutsche Post AG, UPS and Schmidt-Gevelsberg totalled 123 million tonne-kilometres per year and were conducted throughout the year (daily or twice a week tours in overnight transport). The transport performances have been described for each leg and vehicle operation system (in total 31).

Figure 6 GHG emission calculation results for different tools – road transport



Note: HBEFA is a vehicle emissions database used for reference here, to compare the tools with.

The results in Figure 6 show large deviations between the tools for the overall carbon footprint of the transport service (sum of twelve tours, represented by the blue bars). The spread in results is approximately ~40% in this case (from +24% with DEFRA to -13% with ecoTransIT). When looking at single tours (green and red bars), the spread in results is even larger. These differences are caused by multiple factors, such as the underlying route functions, the level of detail in the default values (e.g. ability to specify a load factor), varying default values, and so on.

Another comparative calculation has been performed in the R&D project *Bothnian Green Logistic Corridor,* which evaluated intermodal transport[24]. The free versions of ecoTransIT World and NTMcalc have been used for the assessment. While the overall direction of the results is comparable for both tools (i.e. lower or higher emissions), Table 10 shows that the magnitude of the results varies significantly. The differences in outcomes are the result of differences in logistical data (e.g. load factor and empty running), but also of different options for vehicle categories and different assumptions with respect to energy consumption and resulting GHG emissions.

24 The calculation referred to a hypothetical transport chain from Bodö (Norway) via Baltic Sea to Gdynia (Poland) and studied impacts of transhipment, transport distance, electrification of rail and size of trucks.

Table 10 **GHG emission calculation results for different tools - intermodal transport**

Atlantic-to-Adriatic logistic corridor concept	NTM calc	ecoTransIT
The CO_2e emissions of train/boat combination are …	... 20% lower than those of a truck/boat combination	... 25% lower than those of a truck/boat combination
Train/boat combination in comparison to truck/boat is … The share of terminal handling in train/boat combination is…	…40% more energy efficient …20% of the total energy consumption	…70% more energy efficient …regarded negligible
Electrification of railway results in…	…35% lower energy consumption and 38% lower CO_2e emissions	…52% lower energy consumption and 90% lower CO_2e emissions

The issue of non-harmonisation can be further illustrated by the default emission factors (g CO_2/tonne-km) for heavy trucks, published in a review study by McKinnon (McKinnon & Piecyk, 2009). These emission factors would be used with a Level 1 calculation (see Section 2.3).

Table 11 **Published default emission factors for heavy articulated trucks**

Organisation	g CO_2/tonne-km	Assumptions
NTM	59	60% utilisation
IFEU	66	Average
TREMOVE	77	
DEFRA	82	> 32t GVW/27% empty running/59% load factor
INFRAS	91	
ADEME	109	Max. load 25t/21% empty running/57% load factor

Source: (McKinnon & Piecyk, 2009).

As can be seen in Table 11, the default values vary significantly, leading to incomparable outcomes. The differences in default emission factors are mainly influenced by assumptions on vehicle fuel consumption, vehicle load factors and empty running. It is crucial therefore, that (at least the most basic) default factors are agreed upon and sufficiently standardised.

Findings from our own analysis

Many tools do not clarify their methodological choices and assumptions, which makes it hard to investigate what causes the differences in outcomes.
There are some exceptions but most providers try to protect their product by not disclosing too much information. Irrespective of this difficulty, the Consortium has evaluated nineteen publicly available tools (eight ones for freight and eleven for passenger transport) on four aspects (where possible) in order to determine the current level of harmonisation. These aspects and their indicators are summarised in the text box.

Framework for analysis on current level of harmonisation

1. **System boundaries and scope:** ***What scope is covered with the tool with respect to …***
   - Transport modes covered (e.g. train, inland waterway transport, maritime, etc.)?
   - Geographical scope (national, European, international (not being European) or global approach)?
   - Carbon dioxide (CO_2) vs. CO_2 equivalent (CO_2e) emissions?
   - Tank-to-wheel (TTW) vs. Well-to-wheel (WTW)?
   - Transport and other upstream processes (e.g. sub-contracted processes, auxiliary processes, pre- and end-haulage processes)?
   - Emissions other than greenhouse gases (e.g. NO_x, PM, CO, SO_2)?
2. **Comparability of the calculation methodology:** ***how has the tool incorporated ….***
   - A calculation approach (Level 1, 2 or 3)?
   - Default values (e.g. number of vehicle classes specified)?
   - Routing (e.g. tool's routing, via points, real distance)?
   - Allocation to logistical processes (e.g. to the company, transport mean, shipment, client)?
3. **Transparency and declaration rules:** ***Is information provided on …***
   - Applied scope of carbon footprint?
   - Data used?
   - Allocation rules used?
   - Assumptions and simplifications made?
4. **Credibility and usability:** ***To what extent is the tool …***
   - Accessible (free, partially free, access fee/license)?
   - Based on relevant stakeholder consensus (small, medium, large stakeholder involvement)?
   - Applicable irrespective of a company's size?
   - Sufficiently up-to-date?

The results of the research project COFRET have been considered, updated and integrated into this analysis where possible.
The analysis is described in detail in Annex C. The main results show that available carbon footprinting tools differ with respect to their:

- *Coverage of different phases of the energy life cycle*: Most notably, some tools use WTW emissions, while others use TTW emissions. This can have a large impact on the results. For diesel, upstream (WTT) processes are approximately 20% of the TTW emissions. For LNG, and especially for biofuels and electricity, the importance of upstream emissions can be much larger.
- *Scope of activities*: some of the methodologies advise or actually include emissions from warehouse activities and cooling, but most tools do not. Tools also vary in how empty running is accounted for, as not all shippers are willing to take responsibility for that.
- *Allocation to various shippers*. The tools use different allocation methods, which can have a large impact on results (see Section 2.3.2).
- *Methodologies used:* each of the three levels for carbon footprint calculations (see Section 2.3.1), is used by at least one tool. Furthermore, tools vary in using default vs. real word data, which has a large impact on results (see Section 2.3.1). Those using default data vary in the number of vehicle classes included, routing, and so on.
- *Alignment with the existing standards*. Most of the tools indicate to be in line with the CEN standard, but still a lot of variation e.g. in the use of default data is possible.
- *Declaration of data used and choices made*. Some of the tools lack a clear and complete description of methodology and assumptions.

Stakeholders participating in the workshops agreed that carbon footprinting is currently inconsistent and incomparable (where the inconsistency in calculations may for example result from the use of different default data). The outcomes of the online questionnaire also confirmed this root cause: 74% of the respondents agree with the lack of comparability and consistency.

In conclusion, all the sources used for our research (the previous studies, our own detailed analysis and the stakeholders) clearly demonstrate that the difference in methodologies hampers fair benchmarking based on the reported carbon footprints.

3.4.2 Root cause 2: Lack of reliability and accuracy

Section 2.3.1 extensively elaborated on the three main approaches available to generate a carbon footprint, and especially on the impact of these approaches on the reliability and accuracy of the footprint. The accuracy in estimating real-world emissions is highest when using a Level 3 calculation (as long as accurate input data are used). However, only 30% of the stakeholders that were consulted for this study use this methodology at the moment, at least for some parts of their calculation.

For the both other levels, some of the crucial determinants are entered as default values. In these cases, the generated footprints not necessarily reflect the real world emissions, even in the situation when a set of common principles is agreed upon. In this latter case, the footprints would be consistent and comparable though.

The lack of reliability and accuracy of calculations was frequently mentioned by the consulted stakeholders. For this reason, stakeholders prefer a Level 3 calculation methodology that is based on real-world data. Due to reasons of information sensitivity, however, the exchange of real world data is limited at the moment, especially for non-road modes (Kiel, 2014). This creates another problem that needs to be overcome as well to make carbon footprinting a business reality.

The Clean Cargo Working Group (CCWG) provides an example of data for maritime transport, further explained in the following text box.

The Clean Cargo Working Group (CWWG)
The Clean Cargo Working Group (CWWG) publishes its average trade lane GHG emissions data per nominal TEU-km. The data are based on the submission of over 2000 ships owned by the world's major maritime transport operators. If this method is accepted as the standard for ocean-going vessels, it will serve as a *de facto* uniform, comparable and consistent methodology. However, the reported figures do not take into account the number of transhipped containers per individual operator, implying that the calculations do not exactly reflect real-world conditions. To remedy, this would require the use of company-specific logistics data.

Making reliable and accurate calculations requires not only data transfers, but can lead to a lot of complexity as well, especially for distribution and groupage transport. Two examples illustrate the difficulty of making reliable and accurate calculations:
- allocation of emissions in a round trip;
- defining a uniform performance indicator.

Emissions of a round trip

The emissions of a (round) trip need to be allocated to various clients. There is, however, no commonly agreed methodology addressing this issue at the moment. The CEN standard and the GHG protocol allow different options. Section 2.3.2 clearly evidenced that different methodologies can be used for the allocation of GHG emissions, leading to large divergences between the calculation results.

Uniform performance indicator

To calculate the emissions of transport at the level of individual services, it is required to define a performance indicator. In case of uniform transport, either a container or a full truck, it does not create particular problems (the indicator 'tonnes' or 'TEU' may be there sufficient). However, where different kinds of goods are transported by a single truck, e.g. both heavy and voluminous commodities, no single suitable indicator for the allocation of GHG emissions can be identified. This makes the allocation process difficult.

3.5 Intermediate problem 2: Companies do not report GHG emissions

The limited share of transport operators reporting their GHG emissions also impedes the benchmarking of transport services. Obviously, it is not possible to benchmark transport operators on their GHG emission performance if no information is available. Most transport operators do not publish carbon footprints and only a minority of shippers asks for this type of information.

CE Delft (CE Delft, 2014) has evidenced the lack of demand for carbon footprints. The cited study was based on workshops with representatives of approximately 70 transport companies and the results of an online questionnaire organised specifically for shippers. Transport operators indicated that only a small proportion of shippers request carbon footprints of the services they offer. Likewise, only 3 out of 14 participating shippers reported to pass such requests to their transport operators while negotiating contracts.

It is important to point out that the situation differs between various Member States and various market segments. In France for example, operators are obliged to report the GHG emissions of each transport service. However, across the EU, government incentives for carbon footprinting at the service level are limited, apart from supporting and financing initiatives (programme subsidies). Generally, the limited number of companies publishing carbon footprints can be explained by two factors:

1. GHG reporting is complex, costly and contains sensitive business information (Section 3.5.1).
2. Lack of incentives and motivation in the logistics industry (Section 3.5.2).

These root causes are further discussed in the following sub-sections.

3.5.1 Root cause 3: GHG reporting is complex, costly and contains sensitive business information

As mentioned above, only few transport operators report on the GHG emissions of their services. This is partially caused by the fact that calculating and reporting GHG emission is perceived as complex and costly. The results of the online stakeholder consultation provide relevant evidence for this assumption (the percentage between brackets refers to the share of the stakeholders that agreed with the statement):

– calculations cause administrative costs and require ICT investments (69%);

– data and methodologies are not harmonised within the sector making it risky to invest in tools (57%).

Furthermore, the majority of the consulted stakeholders (57%) agreed with the statement that some of the underlying data represents sensitive business information, which transport operators are not willing to share and/or disclose (this can concern the actual fuel consumption data, information on load factors, etc.). Sharing this type of information with other stakeholders may trigger their clients (3PLs/shippers) to demand lower prices for example. Therefore, the exchange of data within existing carbon footprint programmes such as Green Freight Europe, Lean&Green, and the Clean cargo working group is always done anonymously, if done at all.

E-Freight initiative: a solution to data exchange sensitivity?

For the exchange of data, there is a need to provide interfaces between companies' IT-systems and carbon footprint calculation tools. A standardised data collection method and a data-quality monitoring/reporting system may be needed to ensure the comparability of the results.

The E-freight initiative[25] may be one of the solutions for increased data exchange, providing the opportunity for intelligent methods of information collection and storage, which can be then incorporated within the emission calculation tools. It would however require additional harmonisation work (between the systems and countries) as well as considerable investments in ICT.

Moreover, as explained in the previous chapter, carbon footprinting can be a highly complex exercise. When determining the carbon footprint of a fully loaded truck, operating on a single trip from A to B, the calculation is relatively easy. However, it becomes more difficult when more data needs to be processed. This has been illustrated by the following two examples:

– Consider a logistic service provider without a vehicle fleet of his own who hires multiple operators to perform the transport services contracted. In this situation a carbon footprint for the 3PL would obviously require significant data transfer between the 3PL and the multiple operators.
– Imagine a multi-modal transport operation in which a sea container is transported from hinterland Asia to hinterland Europe, involving many different modes and hence multiple operators. Again, this will require significant data exchange between the numerous parties involved.

More detailed examples have already been described in Section 2.3.2. In such complex cases, the data sensitivity issue addressed above is also more relevant.

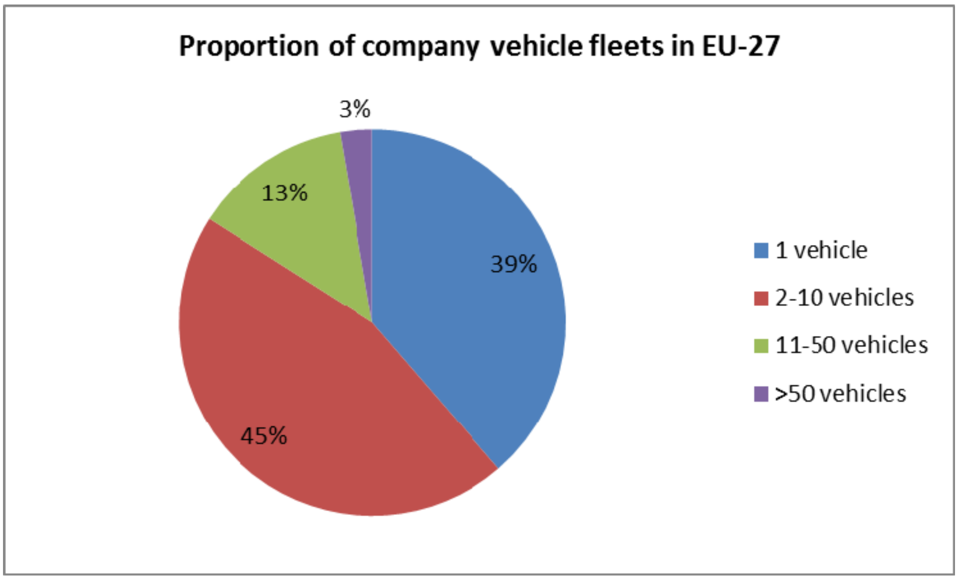
In addition to the aspects related to data collection and exchange, there are other unresolved issues with carbon footprinting methodologies, increasing their complexity even further. For example, there is no commonly agreed methodology available for allocating the aggregate emissions of a transport activity to various clients. Moreover, to allocate the emissions of individual services, a suitable performance indicator must be defined. As far as the uniform transport is concerned this is unproblematic, and tonnes or TEU will suffice. However, in case of a truck transporting multiple goods types

25 Initiative 7 'Multimodal transport of goods: e-Freight' of the White Paper for Transport, published by DG MOVE in March 2011 (EC, 2011), aims to create the appropriate framework to allow tracking goods real time, ensure intermodal liability and promote clean freight transport.

(e.g. both heavy and voluminous commodities), no suitable indicators exist for the purpose of allocation.

Especially for small companies, without highly educated staff, calculating and reporting GHG emissions can be difficult and expensive. As evidenced in Figure 7, 39% of the road transport companies in the EU-27 (without Croatia) operate with one truck. Also, the inland navigation sector mainly consists of self-employed skippers.

Figure 7 **Share of company sizes in domestic and international road freight transport in EU-27**



Source: (AEA, 2011a).

For the reasons outlined above, today the main focus is on self-assessment by the industry, as explained in the following text box.

Self-assessment
In many of the programmes and initiatives inventoried in Chapter 2 and Annex B, transport operators calculate the GHG emissions at their company rather than service level. In those cases, the objective is self-assessment and internal benchmarking over time. Internal benchmarking does not require a harmonised methodology within the industry. It is sufficient if a company benchmarks its own GHG performance by using a methodology that is sound for its operations and repeats this methodology regularly. As such, internal benchmarking is also beneficial for improving the GHG emissions performance of transport operators.
Internal benchmarking is done for example within the ‘Lean and green’ programme in the Netherlands. Companies are rewarded with a ‘Lean and green award’ after submitting an action plan that is aimed at 20% reduction of GHG emissions, and receive a ‘Lean and green star’ when they achieve it. The calculations need to be verified by an independent organisation, but companies are free to define their own measures and performance indicators. Therefore, the emission reduction can be defined both in absolute (e.g. in kg) or in relative terms (e.g. in relation to the number of tonnes or tonne-kilometres).
Another initiative that focuses on self-assessment is Green Freight Europe (GFE). Companies report their emissions with a predefined framework that allows for different calculations with different levels of complexities. The GFE platform subsequently calculates an average performance indicator on the company level.

The only exception is France, where transport operators are obliged by law (Decree 2011-1336, see Section 2.4.1) to report GHG emissions at the service level.
More information on these standards and initiatives can be found in Annex B.

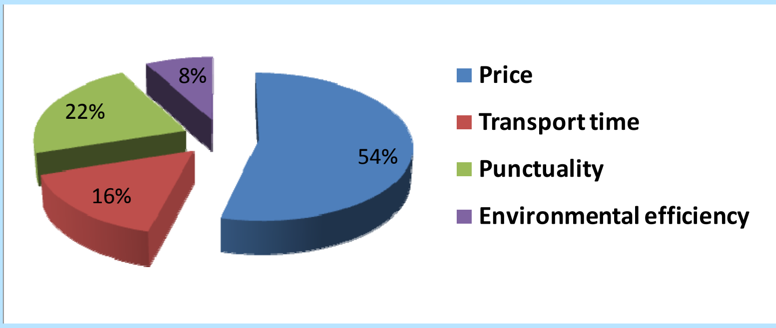
3.5.2 Root cause 4: Lack of incentives and motivation for reporting GHG emissions

Several explorative studies have shown ecological and social aspects are increasingly receiving attention in the logistical industry. Irrespectively, this is not (yet) reflected in the purchasing behaviour of shippers and 3PLs. Isaksson (Isaksson, 2012) found that customer demand and decisions from top management are the main triggers for transport operators to start adopting green initiatives. However, such triggers are mostly absent. When negotiating contracts, the GHG emission performance and/or reporting hereof only plays a minor role. Few shippers ask explicitly for GHG emission data. Those shippers that do ask for this type of information, usually do not use it for the decision-making process, but merely as background information. An Irish survey concluded that 3PLs and shippers are increasingly concerned about environmental performance, but buying decisions are still made on 'traditional' performance objectives, such as price and timely delivery for example (Byrne, et al., 2013) This was also concluded by (Wolf & Seuring, 2010) after conducting nine case studies.

The lack of priority for GHG performance when making a transport decision is also evidenced from several surveys conducted in Sweden. These surveys indicate that despite the increased attention given to environmental issues in the transport sector, the buying criteria have remained relatively stable over the years. This is explained in more detail in the following text box.

Green transport purchasing behaviour in Sweden
Lammgård (Lammgård, et al., 2013) surveyed over 175 Swedish employees responsible for purchasing transport in their company (e.g. transport managers, logistics managers, purchasing managers, supply chain managers, etc.). The final sample comprised of a selection of companies (with ≥ 100 employees) having a significant impact on freight transport in Sweden, representing a variety of industries with no obvious bias to any sector.
Respondents were asked to indicate their priorities when purchasing transport. They could do so by dividing a 100% between four service performance indicators according to the relative importance. The results are shown in the following figure.

As can be seen, the price factor appears as the most important one when selecting a transport service (weighs 54% in the transport decision). On-time delivery from door-to-door was ranked second most important (22%), followed by the transport time from door-to-door (16%). Finally, environmental efficiency (in terms of the GHG emissions of the transport service) was attributed a weight of only 8%.



Source: (Lammgård, et al., 2013).

Interestingly, a similar survey was conducted by these authors in 2003. The outcome was roughly comparable to the results of the 2012 survey: price 51%, transport time 23%, on-time delivery 18%, and environmental efficiency 8% (Lammgård, 2007). Hence, although attention to environmental issues is argued to have increased, this has not resulted in a shift between the priorities while making a purchase decision.

Another survey in Sweden that was sent to Swedish shippers by Conlogic (Conlogic, 2013)) resulted in similar results. Financial and operational aspects are given the highest priority and environmental performance is ranked relatively lowest. It should be mentioned that the absolute difference in evaluated scores is not too large.

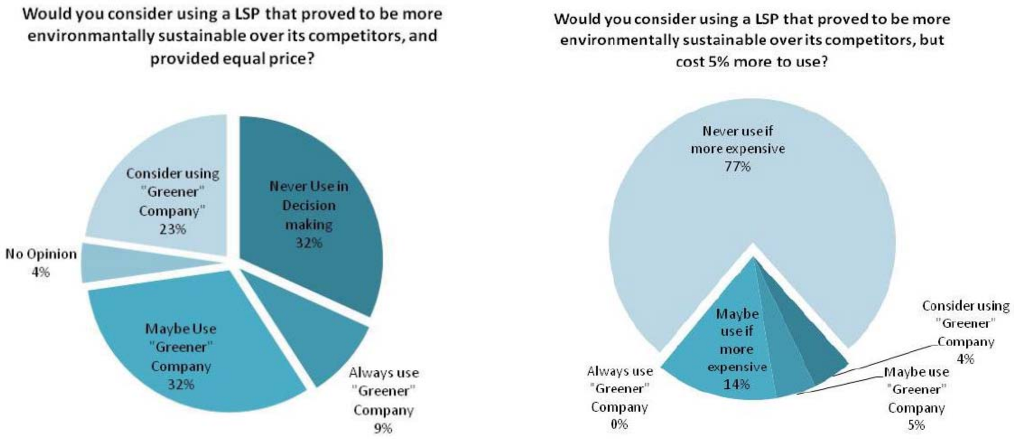
Parameter	**Evaluated average (max = 4)**
Delivery on time	3.79
Price	3.71
Transport time	3.56
Flexibility	3.47
Security and safety*	3.15
Administration	3.13
Environment	3

* Operators within hazardous cargo ranked this issue as the most important aspect.

Lieb and Lieb (Lieb & Lieb, 2010) investigated green purchase behaviour in a slightly different way, providing additional evidence for the lack of (financial) incentives in the market. First, they asked whether shippers would consider an operator with a better sustainability performance under equal price and quality conditions.

As shown in Figure 8, one tenth of the shippers would always use this operator, and over half of the shippers would maybe do so. However, when asking the same question with the exception that the more sustainable operator would cost 5% more, priorities changes significantly. Not one of the shippers would definitely use the greener company and only 23% would still consider choosing for this company. However, the majority of the shippers (77%) would not consider a more sustainable operator at all if it is 5% more expensive than its competitors. This indicates that the willingness to pay for sustainability is very low. Consequently, transport operators that have improved their GHG performance will generally not be able to ask a premium price in return.

Figure 8 **Shippers' willingness to pay for sustainability**



Source: (Lieb & Lieb, 2010).

The studies above provide ample evidence that shippers attach limited value to environmental performance, especially when it increases costs (i.e. low willingness to pay). Other logistic and performance criteria are more important. Transport operators are very sensitive to requests and preferences of their clients, hence, as long as they do not demand a carbon footprint and/or do not acknowledge (or preferably financially reward) an improved GHG emission performance in their purchase decision, incentives given for carbon footprinting and emission reduction measures will be limited.

The above-described evidence from literature is widely supported by the three means of stakeholder consultation. The majority of respondents to the online questionnaire acknowledged that reporting GHG emissions is currently not often a customer requirement (46% agree, 21% disagree) and is not adequately included in procurement (47 % agree, 10 % disagree). Interviewees clearly confirmed that price and service quality are the most important criteria in contract negotiations and that the shippers seem to have a limited interest in environmental performance when making their transport decision.

In general, the results of the online questionnaire indicated that the incentives to report GHG emissions are:
- insufficient from a financial point of view (agree 63%; disagree 15%);
- insufficient from a social point of view[26] (agree 47%; disagree 14%).

3.6 Problem definition, passenger sector

The problem of information failure and its underlying causes identified for freight transport (see the problem tree presented in Section 3.2) to some extent applies also to passenger transport, as it was confirmed by the stakeholders. At the same time, though, it is important to point out that passenger transport is dominated by private car transport, which has only limited relevance for carbon footprinting of transport services, since this type of transport is generally for purely personal use.

[26] Limited pressure from the general public.

Therefore, in general it can be argued that the problems and causes are less significant for passenger transport than for freight transport. This is further explained in the remainder of this section.

3.6.1 Intermediate problem 1: Lack of harmonisation

The analysis in Annex C illustrates the large number of tools and initiatives available for passenger transport operators. As was the case for freight transport, our own analysis shows significant differences in their underlying assumptions. The tools may include different modes, cover emissions differently, and use different calculation methods and parameters, sometimes leading to noticeable differences in their outcomes. In 2008 a comparative assessment of six carbon footprint tools used in Ireland was made by the University of Dublin (Kenny & Gray, 2009). By using typical data for a household of three people, the annual transportation emissions computed by the six tools were compared with specific reference values derived from fuel mixes and net energy use values published by several Irish sources.
The comparison showed that the variation between the outcomes and the reference values was −20% to +15% for road transport and −7 to +38% for passenger aviation.

The lack of harmonisation is therefore also relevant for passenger transport. However, due to the fact that passenger transport is much less complex (e.g. no single journeys with goods from multiple clients, etc.) and much more standardised (e.g. fixed time schedules) than freight transport, it will be easier to harmonise carbon footprinting. Moreover, if one common set of defaults can be agreed upon, these averages will better reflect the real world emissions of a transport operator than would be the case with freight transport, which is much more sensitive to many underlying variations (e.g. larger variation in load factors, larger number of vehicle types used, etc.).

3.6.2 Intermediate problem 2: Companies do not report GHG emissions

0 showed that there are at least some passenger transport service providers that already provide information on their carbon footprints. This is particularly the case for airlines, but increasing carbon footprint reporting is also observed in the rail and bus sectors. It may indicate that the intermediate problem of limited reporting of carbon footprints is also less significant compared to freight transport. The fact that some operators do provide carbon footprints may be explained by the fact that the root cause ‘carbon footprinting is complex, time-consuming, and contains sensitive business information’ may be relatively less problematic. As was mentioned above, carbon footprints for passenger transport are less complex (and therefore less time-consuming) to generate. For example, there are no significant allocation issues, since the ‘goods’ transported are generally always the same: human passengers. In addition, routes are often fixed, with standardised time schedules, making a single carbon footprint for a particular service by a given operator applicable throughout the year.

The other root cause of ‘lack of incentives and motivation for carbon footprinting’ seems to be highly relevant for passenger transport as well. Even though there is a general consensus that individuals’ awareness of the emissions caused by their behaviour or life style has been increasing, it is not clear to what extent this awareness is taken into account when making transport choices. A case study of a European multimodal travel planner that was performed for the COMPASS project (TRI, 2013) recently concluded that only a small amount of travellers seems to be interested in the carbon performance of passenger transport choices. With this multimodal travel planner (routeRANK) users can plan and book trips by all available modes throughout Europe (and worldwide for air transport) and rank different travel options with selected criteria (e.g. time, costs, GHG emissions and other attributes). An analysis of 100,000 searches (made in February-May 2013) showed a significant preference for minimising travel costs (46,9%), while CO_2 performance was the least chosen criterion (7,7%). Another indication of passengers' interest in carbon footprints can be derived from airline carbon offset schemes, with which passengers can compensate their own emissions. Over the last few years several of such voluntary schemes were introduced. The British Airways scheme was claimed to be successful. However, according to the airline's CSR report, only 0,32% of the passengers participated in the scheme in 2010[27]. Likewise, the OMEGA project (Hooper, et al., 2012) surveyed 500 passengers at Manchester Airport to investigate their awareness and attitude on carbon offsetting in 2008. Relatively few (less than 10%) were willing to change their air travel behaviour. A comparable study surveyed 300 passengers at Stansted airport in 2009 and concluded that 93% of the respondents did not offset their emissions. Only 9% indicated to have taken fewer flights compared to the previous year for environmental reasons. Moreover, only 3% indicated that their choice for an airline had been affected by the environmental performance of the airline[28].

When looking at commuter travel, the environmental performance of the transport modes is not ranked high on the list of evaluation criteria either. Car ownership, possession of a drivers' license, household structure, travel time, cost and accessibility are ranked highest (Kohlová, 2012) In an Australian survey (Transport Data Centre, 2007) environmental concerns were ranked as the 7th out of ten most important argument. The above described evidence suggests that the incentives provided by decision-makers (i.e. passengers) to transport service providers are few. Carbon footprints are currently only evaluated by a small share of the passengers and in most cases this information does not substantially affect travel behaviour.

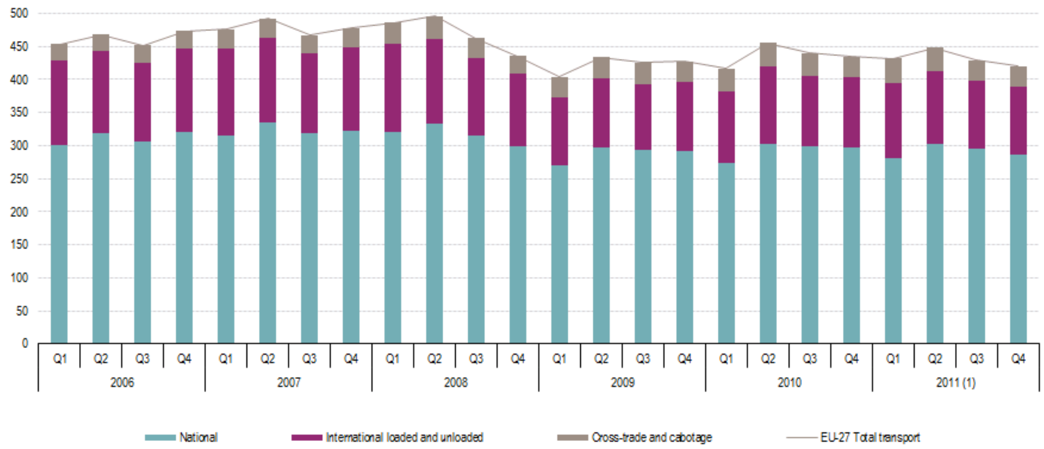
3.7 Compliance with the subsidiarity principle

Transport is a transnational business, operating and competing on a European scale. Especially freight transport has an international character. Freight transport by rail, inland barges and maritime ships often covers more than one country. Also, international road transport and cabotage play a significant role in the EU's internal market, as is illustrated in Figure 9.

27 Source: http://www.greenaironline.com/news.php?viewStory=1320.

28 Source: http://www.theguardian.com/business/2010/aug/30/carbon-emissions-offset-civil-aviation-authority.

Figure 9 Road freight transport in the EU (billion tkm)



Source: Eurostat.

Also passenger transport has an important international dimension. Almost a quarter of all trips (24%) cross national borders. Around half of these international trips were made for leisure and holiday activities (Eurostat, 2014). Passenger cars are the dominant mode used for these trips (65%), followed by aircraft (15%), trains (12%), buses (6%) and ferries (2%).

Legal base and subsidiarity
Transport is one of the areas where both Member States and the European Union shall share competences, as laid down in the Treaty of the European Union. However, the EU is only allowed to solve problems which cannot be adequately addressed by the Member States acting on their own.
This has been regulated with the principle of subsidiarity (Treaty on European Union; Article 5(3) – (4) TEU).

Chapter 2 and 0 evidenced the growth in the number of individual methodologies and standards. As was pointed out earlier in this chapter, these methodologies and tools need to be harmonised in order to allow for fair benchmarking. Although transport operators acknowledge the need for and importance of harmonisation, the ability of this large amount of individual operators to contribute to harmonisation is limited.

Furthermore, one Member State (France) has already standardised the calculation of carbon footprints within its territory and since 2013 it obliges transport operators to publish their results. While such individual national schemes may improve carbon footprinting on particular national markets, they might negatively influence the harmonisation at the EU scale thus hindering the functioning of the Single Market. In particular, the development of methodologies and collection of data by individual Member States may risk inefficiency and additional costs for international operators due to different calculation and reporting requirements. Therefore, it is considered that the international harmonisation of carbon footprinting may lead to reduction of such costs for the industry and improvement of the level playing field between countries and operators. This calls for a co-ordinated EU action.

As a part of the analysis of the role of the EU in the harmonisation of carbon footprinting methodologies, the need for a high level of harmonisation was confirmed by the consulted stakeholders. However, stakeholders prefer the harmonisation of methodologies rather at a global than EU-level.

4 Policy objectives

The results of the analysis presented in this chapter are based mainly on the findings deriving from the problem definition (Chapter 3) and the stakeholders' input gathered by means of workshops, interviews and an online questionnaire.

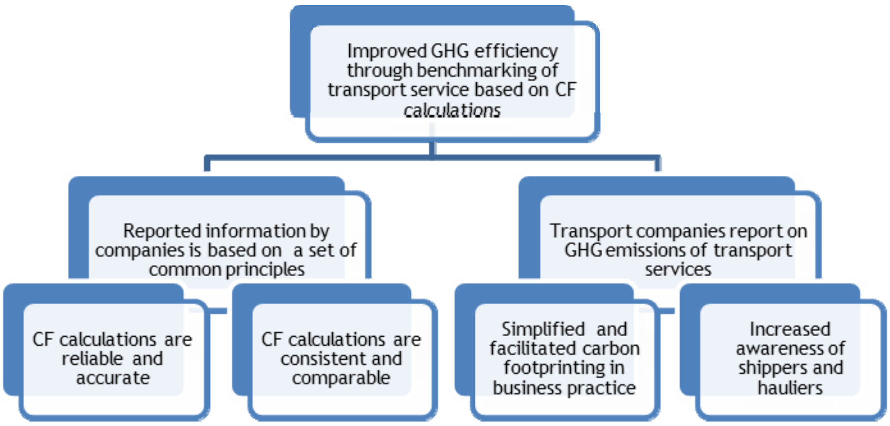
4.1 Introduction

This chapter defines the policy objectives for carbon footprinting at the service level, which is the second step in the impact analysis. The objectives are closely linked to the problems and their root causes identified in the previous chapter.
Section 4.2 formulates objectives at different level (general, specific, operational). More detailed insight into them is provided in Sections 4.3, 4.4 and 4.5.

4.2 Overview of objectives and intervention aims

We have defined the objectives of the envisaged policy intervention proceeding from the problem tree presented in Chapter 3. As shown in Figure 10, we propose a hierarchical structure of objectives ranging from general (the highest level) to specific ones (the second and third levels). In pursuit of these specific objectives, several operational objectives have also been identified.

Figure 10 Hierarchical overview of objectives



4.3 General objective

The general policy objective is to improve the GHG efficiency of transport services by enabling and stimulating benchmarking of transport services with carbon footprinting. It addresses the main problem that was identified in the previous chapter ('Suboptimal GHG efficiency of transport services due to a lack of the possibility to benchmark').

The general objective can be achieved by attaining two underlying objectives, which are formulated below:
- many transport companies report the GHG emission of their services;
- the methodology and data on which the reported carbon footprints of transport services are based are sufficiently harmonised to enable useful benchmarking and provide incentives for all the main GHG emission reduction options.

4.4 Specific objectives

Four specific policy objectives can be defined as a direct response to the intermediate problems identified in Chapter 3:
- carbon footprinting calculations are consistent and comparable;
- carbon footprinting calculations are reliable and accurate;
- simplified and facilitated carbon footprinting in business practice;
- increased awareness of shippers, 3PLs and hauliers.

These specific objectives will serve as a basis for development of policy options and assessment of their impacts.

The remainder of this section provides more arguments on the relevance of these objectives and the interrelations between them.

4.4.1 Objective 1: Reported information is comparable and consistent

To achieve this objective, all calculations need to be made on the basis of a set of common principles, including standardised calculation and allocation rules and default values for the main parameters that are easy to use in basic calculations within the industry. The common principles can prescribe either simple calculations (like a Level 1 approach, as described in Section 2.3) or be more sophisticated (Level 2 or 3).

4.4.2 Objective 2: Reported information is reliable and accurate

Designing a carbon footprint calculation that is reliable and accurate requires a higher level of detail in the calculations, which in turn needs significantly more detailed policy instruments and industry efforts. Existing standards, methodologies and calculators therefore need to be unified, elaborated and adjusted to incorporate more detail, including the use of real-world data in the calculation. In this respect, the following requirements for the standardisation framework may be therefore considered:
- Develop, endorse and use, as the reference methodology for the transport industry, the standards and guidelines incorporating a higher level of detail.
- Organise data exchange between parties, bearing in mind that the Level 3 methodology strongly relies on the use of real-world measured information. This can be done directly between shippers and operators and/or with a platform for data exchanges.
- Develop a system which explicitly takes into account the diversity of operators (e.g. urban transport vs. long haul transport).

Carbon footprint calculators that are reliable and accurate generally provide better incentives for reducing GHG emissions, since fuel saving measures do lower the result of the carbon footprint calculation. This may finally result in a higher level of competition and enable better benchmarking between operators that perform similar services.

4.4.3 Objective 3: Simplified and facilitated carbon footprinting in business practice

In addition to the methodological objectives described above, carbon footprinting needs to be made more attractive to the market, implying that it should be simple and easy to use by the transport industry, limiting the administrative burden to operators.

In previous chapters it has already been illustrated that carbon footprints which reflect real world emissions, do require a significant amount of data to be collected and used. Therefore, in order to achieve the simplified and facilitated carbon footprinting in business practice, a relevant methodological framework should be developed, which:

– builds as much as possible on information that is already collected by operators and which does not require specialised knowledge;
– balance precision (i.e. the level of detail and resulting accuracy) and easiness to use;
– facilitate easy reporting and exchange of data.

4.4.4 Objective 4: Increased awareness of shippers, 3PLs and hauliers

To achieve the main objective, it is important to increase the awareness and interest of shippers as well as hauliers and 3PLs in the GHG emission performance of the services they use or operate. While today the main focus is on the price and quality of provided services, it would be desirable if the operators' GHG emission performance play a more prominent role in transport/logistics decisions. Therefore:

– operators' awareness of their GHG emission performance and how this compares to that of competitors, needs to be improved, resulting in an incentive for continuous improvement;
– transport operators with a superior GHG emission performance should be rewarded by shippers and 3PLs;
– operators and shippers should cooperate more throughout the entire supply chain with a view to optimising their strategies.

4.4.5 Trade-offs between the specific objectives

The main trade-off between the objectives described above is between the simplicity (and hence, attractiveness to be used by the industry) on one hand and the accuracy and reliability on the other. The higher the level of reliability and accuracy, the more data and complex calculations are needed. This requires more data collation and exchange more detailed standards and methodologies.

However, companies are usually reluctant to exchange data about their performance. The SMEs, in particular, may lack the expertise and resources to perform complex calculations. This can seriously limit the application of available carbon footprint tools. Therefore, a balance needs to be found between the level of complexity and the attractiveness to the industry in terms of data exchange, costs and administrative burden. The potential impacts of the policy options on the likelihood of forcing companies to disclose sensitive information are adequately addressed in the analysis performed in Chapter 6.

One way to limit the volume of data exchange and guarantee the confidentiality of company-specific information would be reporting only on the results of the calculations, rather than on the input data employed (e.g. on fuel consumption, vehicle loading). However, in such a case, to guarantee reliability of the results, this would require independent verification of the input data used.

4.5 Operational objectives

The specific objectives have been translated into operational objectives, providing a means of monitoring progress. Relevant indicators to be used for this monitoring process are presented in Chapter 8.
Table 12 summarises the operational objectives for each of the specific objectives identified in the previous section.

Table 12 Operational objectives

Specific objective	Operational objective
Carbon footprinting calculations are consistent and comparable	– The estimations are based on the same methodology (being Level 1, 2 or 3) – The scope and equations used (i.e. specific methodological choices) in the calculations are sufficiently harmonised – The default parameters used are sufficiently harmonised
Carbon footprinting calculations are reliable and accurate	– The common methodology is sufficiently sophisticated and accurate. Preferably a methodology based mainly on real-world measured data is used – The methodology is correctly applied
Simplified and facilitated carbon footprinting in business practice	– Operators –irrespective of their size- perceive the calculation of carbon footprint as easy to use – The costs of the calculations are limited
Increased awareness of shippers, 3PLs and hauliers	– Transport decision-makers use carbon footprints as a relevant criterion – (Freight) transport contracts include requirements about carbon footprinting

5 Policy options

The policy options presented in this chapter are based mainly on the findings deriving from the problem definition (Chapter 3) and the analysis of objectives (Chapter 4). Additional use was made of input from the stakeholder consultation and the knowledge available within the Consortium.

5.1 Introduction

This chapter develops a list of options for a policy intervention. Based on several selection criteria, this list is narrowed down to the options, which contribute to the largest extent to the achievement of the objectives defined in the previous chapter. As a subsequent step of the study, these 'shortlisted' options will be subject to detailed assessment with respect to their social, economic and environmental impacts (Chapter 6). Section 5.2 identifies the long list of relevant policy options. Section 5.3 then describes in detail the selection criteria used to generate the short list and presents the options selected. Finally, Section 5.4 outlines the baseline scenario, i.e. the situation without any policy intervention.

5.2 Long list of policy options

As indicated above, the policy options have been designed with due consideration of the objectives determined in Chapter 4 of the present study. This implies that the aim of the option is to harmonise carbon footprinting methodologies and increase the proportion of operators reporting their carbon footprint.
In order to adequately structure and distinguish the options for policy intervention, they have been constructed around four main dimensions.

Firstly, with respect to the *reporting* objective, the intervention can be either voluntary or mandatory:
- voluntary: market actors choose whether or not to calculate a carbon footprint;
- mandatory: all transport operators are obliged to calculate a carbon footprint.

The second and third dimensions relate to the *harmonisation* of carbon footprinting.
The second one determines the extent to which carbon footprinting is harmonised. Consequently, the following main type of interventions may be conceived:
- No harmonisation: the choice for a particular methodology is left to the transport operators.
- Harmonised guidelines, voluntary: support development of a set of voluntary but harmonised guidelines for the carbon footprinting methodology. This may be done in close cooperation with the market and be supported by a certification system.
- Harmonised guidelines, mandatory: use of a specific carbon footprinting methodology is mandatory. This may require relevant legislation to be developed and implemented.

The third dimension covers the *type* of carbon footprinting methodology, whether mandated or merely recommended. As discussed in Chapter 2, three main methodologies exist at the moment (with different levels of accuracy, reliability and incentives provided). Hence, based on this dimension, the policy intervention may contribute to the harmonisation of:
– Level 1 methodology: default performance based emission factors.
– Level 2 methodology: default vehicle emission factors.
– Level 3 methodology: measured vehicle fuel consumption.

The fourth dimension focuses on the scope of the intervention or, more specifically, on the specific sector of the transport market covered by the policy option. Three options can be identified here:
– passenger transport;
– freight transport;
– both passenger and freight transport.

An additional dimension would be the geographical scope of harmonisation. While this study focuses on the EU, there are ongoing discussions about harmonisation on a global level rather than merely the European level, given that many transport operators are active internationally or globally. Within the scope of the present study, though, only a qualitative analysis of EU versus global harmonisation has been performed.

A combination of the first three dimensions defined above leads to ten policy options, which are summarised in Table 13. If the fourth dimension is also included, it results in a total of 30 policy options, as each of the ten basic scenarios can be applied to passenger transport, freight transport, or both of them.

Table 13 Overview of policy options

Increased CF reporting Harmonisation of CF methodology	Voluntary reporting of CF	Mandatory reporting of CF
No EU harmonisation efforts		
Voluntary guidelines for CF methodology		
Mandatory CF methodology Level 1		
Mandatory CF methodology Level 2		
Mandatory CF methodology Level 3		

5.3 Short list of policy options

From this long list of policy options, a short list of four was defined for the purpose of impact assessment. To this end, the following selection criteria were used:
– The selected policy options should be sufficiently different from each other and from the baseline scenario.
– In order to be effective, any selected carbon footprinting option should be sufficiently accurate and reliable. If not, the carbon footprint would only provide a very limited incentive to operators for improving their carbon footprint. Therefore, a mandatory Level 1 approach is excluded.
– The development of a harmonised Level 3 methodology is very complex, particularly for groupage transport and international multi-modal supply chains, as illustrated in Section 2.3. A mandatory Level 3 methodology will therefore only be combined with voluntary reporting.

- Both passenger and freight transport are covered in all scenarios.
- All options focus on elements that can be influenced by the European Commission, not taking into account a possible global approach.

Table 14 summarises the options that have been chosen for the short list (in bold) and also provides the main arguments for excluding the other options. More detailed explanatory notes for the scenarios not retained can be found in the text box at the end of this section.

Table 14 Overview of selected and unselected policy options

Harmonisation of CF methodology \ Increased CF reporting	Voluntary reporting of CF	Mandatory reporting of CF
No EU harmonisation efforts	**Baseline scenario**	Not useful as a scenario, makes no sense as policy intervention
Voluntary guidelines for CF methodology	**Option 1 (mild)**	**Option 3 (medium)**
Mandatory CF methodology Level 1	Neither effective (only incentivises modal shift) nor reliable	Neither effective (only incentivises modal shift) nor reliable
Mandatory CF methodology Level 2	Comparable to **Option** 4	**Option 4 (strong)**
Mandatory CF methodology Level 3	**Option 2 (medium)**	Unfeasible: too complex

Note: The different approaches have been introduced and explained in Section 2.3.1.

As can be seen in Table 13, the baseline scenario for all Member States (except France) reflects an absence of EU harmonisation efforts and the voluntariness of reporting a carbon footprint. For France specifically, the baseline scenario assumes no EU harmonisation as well, but the reporting of carbon footprints is mandatory by law. This baseline is described in more detail in Section 5.4.

Stakeholders' point of view

The majority of the consulted stakeholders perceive policy options in which methodologies and measures are harmonised as important (62%). Stakeholders prefer in particular a voluntary intervention, in which the EU supports ongoing industry activities (73%).

With respect to reporting, 59% of the respondents see a need for a relevant action at the EU-level. However only 41% of them agree with mandatory reporting and 37% prefer mandatory evaluation of GHG emissions in tendering procedures. A larger share prefers voluntary reporting.

Furthermore, the majority of consulted stakeholders strongly prefer a global harmonisation approach (82%), because of the international character of logistic chains.

The policy options selected for the impact assessment are hereafter described in more detail.

Scenario 1 – focus on harmonisation (mild)

This is a relatively mild market intervention scenario, which provides maximum flexibility to the industry due to its voluntary character. In this scenario, the decision for a specific methodology and to report a carbon footprint is left to the market. However, by developing clear guidelines on each of the available methodologies (Level 1, 2 and 3), the EC can improve the level of harmonisation by guiding the market, at rather low administrative costs for the industry.

As a first step, the EC could contribute to more R&D on carbon footprinting of transport services by providing funding and/or additional pilots. Hereafter, the EC can realise improved harmonisation through following one of two pathways:

- develop an EU recommendation, providing guidance to the logistics industry for Level 1, 2 and 3 calculations (similar to, and in line with Recommendation 2013/179/EU on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations);
- contribute to the existing EU harmonisation efforts led by the industry, focussing on further specifications of the calculation framework.

The following activities could be undertaken in both pathways:

- contribution to further specification of existing standards and provision of guidance to sub-sectors;
- contribution to the translation of the existing standards into a global standard;
- development (or contribution to development) of a harmonised common database of agreed Level 1 and 2 emission factors for both passenger and freight transport.

As a part of the cooperation and interaction with the industry, the industry could be further encouraged to report carbon footprints, by:

- assistance to the development of pilots;
- exchange of best practices;
- communication and promotion activities; and
- organisation of discussions.

Such pilots could contribute to the development of a general monitoring and reporting system by focussing on data collection, calculation, verification and reporting.

Scenario 2 - harmonised and accurate carbon footprinting (medium)

This scenario has a strong focus on harmonisation by guaranteeing that all carbon footprints made are based on the same, accurate, Level 3 methodology: *if* a transport operator decides to calculate its carbon footprint, it is enforced to use the legally binding Level 3 standard. Due to the complexity associated with this method, it risks that the number of entities reporting their carbon footprint is limited. However, it does guarantee that shippers and other clients can compare the available carbon footprints. Additionally, the Level 3 calculation ensures that transport operators reporting their carbon footprint are incentivised for all GHG emission reduction options available (logistic/technical/operational), as it was explained in detail in Section 2.3.

On top of the activities focused on the development of a level 3 methodology that were mentioned above for Scenario 1, this option can be further characterised by:

- A stronger focus (e.g. in R&D) on the fundamental and complex questions, such as data collection, the allocation of emission to different services and clients, and of data exchange. This will improve the methodological framework and in more in-depth experience with benchmarking carbon footprints.
- Refining the existing standards and guidelines. This can for example be accomplished by cooperating with industry bodies (e.g. CEN and ISO) and exploring the existing EU legal framework taking due account of such initiatives as Product Environmental Footprint and Organisation Environmental Footprint. A fully applicable Level 3 methodology needs to be incorporated.
- Generate experience with reporting of GHG emissions over the entire supply chain, including the organisation of data exchange between industry stakeholders. This latter aspect, for instance, can be realised with an electronic interface that is closely linked to the e-freight initiative.
- Development of an own Commission' standard or assistance and contribution to a standard established by the industry.
- Implement a legally binding standard (level-3 methodology) for transport services performed in the EU.

Scenario 3 – Focus on reporting (medium)
This scenario aims to increase the share of transport operators reporting their carbon footprint, by making carbon footprinting mandatory. However, similarly as in Scenario 1, we assume there the availability of voluntary guidelines on carbon footprinting. The transport operators are free to choose their own calculation methodology (at the Level 1, 2 or 3).
Therefore, in addition to the activities related to the voluntary harmonisation approaches as mentioned in Scenario 1 above, this option is further characterised by:

- The development of EU legislation that obliges all transport operators to report the carbon footprint of their transport services. Several ways for regulating reporting can be distinguished:
  - in advance of the service (based on history/statistics);
  - after the service has been performed;
  - during the negotiations of contracts.

Scenario 4 – Focus on both reporting and harmonisation (strong)

This scenario obliges transport operators to report their carbon footprint, and in addition, specifies the methodology which they have to use while making the calculations. The mandatory methodology entails the Level 2 approach, since the Level 3 would be too complex to be enforced on all transport operators.

With respect to the harmonisation, the specific actions foreseen under this option are to large extent comparable to those mentioned already in Scenario 2, even assuming that the methodology associated with Scenario 4 is much less complex.

As far as the mandatory reporting is concerned, we expect similar EU activities as those outlined in Scenario 3.

Rejected policy options
Five policy options have been rejected. The motivations for their rejection are explained below.

- **No EU harmonised approach - mandatory reporting of CF**. This option is considered to be not useful, as reported carbon footprints will not be comparable nor consistent. A large share of the carbon footprints will not be accurate and reliable either. The contribution to the defined objectives will be therefore very limited.

- **2/3. Mandatory CF methodology Level 1 - voluntary/mandatory reporting.** Both scenarios only provide incentives for modal shift and not for any GHG emission reduction within individual modes (due to the fact that basic default values are used). A mandatory carbon footprinting methodology at Level 1 therefore is not considered to be a very effective tool for the achievement of the main objective of the policy analysed in this study.

- **Mandatory CF methodology Level 2 – voluntary reporting.** Although this option could have been feasible, scenario 4 (mandatory reporting) has been preferred over this option. The mandatory variant was preferred for the short list instead of this option, as level 2 was evaluated as the most accurate and reliable methodology that could be combined with mandatory reporting. Voluntary reporting has been combined with the level 3 methodology.

- **Mandatory CF methodology Level 3 - Mandatory reporting of CF**. A mandatory level 3 option is the most complex one. Considering the difficulties in standardising (e.g. with allocation of GHG emissions to clients, and data gathering of international multi-modal transport journeys, etc.) and enforcing a Level 3 calculation to all transport operators (incl. SMEs with fewer resources) was therefore not perceived realistic in the short or medium term. Differentiation of the reporting requirements between small and large companies, as is the case in the French Decree 2011-1336[29] was also considered as an undesirable option, since a hybrid approach affects the comparability and accuracy of the calculations.

5.4 Baseline scenario/no action

Although it is to be anticipated that efforts will be made to harmonise carbon footprint calculations, the complexity of such calculations, plus other existing barriers, in all likelihood mean that in the absence of EU intervention the current situation will change only incrementally.
In this section the baseline scenario is described through discussion of the following four key issues:
- ongoing standardisation, harmonisation and research efforts on carbon footprinting;
- exchange of carbon footprinting data;
- demand for carbon footprints in the market;
- development of the transport market as a whole.

Ongoing harmonisation efforts
The CEN standard, published in 2012, is one of the main contributing factors in terms of the harmonisation of carbon footprinting. However, as explained in Section 2.4, the CEN standard still leaves room for using different methods for the calculations (Level 1, 2 or 3). Considering that a standard is usually a compromise which results from multiple stakeholder processes, it is unlikely

[29] See 0 for an illustration of the French approach.

that the standard will be adjusted in such a way that it meets the objectives outlined in Chapter 4.

The CEN standard acknowledges different interests and different preferences for the carbon footprinting methodology. Therefore, it aims for wide applicability, rather than for a reliable and comparable outcome. Over the coming years, the CEN standard will probably be updated. However, it is questionable to what extent the guideline will focus on more complex methodologies and stricter requirements for the use of data. It is more likely that in the future the standard will still be defined at a relatively generic level, providing some guidance but also leaving considerable room for own interpretation.

Global logistics industry players will push for a standardisation process at the global rather than EU-level, to prevent a situation in which they have to work with different standards and methodologies in different countries.

The standardisation process could therefore shift from an EU focus to a global level. However, global standardisation is probably even more difficult, since more stakeholder groups will be involved with the standard and it would need to be applicable to transport processes all over the world. Therefore, if any global initiatives are taken at all, most probably they will be also defined at a relatively generic level, not providing much additional guidance.

Annex C illustrates the current lack of comparability and accuracy of available tools. The differences between the outcomes of the tools can be very significant as a result (see Figure 6 in Section 3.4). Although several industry and national initiatives have been started to harmonise tools, the complexity and the versatility of the logistics sector may impede alignment of methodologies. The allocation of emissions from groupage transport to different clients was already described in Chapter 2 as an example of such complexity. This will hinder the development of a standard that is useful for all parties.

Moreover, it may be the case that those who already developed and marketed a carbon footprint tool feel threatened by a harmonisation initiative. Their vested interests may be another important barrier to harmonisation. Furthermore, the number of tool developers is large and the subject may be too complex. Hence, it will be difficult for the industry to realise an agreement without a policy intervention.

Examples of current harmonisation efforts

COFRET

The aim of the COFRET project (2011-2014) was to contribute to the development of more standardised methodologies. Based on COFRET developments, the Global Logistics Emissions Council (GLEC)[30] has been established end 2013, in order to align existing methodologies. The aim of GLEC is to develop:

- A common industry vision statement regarding methodologies and green freight in general.
- Globally harmonised methodologies (Global Framework for Freight Emission Methodologies) for the measurement and reporting of emissions from freight movements, covering all modes, nodes (warehousing, transfer points, etc.) and global regions within the transport supply chain.

30 http://www.smartfreightcentre.org/main/what-we-do/glec.

- Alignment of industry led/backed initiatives across modes and global regions.
- Active engagement and communication with the entire global freight sector and other key stakeholders, e.g. government, scientific/research institutes, NGOs, development agencies, which includes positioning the work of the GLEC within a wider portfolio of programs aimed at increasing freight sector efficiency.

Parallel to the work of the GLEC, an ISO workshop agreement process (IWA)[31] has been started, with the aim of reaching consensus on the issues to be addressed in subsequent harmonisation work.

Environmental Footprinting (see Section 2.2.2)
The Organisation Environmental Footprint (OEF) and the Product Environmental Footprint (PEF) provide a life-cycle approach to quantify the environmental performance of products and organisations. The proposed methods and the pilot process may have a relevance and implication for the carbon footprinting of transport services in terms of contributing to consistent rules for the service/sector.

Data exchange

The calculation of reliable and accurate GHG emissions at the transport service level, requires not only a harmonised methodology, but also the exchange of data if more than one player is active in the supply chain.
At the moment, different players in the transport market are very sensitive to such processes, as it was clearly expressed during the stakeholder consultation. Consequently, hardly any data used for carbon footprinting is exchanged at the moment (see Section 3.5.1). Therefore, rules and safeguards on the confidentiality of the submitted data are an important condition for the development of a dedicated system for handling and exchanging information. Although the majority of stakeholders agree that such a system should be organised, they prefer the platform to be run by a neutral player. It is questionable if the industry is able and willing to set up and operate a system by itself.

Demand for carbon footprints in the market

The number of carbon footprints currently reported is limited. If carbon footprints are calculated, they are mainly used internally (see Section 2.4). This partially results from a low demand for this kind of information. Although there is a continuous drive to reduce costs that may also reduce energy consumption, the weight which shippers attribute to the environmental performance of logistics in comparison to other criteria is limited, except for some niches (e.g. front running companies that have incorporated environmental performance in their business strategies). This was illustrated in Section 3.5.2. Although it is very difficult to quantify the share of trips for which carbon footprints are currently reported, experts estimate that this is around 1-2% at the moment (except in France, where reporting is mandatory).

Any increase in future demand for carbon footprint reports is strongly linked to the availability of more comparable and accurate methodologies, stakeholders argued. However, as this is unlikely to happen without intervention (see the previous paragraph), the share of transport operators reporting their carbon footprint is expected to increase only marginally. Any increase will most probably be due to larger companies joining existing initiatives (which are already supported mainly by such companies). SMEs do not generally join green transport initiatives, nor do they currently calculate their carbon footprint,

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31 An IWA is an ISO document produced through workshop meeting(s) and not through the technical committee process. An IWA can be developed in less than 12 months.

and it is therefore highly unlikely that they will start doing so of their own accord.

Development of the transport market as a whole

Various characteristics of the transport market will change over time, partly driven by other EU policies (see Section 2.2.2):

- transport demand is expected to keep on growing (particularly freight transport and passenger transport in the eastern part of the EU);
- modal split could change but the direction and magnitude of the net changes are unclear and may differ per market and Member State;
- the CO_2 efficiency of transport modes will improve, in particular due to increased fuel efficiency of cars and vans, following the implementation of CO_2 standards for these vehicles;
- overall CO_2 emissions will drop over time by 10%, between 2015 and 2030.

All these autonomous developments build on existing baseline scenarios for the EU transport market They have been identified by using a dedicated ASTRA-EC model, established within the 'ASSIST project' (Krail, et al., 2014)[32].
The baseline scenario is consistent with the latest projections reported by European Commission (EC, 2013) and is depicted in Table 15.

Table 15 Well-to-wheel CO_2 transport emissions - Reference scenario (Million tonnes/year)

	2010	2015	2020	2030
Road Passengers	635	580	510	464
Road freight	295	278	274	273
Rail passengers	15	15	14	13
Rail freight	6	6	6	6
Maritime	9	9	10	11
Air	141	140	145	153
Inland waterway	6	6	6	6
Total	1,107	1,033	964	926

Note: Air transport refers to passenger transport only and includes intra and extra European flights.
Maritime transport refers to intra-Europe only.
Source: ASTRA-EC model.

Conclusion on the baseline scenario

The following conclusions have been drawn for the baseline scenario:

- no further significant harmonisation of methodologies takes place;
- the share of companies that report carbon footprints at the service level remains low (not significantly higher than current 1-2%), except in France, where reporting is mandatory;
- no system for a systematic exchange of data on carbon footprints will be developed;
- transport demand growth, modal split and CO_2 efficiency of transport modes will develop in line with the baseline scenario of the mentioned above ASTRA-EC model.

[32] See also Annex E for more information.

6 Analysis of impacts

The results of the analysis presented in this chapter are based mainly on the findings deriving from the problem definition (Chapter 3) and are directly related to the policy options and baseline scenario discussed in Chapter 5.

6.1 Introduction

This chapter presents the results of the impact analysis performed for the four shortlisted policy options (described in Section 5.3).

As explained in the previous chapter, each policy option will be applied to both passenger and freight transport and will address relevant measures rather at the European than the global level (the global dimension will be addressed qualitatively in Chapter 9). Hence, these options vary with respect to three factors:
- mandatory or voluntary reporting of the carbon footprint;
- mandatory or voluntary use of a certain method for calculating the carbon footprint;
- the accuracy of the methodology (e.g. in estimating real world emissions).

Table 16 outlines the relation between these distinguishing factors and the selected policy options.

Table 16 **Characteristics of the policy options**

Increased CF reporting / Harmonisation of CF methodology	Voluntary reporting of CF	Mandatory reporting of CF
No EU harmonisation efforts	**Baseline scenario**	-
Voluntary guidelines for CF methodology	**Policy Option 1**	**Policy option 3**
Mandatory CF methodology Level 1	-	-
Mandatory CF methodology Level 2	-	**Policy option 4**
Mandatory CF methodology Level 3	**Policy option 2**	-

These policy options have been evaluated in terms of different impacts. In the remainder of this chapter, each section presents the results for one of the following impacts:
- the impact on the provision of information (Section 6.4);
- the impact on the transport market (Section 6.5);
- the impact on transport operators' administrative costs (Section 6.6);
- the impact on the workload of the European Commission (Section 6.7);
- the impact on national/regional governmental policies (Section 6.8);
- the impact on the economy (Section 6.9);
- the impact on the environment (Section 6.10);
- the social impacts (Section 6.11);
- summary of all impacts mentioned above (Section 6.12).

Before elaborating the impacts of the respective policy options, however, we first describe the research methodology employed (Section 6.2) and the relevant lessons learned from comparable existing measures and initiatives (Section 6.3).

6.2 Research methodology used for the impact assessment

Ideally, an impact assessment based on EU guidelines should estimate each impact in quantitative and monetary terms, enabling comparison of the various policy options. If this is not possible, the impacts can be determined in qualitative terms, or by indicating a 'direction' of the impact (i.e. bigger, fewer, less, etc.).

The impacts of the respective policy options depend on a large number of decisions, which in turn are made in relation to a specific situation, types of stakeholders, etc.

The available sources do not provide extensive and detailed information on the impacts of the different policy options. However, these sources qualitatively illustrate the overall impacts that can be expected. It is important to note that the impacts of policy options targeting carbon footprinting within the transport sector have never been studied before. Consequently, there is hardly any data available on the behavioural change that can be expected, making it difficult to perform a detailed quantified impact assessment. Therefore, a mostly qualitative analysis has been performed, where possible complemented with quantitative calculations for the main impacts.

Stated preference research
In order to perform a detailed quantitative impact assessment, which provides insight into the precise effects of the different policy options (e.g. the expected GHG emission reduction per modality), more detailed and specific information is required (e.g. exploring situations where the shippers/consumers prefer a certain transport provider over another based on its carbon footprint). Ideally, different stakeholders (the transport operators, shippers/consumers and governments) should be confronted with several sets of detailed questions, including real options (i.e. no general concepts), to estimate effects quantitatively. Such an exercise could be performed with detailed questionnaires and/or as part of a stated preference research. However, this approach was outside the scope of the current project.

Figure 11 shows the how many complex interactions determine the actual GHG emission reduction realised with a given policy option. Firstly, this depends on the way transport providers react to the carbon footprint. Secondly, a shipper or consumer might change behaviour if fair benchmarking becomes possible. As shown in the figure, both transport operators as well as their clients (shippers and/or consumers) need to change their behaviour to realise lower GHG emissions.

Figure 11 Overview of interrelations between policy options, actors, and impacts

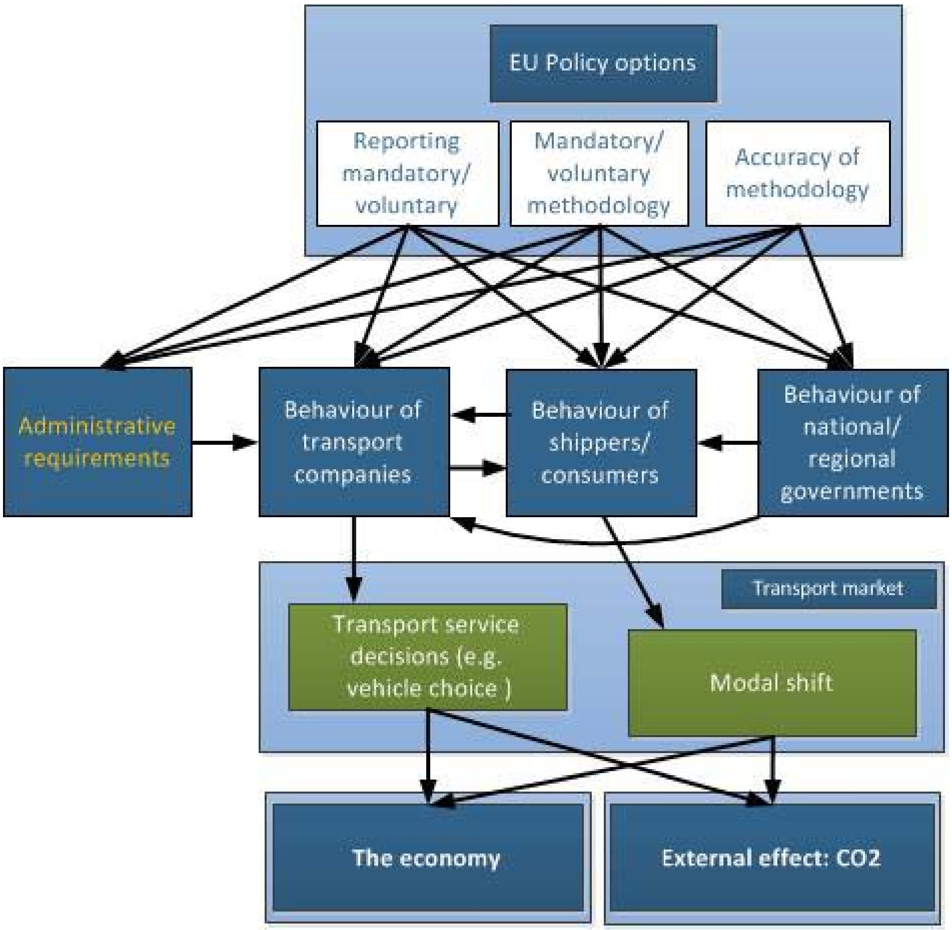
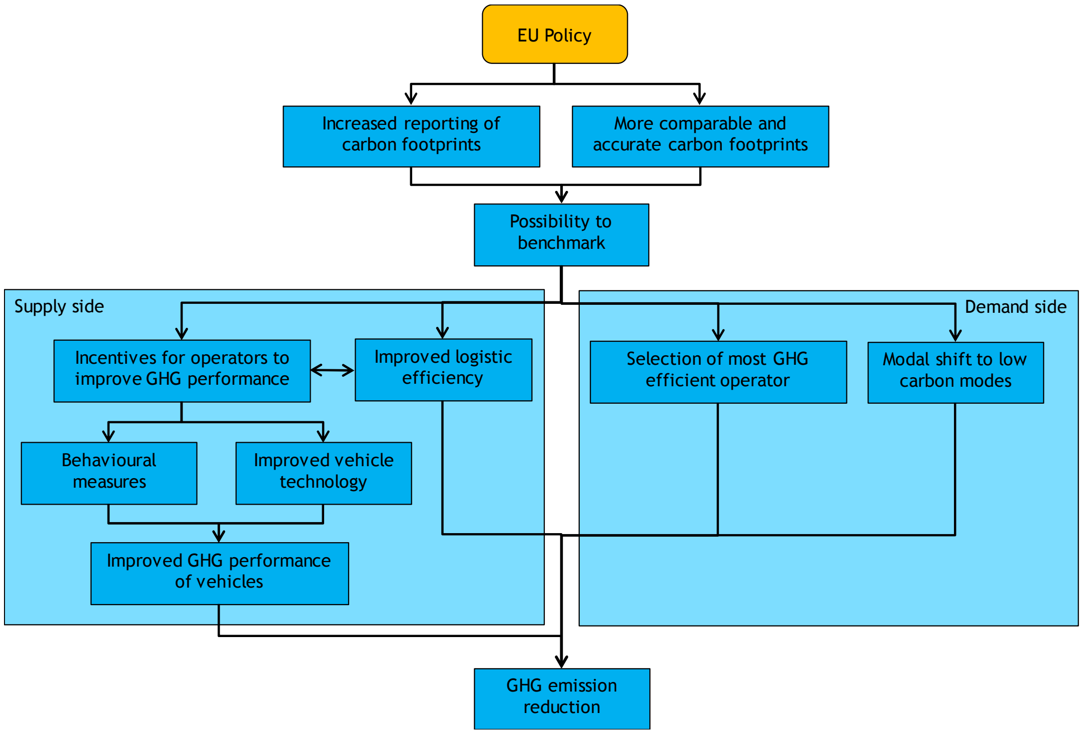


Figure 12 zooms in on the relation between CF policies and GHG emissions performance improvement. The policy directly affects the share of the market reporting carbon footprint and the accuracy, reliability and comparability of the carbon footprints that are made. This provides the possibility to benchmark transport services from different operators and/or transport modes on their GHG emission performance, and in turn can impact choices made by both the supply and demand side. The impacts of these choices determine the impacts on the overall GHG emission performance of transport.

Figure 12 **Relation between EU policy and GHG emission reduction**



The following input has been used in this study to perform the impact analysis:
- The stakeholder consultation, which was performed by using several dedicated tools, namely:
  - workshops: resulted in insight into the problems currently perceived as well as the expected benefits of different policy designs;
  - online questionnaire: provided general information on the expected impacts of increased benchmarking, verified and complemented the problem definition and objectives, and contributed to the establishment of the policy options
  - interviews: yielded information on the general impacts expected for the different policy options.
- Literature and other publicly available sources on the general impacts, like lessons learned from similar initiatives.

Based on these sources, all impacts presented in this chapter have been scored using the legend shown in Table 17.

Table 17 **Legend: strength and direction of impacts**

Sign	Meaning
--	Very negative
-	Negative
-/0	Slightly negative
0	Neutral
0/+	Slightly positive
+	Positive
++	Very positive

6.3 Lessons learned from other measures and initiatives

In this section, we analyse other relevant measures and initiatives targeting lack of information in the transport market. These provide lessons to be learned for the impacts of the policy options analysed in this study.

France (Decree 2011-1336)

As was already mentioned in Section 2.4, the French government obliges transport operators to calculate and report their carbon footprint. The main benefit expected from this policy measure is the possibility to quantify and monitor CO_2 emissions from transport services with a view of including a GHG emission criterion while making a transport decision.
The experience with this policy measure is very limited:

- Implementation of the decree by the transport service providers took time: a number of operators were not ready by the 1st of October 2013 when the decree entered into force.
- Some shippers indicated that they will integrate the request for a carbon footprint in their future contracts with transport operators.
- An example of public transport in and around Paris (by RATP) shows possibilities for assisting passengers in finding a transport solution with harmonised and customised data from the transport operators.
- Further feedback will be generated in the coming months with a public report planned for the end of 2015.

HDV CO_2 emissions monitoring (COM(2014/285))

As part of its strategy to reduce the CO_2 emissions of HDVs, the European Commission identified policy measures for the short and medium term. For the medium term, regulating CO_2 emissions at the vehicle level (e.g. by a label or standard) is considered as the most likely option. For the short term, the Commission considers reporting and certification of HDV CO_2 emissions as a first step in the process of implementation of this policy. However, its effectiveness in terms of the reduction of CO_2 is assumed to be rather limited: *"While certification, reporting and improved consumer information are not expected to significantly curb HDV CO_2 emissions, they are expected to have a positive impact by enhancing transparency on vehicle efficiency in the market and thus improve competition"*.

Passenger car energy labelling (EU Directive 1999/94/EC)

This Directive obliges the display of information on the fuel efficiency and GHG emissions on a fuel economy label for all new cars being sold. Several evaluation studies (e.g. (AEA, 2011a); (ADAC, 2005)concluded that there is limited evidence to suggest that the Directive has a positive impact on buying behaviour. However, these studies have not been able to quantify the precise impact of vehicle labelling on GHG emission reduction.
Within the Netherlands, the labels were combined with financial incentives between 2006 and 2010. Evaluations studies (e.g. (PBL, 2009); (Ecorys, 2011) show that although impacts were limited, the combination of both instruments has contributed to a shift to more fuel-efficient cars. Results show an additional 11,000 cars were sold in the more fuel-efficient A- and B-vehicle segments due to the instrument. However, when comparing this amount to the total annual sales volume of 500,000 new cars, it can be concluded that impacts were modest. Moreover, it is likely that the financial incentives have contributed to these impacts to a larger extent than the energy labels.

Monitoring, reporting and verification (COM(2013/480))

In 2013, the European Commission has published a proposal for monitoring, reporting and verification (MRV) of EU shipping emissions. The calculation of emissions is based on real-world fuel consumption data. The general purpose of this proposal is to assist processes of the International Maritime Organisation (IMO) by providing clarity on the environmental performance and energy efficiency of ships.

According to the official impact assessment performed under the auspices of the European Commission, the GHG emissions from shipping are expected to drop by 2% as a direct result of implementing this measure. This estimation was based on stakeholder's input. On the other hand, the supporting study to the official impact assessment (AEA, 2013) concluded that it was not possible to quantity GHG benefits resulting from MRV. However, the discussions with stakeholders, which were held in the framework of the latter study, confirmed an emission reduction of 0-4% for individual transport operators, thus demonstrating positive environmental impacts of this policy.

Conclusion

The examples above indicate that quantitative information is indeed scarce. For the policies that have been quantified, studies show that reporting can stimulate more environmentally friendly behaviour. However, impacts in most cases are rather limited and should therefore not be overestimated.

6.4 Impact on the carbon footprint information provided

This impact has been defined as the extent to which transport operators provide information about their carbon footprint to their clients as a result of governmental policies. This impact is threefold and may concern:

- **The accuracy and reliability of the information provided,** which is directly related to the methodology used by the transport operator; default values will be less accurate than real-world in-vehicle measured data.
- **The comparability of the information provided**, which relates to the level of harmonisation in the market (calculation rules, scope, default data). The shares of the three different methodologies (Level 1, 2 or 3) used by the market to generate a carbon footprint may be a good indicator here.
- **The number of operators** (i.e. market share) **providing information** on their carbon footprint to their clients.

The policy options have been assessed to determine their impact on each of these elements. The results of this analysis are shown in Table 18 and described in detail in the following sub-sections.

Table 18 Impact of policy options on the provision of carbon footprint information

Element \ Option	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Accuracy and reliability of the provided information	0	++	0	0/+
Comparability of the provided information	0/+	++	0/+	++
Share of the market that provides information	0/+	+	++	++

6.4.1 Accuracy and reliability of the provided information

The accuracy and reliability of the provided information depends (among other factors, such as accountability of the company-specific data that are used) on the methodology that is applied. The main options (levels) were explained in detail in Section 2.3.1. As a Level 3 calculation is based on real-world measured data, it is most accurate in estimating real world emissions. As the use of this methodology is mandatory in Option 2, this option will have the largest positive impact in terms of accuracy. Option 4, which obliges transport operators to use a Level 2 methodology is also expected to have a positive impact, although the impact will be relatively smaller compared to an obligatory Level 3 methodology.

For companies already reporting at Level 3 in the baseline, Option 4 would result in less accurate carbon footprints. Therefore the net effect of Option 4 on the accuracy and reliability is significantly less than Option 2.

The other two policy options allow the transport operator to choose any methodology, with varying levels of accuracy. As this is comparable to the situation in the baseline scenario, these options are not likely to have a significant impact.

6.4.2 Comparability of the provided information

The comparability of the provided information is related to the methodologies used. Comparability does not necessarily increase with a more complex methodology, but does improve when a large(r) number of companies provide similar information (i.e. the market share of a particular methodology).

Interviewees indicated that all the three methodologies are currently in use, and at least a part of the operators apply a mix of them. This practice will be continued in the baseline scenario. Therefore, those policy options which mandate the use of one particular methodology (Options 2 and 4) will have a positive impact on the comparability. On the other hand, the policy options allowing different methodologies (Options 1 and 3), will not have any significant impact on the comparability of carbon footprints compared to the baseline. However, one could argue that the voluntary guidelines in these two options may have some harmonising effects, such as the development of a more consistent set of default values to be used for the Level 1, 2 and 3.

If operators also report the applied methodology, the comparability of calculation results will become slightly better than in the baseline. This finding is true for both Option 1 and 3.

6.4.3 Share of the market providing information

Finally, the share of the market providing information is a direct result of the voluntary or mandatory nature of the policy option with respect to the reporting, and also of the reliability and comparability of the methodologies applied. In the baseline scenario, reporting is voluntary (except in France). Hence, introducing obligatory reporting of carbon footprints will have a significant positive impact and will result in a full uptake by the market. Consequently, policy Options 3 and 4 score best on this element.

Voluntary reporting, which is applied in Option 1 and 2, will not result in large impacts on the uptake of carbon footprinting compared to the baseline. However, option 2 is expected to result in a higher uptake than option 1, due to the use of harmonised level 3 methodology for calculation of GHG efficiency, producing more reliable data and allowing for better comparison of operators. SMEs and micro-enterprises, representing a large share of the transport market (especially in the road transport), are expected not to participate. Carbon footprinting, at least in the initial phase, would therefore remain an activity performed mainly by the large operators in the market (with the exception of France, where every operator is obliged to calculate and report GHG emissions). Conversely, the success of voluntary schemes such as the Smartway programme in the USA demonstrates that considerable market share could be obtained when harmonised guidelines become available.

Option 1 will have a small positive impact as a result of providing clear guidelines for carbon footprinting to transport operators. Such clear, uniform guidelines are not available in the baseline and are expected to represent an incentive for the market to make a carbon footprint. However, as a broad range of methodologies will be still used (Level 1, 2 and 3), the lack of comparability will limit further significant uptake.

In Option 2, the mandatory guidelines at Level 3 may limit the market share that calculates a carbon footprint, because only a relatively complex methodology is allowed. On the other hand, methodological harmonisation should increase the added value of a carbon footprint, because the footprints reported permit true benchmarking as they are both accurate and comparable. Furthermore, the harmonisation of the methodology may lead to the development of tools which will improve uptake and application of carbon footprinting by the industry. The size of these various effects is likely to result in an increase of the share of the market providing a carbon footprint compared to the baseline, especially in the longer run when CF becomes more common, and more operators may follow.

6.5 Impact on the transport market

Carbon footprinting can have different impacts on the transport market. We have structured these impacts around four main elements:

- Impact on **the functioning of the market**: the impact of a policy option on competition amongst transport operators and the relationship between transport demand and supply.
- Impact on **the supply side (the efficiency of operators)**: impact on the reaction (i.e. behavioural change) of transport operators. This can concern

changes in technologies used, logistical measures and/or operational measures.
- Impact on **the demand side (choices of consumers and shippers)**: impacts on the behaviour of consumers, in principle in terms of selecting the most GHG efficient operator or of choosing an alternative transport mode;
- Impact on **the competition, resulting from disclosure of sensitive information**. This sensitivity can be understood twofold; operators can be reluctant to share information with other transport operators (e.g. concerning data on competitive advantages) or with shippers (e.g. disclosing detailed information to the clients may trigger their demands for lowering prices).

These elements are closely related to the impact on the characteristics of the information reported by transport operators (Section 6.4). The share of the market providing carbon footprints and the comparability and accuracy of this information determines to what extent transport decision-makers can use the carbon footprint in their decisions and hence, the extent to which operators will change their behaviour.

Table 19 provides an overview of the impacts on the transport market that can be expected with each of the policy options defined. Each element is described in more detail in the following sub-sections.

Table 19 Impact of policy options on the EU transport market

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Functioning of the market	0	+	0	0/+
Supply side: efficiency of operators	0	+	0	+
Demand side: choices of consumers/shippers	0	+	0	0/+
Impacts on competition from disclosure of sensitive information	0	-	0/-	-

6.5.1 Functioning of the market

There is a general consensus that attention to environmental issues in the transport sector is gradually growing. Both shippers and transport operators are increasingly opting for green solutions, although this is often the result of factors other than environmental concerns (e.g. fuel savings, competitive advantages, etc.).

Despite this increasing awareness, the connections between transport operators, 3PLs and shippers with respect to the supply and demand of green transport services has not received much attention in previous research. Carbon footprinting can have an impact on both sides of the market, though. These impacts are described separately in Section 6.5.2 (impact on supply) and Section 6.5.3 (impact on demand). The overall impact on the EU market is the direct result of both of these and in particular their interaction: in a well-functioning market, shippers would include the GHG performance while benchmarking different operators and operators would respond by improving their GHG emission performance.

Nevertheless, it appears that there are currently gaps between the demand and supply sides of green transport service. Martinsen and Björklund (2012) conclude that today's supply of green transport operations exceeds the demand for such services from shippers. This imbalance may be caused for example by the fact that green transport operators expect demand for such services to increase in the future.

Likewise, Wolf and Seuring (Wolf & Seuring, 2010) showed a discrepancy as regards the perception of environmental considerations at both the demand and supply sides of transport services: the shippers identified purchasing of transport services as part of their environmental strategies, but the transport providers stated that they receive no environment-related requirements from the buyers. The latter is in line with the evidence described for the problem definition, which was explained in detail in Section 3.5.2.

Stakeholders provide interesting contribution as regards the relative impact on GHG efficiency that can be expected. The majority of the respondents state that carbon footprinting contributes adequately to evaluating the GHG performance (agree 44%; disagree 22%). However, their opinion on the current applicability of carbon footprinting as a tool for improving GHG performance is mixed. In the freight sector, 31% of the respondents do not support this statement, while 30% do. In passenger transport this scepticism is even higher (36% disagree and 26% agree). On the other hand the stakeholders see a future potential of carbon footprinting as a tool for improvement of the GHG efficiency of transport, under the condition of an improved methodological framework (57% agree and 18% disagree). The stakeholders also recognise its usefulness for implementation of technical (56% agree and 7% disagree) and operational (61% agree and 6 disagree) optimisation measures.

The options with voluntary reporting (Policy option 1 and 2) will only limitedly impact the share of operators that calculate and report their carbon footprint, with a larger impact for option 2 than for option 1. Indeed, when zooming in on the (small) share of the market that *does* provide a carbon footprint, Option 2 will improve the functioning of this sub-market. Both incentives provided to supply and to demand will be larger than in the baseline, due to the fact that the methodology is based on real-world measurements and all information is harmonised, respectively. Furthermore it can be expected that under option 2 specific groups of shippers may become increasingly interested in benchmarking of transport services on GHG emissions, as with Option 2 there is an accurate and harmonised methodology available.

Moreover all carbon footprints that are reported under Option 2 give incentives to transport operators for all types of GHG emission reduction options. This may over time increase the application of carbon footprinting in the market, since the implementation of measures leads to lower calculated values. We therefore conclude that with Option 2 there can be expected some significant improvements in the functioning of the market (scored with a '+').

With Option 1, the main share of the market would use mainly Level 1 and Level 2 calculations. The use of defaults in these methodologies will limit the incentives for applying GHG emission reduction measures. Thereby, the different methodologies impede benchmarking and thus limit the incentives given by the demand side of the market.

With the mandatory reporting Options 3 and 4, the amount of information available increases enormously, which can positively influence the functioning of the market. However, the increase in the availability of information does not automatically result in better functioning of the market (i.e. stronger interactions between the supply and demand of /green/ services), given the limited role of information failure as a barrier. With this limitation in mind, the impact of Policy option 4 will be larger than of Option 3, given that the information is harmonised (i.e. if one methodology is used) and shippers can benchmark with this policy design. However, the incentives that result from this increased demand are still limited due to the fact that the operators are not rewarded with a lower footprint for every GHG emission reduction measure they implement (due to the use of defaults). Overall the impact on the functioning of the market of Option 4 is scored with a '0/+' mark and the one of Policy option 3 with a '0'.

6.5.2 Supply side: GHG efficiency of operators

The impact on the supply side depends on the share of the market that reports carbon footprints and on the measures that transport operators apply, being incentivised by the different calculation methodologies. The impacts on the share of the market reporting carbon footprints of their transport services was assessed in Section 6.4.3. It was concluded that in the mandatory schemes (Option 3 and 4) this share grows significantly (up to 100% of the market), while in Option 1 and 2 (the voluntary ones) the increase is rather limited, compared to the baseline scenario.

The impacts of carbon footprinting on the measures implemented by transport operators depends mainly on the carbon footprinting methodology that is used. Transport operators can apply different measures to improve their GHG emission performance (see Section 2.2), such as adopting fuel-saving technologies, optimising logistics or adopting eco-driving. Especially operational optimisation and increased efficiency are well established practices, which are considered fundamental for competitive gains in a sector where the level of competition is very high and profit margins are very small. However there is still considerable room for improvement on all these aspects.

It is considered that carbon footprinting may increase operators' awareness and transparency with respect to their own GHG emission performance. The benchmarking with other operators may incentivise the management to improve the carbon footprint. Different drivers can influence this reaction, such as the level of trust in carbon footprint calculations as a tool for managing GHG emissions, the possibilities for improvements disclosed by carbon footprinting (and not known prior to the calculation), and the capability and willingness to invest in optimisation measures. As these factors vary between operators it is rather difficult to quantify general impact that can be expected on the supply side.

However, an important precondition to incentivise company managements to adopt measures, is that the calculation result should form a true reflection of real-world operations. The Stakeholder consultation indicates that this is currently not the case. 70% of the calculations performed today are based on the Level 1 and 2 methodologies. These methodologies use default values, and therefore do not reflect limitedly GHG emission reduction efforts taken by the operator. Therefore, it is understandable that these calculations do not incentivise operators to take into account the full range of available fuel-saving measures. With the Level 3 methodology – based on real-world measured data - this is not the case. This methodology has the largest positive impact on improving the GHG efficiency and stimulates the application of all kinds of operational and technical measures.

On a company level, the impacts of carbon footprinting on the supply side are largest with Policy option 2, obliging operators that make carbon footprints to apply the Level 3 methodology. With Policy option 4 the carbon footprints are based on a Level 2 methodology. As a result, the incentives given to the supply side are limited to logistical optimisation. Therefore the impact on a company level is much smaller than for Option 2. In case of Policy options 1 and 3, due to reasons stated in 6.4, the incentives for harmonization of carbon footprints are even more limited. This makes that barriers for benchmarking will remain, resulting in lower levels of efficiency improvements at the supply side.

Besides the direct impacts on the supply side, also indirect effects on the transport demand can be expected (i.e. if shippers/consumers change their behaviour/decision due to the availability of carbon footprints). If shippers/ consumers include the carbon footprint of operators in their transport decision, operators will receive a strong incentive to improve their GHG performance. According to Lin and Ho (Lin & Ho, 2008) logistical service providers are willing to make their services more environmentally friendly and to react to customer demands. This interaction between supply and demand was covered in the previous section.

To conclude, the total impact on the supply side of the transport market is largest with Option 2 and 4. With Option 2 the share of the market that reports a carbon footprint is limited, but the impact of these footprints is foreseen to be much higher (high comparability). Furthermore with Policy option 2, effects may increase over time, if more companies follow the front-runners. However, without mandatory reporting this process will likely be limited mainly to the medium and larger companies, while the largest share of the transport market is dominated by the SMEs and micro-enterprises (see also Section 6.6).

Option 1 is assumed to have very limited impact on the supply side as there is no single methodology put forward, and reporting remains voluntary. This will not result in significant impacts on the accuracy, comparability and market penetration of carbon footprinting. Policy option 3 is not expected to substantially influence the supply side either. Similarly, as in option 1, the type of methodology is left up to the market, reducing the comparability and accuracy of carbon footprints. Consequently, most operators are likely to choose the Level 1 or 2 methodology, which will not capture many reduction measures, and hence, will not incentivise the market. Furthermore, different operators will use different methodologies, making it difficult for an operator to benchmark its own performance to that of a competitor.

6.5.3 Demand side: choices of shippers/consumers

Section 3.5.2 (freight) and Section 3.6.2 (passenger) provided ample evidence for the current low level of priority that is given to environmental performance when transport decisions are made. Despite the lack of weight given to such criteria and the low level of willingness to pay for green transport solutions, the problem definition did indicate that if competitors score the same on price and quality, a significant share of transport decision-makers (approximately 65%) would consider an operator with lower GHG emissions.

This indicates that *if* accurate and comparable carbon footprints are reported by a large share of the market, at least a significant share of the shippers may change their transport decision in favour of operators with lower carbon footprints. In this respect, increased and/or improved carbon footprinting can have a positive impact on transport demand. However, this positive impact will only occur when the price and quality of the different suppliers of a transport service are (roughly) comparable. Shippers can also decide to choose a different mode with a lower environmental impact. However, the impact of carbon footprinting is likely to be limited, as shippers in general are already aware of the lower environmental impact of non-road modes. Shippers opting for road transport do so for cost and quality reasons rather than for lack of information.

When keeping these general limitations in mind, the policy options can differently impact transport demand. In the baseline, few operators report their carbon footprint and information provided is not necessarily comparable nor accurate. The impact of the different policy options on transport demand are closely related to their impact on the characteristics of the information provided (see results of Section 6.4).

For significant impacts on the demand side, available carbon footprints need to allow for fair benchmarking between transport operators. This precondition is only truly met with Policy option 2, as the mandatory Level 3 methodology ensures that all carbon footprints reflect the real world emissions and makes carbon footprints from different operators comparable. The impact on the demand side with Option 2 is however limited by the fact that only a small share of the market will decide to report carbon footprints due to the voluntary character of this option and high level of details to be used for calculations. Therefore the possibility for shippers to benchmark various transport operators they consider to contract, will be limited to front-runners. Furthermore, as explained above, it should be kept in mind that this possible positive impact is restricted to situations where price and quality aspects of the same service providers are roughly comparable. On the other hand, the mandatory methodology at the Level 3 prevents shippers to be confronted with misleading carbon footprints suggesting that a specific service is relatively 'green', while in reality is not. Also this element can be regarded as a contribution to proper functioning of the market.

Option 4 has also impacts on the demand side as shippers may get information on the GHG performance of all transport services. However, since it uses a methodology at the Level 2, the carbon footprint just reveals the differences in environmental performance of different transport modes and the logistical efficiency of the operator. It does not account for some important options for GHG emission reduction, such as the vehicle technology and driving behaviour. However, the information on the environmental performance can deviate significantly from the real world performance, potentially resulting in suboptimal decisions by shippers. This will significantly limit the effectiveness on the demand side and the possibility for shippers to benchmark properly. The net overall impact on the functioning of the market with Option 4 is therefore scored somewhat lower than for Option 2.

With Policy options 1 and 3, benchmarking transport services with respect to GHG emission performance is expected to remain problematical, due to lack of comparability of carbon footprints. Therefore the impacts of these options on the demand side are likely to be negligible.

6.5.4 Impacts on competition resulting from disclosure of sensitive information

Section 3.5.1 illustrated that carbon footprinting may be associated with the exchange of sensitive business information. This can have also impacts on the functioning of the transport market.

The sensitivity of the provided information is highly dependent on whether or not the transport companies are obliged to make their carbon footprints available to third parties. In the baseline, reporting is voluntary (except in France), and hence, in most cases the operators will probably decide not to report. In general, the policy options with mandatory reporting (3 and 4) have a negative impact on the provision of sensitive information, since those operators, which are reluctant to sharing information are forced to do so. Furthermore, it can be argued that the higher the level of detail of the information provided, the more likely that sensitive information is included in the report. For this reason, Option 4 which has a mandatory methodology (and hence a mandatory level of detail in the provision of information), scores slightly worse on this element compared to Option 3 in which operators can choose the level of detail that discloses the lowest amount of sensitive information.

The same logic can explain why Policy option 2 has a negative impact on the sensitivity of the provided information. This option mandates the use of the Level 3 methodology (with the highest level of detail), bringing the largest risk of disclosing sensitive information. Since reporting is voluntary with this option, the impact is limited to a smaller share of the market. However, as the impact per company that does report is likely to be much higher than with option 4, we assume eventually that option 3 is likely to score roughly the same as option 4 (a “-“). The other voluntary reporting option (Policy option 1) allows operators to choose the methodology that discloses the lowest amount of sensitive information (most likely a Level 1 calculation), which is also the case in the baseline scenario. Moreover, Option 1 is not expected to result in a significant increase in the share of transport operators reporting their carbon footprint. For both reasons, Policy option 1 will not have a significant impact on the sensitivity of the information compared to the baseline.

6.6 Impact on transport operators’ administrative burden

This section deals with the administrative efforts and costs for transport companies resulting from each policy option. The main costs for companies are related to the implementation, operation, and maintenance of (automatically operated) carbon footprinting systems and the involved personnel. Additionally, companies using external tools (e.g. software) will likely have to pay a fee. Annex D provides an overview of fees from existing initiative that may represent an indication of the magnitude of such costs.

To assess this impact, a distinction is made between large companies, SME’s and micro-enterprises[33], as the administrative costs of a carbon footprinting system are highly dependent on the size of the company and on its business structure (e.g. number of employees, dimension of the vehicle fleet, type of operation, number of subcontracts, etc.). Table 20 summarises the impact of

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[33] The European Commission defines SMEs as companies which have less than 250 employees and an annual turnover of € 50 million or less. Micro-enterprises are defined as companies with fewer than 10 employees and an annual turnover of € 10 million or less. Source: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/

each policy option on the administrative efforts/costs for two main categories of transport companies. These results are explained in more detail below.

Table 20 **Impact of policy options on overall administrative costs in the EU**

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Administrative effort/costs for SME's and micro-operators	0	0	-	--
Administrative effort/costs for large companies	0	0/-	0/-	-

The used methodology has a significant impact on the administrative costs to be incurred by companies. Irrespectively of company size, lower administrative costs will result from the Level 1 and 2 methodologies, as these are based on default values. The more detailed Level 3 calculation requires more data to be measured and collected, which increases workload, and consequently the administrative costs.

In general, voluntary reporting is expected to have a more limited impact on administrative costs than mandatory reporting. Therefore, we assume that in Option 1 the administrative costs might be only slightly higher than in the baseline, taking into consideration rather slow development of carbon footprinting at the market. In Option 2, the administrative burden for companies making a carbon footprint will increase due to the fact that they are obliged to apply the Level 3 methodology which is complex and has high data requirements. Since the SMEs and micro-enterprises are in general unlikely to report in this case, the score for that category is '0'. For large companies, the score is '0/-', as they will report more frequently.

The implementation of a mandatory carbon footprinting system (Policy option 3 and 4) will increase the costs that companies incur, since each company is obliged to calculate and report their carbon footprint. This impact will be relatively less negative with Option 3. In this case voluntary guidelines are made available enabling companies to choose the methodology which suits them best. Therefore, this impact is likely to be limited for both the large companies and SMEs/micro-enterprises.

For the other mandatory reporting option (Policy option 4), relatively detailed calculations with default vehicle emissions factors (Level 2 calculations) are obligatory. As a result, companies cannot choose the methodology with the lowest cost. This increases the impact on both small and large companies in terms of the experienced administrative costs. However, the relative impact of such administrative costs will be smaller for larger companies (when compared to their annual turnover).

Administrative effort/costs for SMEs and micro-enterprises

Considering that SMEs and micro-enterprises would need to collect and manage only a small set of data, which should not substantially increase the administrative efforts related to the carbon footprint calculation, only a simple carbon disclosure system may be needed. In this case it would probably be sufficient to set-up a computation system that, in the simplest configuration, might be based on a personal computer and electronic calculation programmes allowing electronic data exchange with a server, without the need to purchase dedicated software. Although this lowers the administrative costs of their carbon footprinting, it should be kept in mind that even a small increase in costs can still result in a problematically high burden for these small companies, operating with very low profit margins and using limited resources.

Moreover, SMEs and micro-enterprises will generally not have sufficient number of educated staff to perform the calculations, which can represent a real barrier to carbon footprinting by these companies as well. Some of the interviewees confirmed that administrative costs can be very high for SMEs, especially if automatic systems for data collection and the calculation process are not available.
Both factors are likely to result in a low level of acceptance for any mandatory reporting scheme by SMEs and micro-enterprises.

Carbon footprinting especially may be a challenge for companies, which are active in the road sector. This sector is highly fragmented and characterized by a large number of micro enterprises (approximately 39% of the transport operators are one-man companies and 45% of them operate a fleet comprising of two to ten vehicles). In total 80-90% of the operators own less than five vehicles. Similar situation can be expected in the inland waterway sector, also dominated by smaller family-owned companies.

Interviewees therefore clearly stressed the need for measures that will enable small- and medium-sized enterprises to calculate their carbon footprint without any significant increase in their administrative burden (both in terms of time and costs). It is realistic to assume (and strongly recommended) that the policy options with mandatory reporting (Policy option 3 and 4) will provide such measures to guarantee that small and micro-enterprises can meet the requirements. This could for example be realised with the development of simplified and easy-to-use web-tools and by making these tools available free-of-charge (or at a very low fee) in every EU language.

Quantification of the administrative costs for small and micro-enterprises

If simple and cheap tools are widely available for small companies, the 'only' administrative efforts will be limited to compiling the web-forms. We assume that the entire process may take a few man days per year (e.g. in the range of five to ten man days per year), depending on type of operator. In addition, a few hundred euros (e.g. ranging from € 0 to 300 annually) may need to be invested to access the on-line reporting forms.
With the assumption that Eastern European monthly wages are between € 1,200 to 1,500 Western European wages from € 2,500 to 3,000 (TRT , 2013) the administrative costs for small and micro-enterprises might range between*:
€ 400-1,100 for Eastern European operators;
€ 700-2,000 for Western European operators.
For both micro and small companies, these costs are assumed to be around 0.5 - 1% of their annual turnover.

* The number of man days required to process the data multiplied by the proportion of the respective wages + the fee to access the web-forms.

Administrative effort/costs for large companies

A study by the OECD (OECD, 2012) on the industry sector confirms that setting up and maintaining a carbon disclosure system results in costs that may in some cases not be outweighed by the benefits. However, only a small number of studies have been conducted to assess the costs and benefits of carbon footprinting for the business in general, not for the transport operators in particular. This would be a complex analysis requiring access to business strategies and detailed financial statements, where both direct and indirect effects would need to be addressed. This finding has also been confirmed by the conducted interviews. Several companies indicated that they are not able to clearly attribute the costs related to the implementation and management of a carbon footprinting system.

An indication of the costs is provided in the following text box.

Quantification of the administrative costs for large- and medium companies.
Similarly, as it was the case for the SME's, the large companies will incur additional administrative costs for carbon footprinting. Interviewees, representing some of the largest transport operators in the EU, provided relevant data on the costs related to setting up and maintaining a carbon footprint system. For very large companies, such costs may be estimated in the order of € 40,000-50,000, mainly resulting from the IT development. Personnel costs resulting from maintaining the system and performing the calculation are also significant. In general, several departments are involved in the data management process (e.g. IT department, sustainability department, tendering department) and as a result this process may require up to 5-6 persons, depending on the extent to which the process is executed automatically.

Differences exist in the IT software used. Some companies rely on software provided by existing initiatives in the sector, which they can use for an annual fee. Other companies apply in-house developed tools, which in most cases are based on Microsoft Excel application. Such systems require a lot of manual work.

Other costs can also emerge from participation to some of the existing CF initiatives (see 0). When summing up the total costs, implementing and maintaining a carbon footprint system will costs a large company approximately € 20,000-40,000 per year, assuming that the figures presented above apply to companies with a vehicle fleet of several hundreds of vehicles. When comparing these costs to companies' annual turnover, the relative impact is considered to be relatively low: <0.1%. Large companies are assumed to have economies of scale, given that they have to administer large amounts of trips.

For medium sized company the cost will be somewhat lower and are estimated at € 25,000 for setting-up the system and an additional € 5,000-7,000 for data collection, monitoring and reporting. For these companies, carbon footprinting will also have a relatively small impact on their turnover (indicatively in the range 0.1-0.5%).

As evidenced in the text box above, the impact of mandatory carbon footprinting on the administrative costs of medium and large companies is limited when compared to their annual turnover. As the maritime, air and rail sectors are mainly operated by a small number of large players (due to substantial investments required in equipment), the impact of mandatory carbon footprinting on the administrative costs for companies in these sectors are expected to be limited.

Illustrative costs for the EU transport market; road freight sector

Combining the quantifications for the costs of carbon footprinting for micro, small, medium and large companies with their respective shares in the EU transport market provides insight in the overall costs for the whole EU road freight transport market.

The number of transport operators of a particular size can be estimated using the market shares provided by AEA (AEA, 2011a); see Section 3.5.1) and Eurostat data on the total number of road haulage enterprises. Multiplying these numbers by the respective costs of carbon footprinting per type of enterprise (i.e. micro, small, medium and large), it results in a cost figure per market segment. The outcome of this calculation is shown in the following table.

Table 21 Estimated average costs of carbon footprinting for differently sized operators (based on the road transport example)

Type of enterprise Element	Micro	Small	Medium	Large
# of vehicles in operator fleet[34]	1	2-10	11-50	>50
% of EU28 road transport enterprises[35]	38.6%	45.4%	13.3%	2.7%
# of enterprises in EU28[36]	222,000	261,000	76,000	15,000
Annual cost for CF per company[37]	€ 550-€ 850	€ 1,550-€ 1,850	€ 7,500-€ 9,500	€ 20,000-€ 40,000
Total annual costs for road companies in EU28	€ 122-€ 188 million	€ 404-€ 482 million	€ 573-€ 725 million	€ 310-€ 620 million

Costs for carbon footprinting per policy option

A detailed magnitude of the costs cannot be estimated due to lack of precise quantitative data on the changes in behaviour within the industry. Nevertheless, relevant illustrative calculations have been made for the road freight sector, providing a rough overview of costs per policy option. These estimations are based on the average figures reported by the stakeholders. The administrative costs at a company level are illustrated in Table 22.

34 These figures are based on the division of enterprises as shown in the AEA ((AEA, 2011a).

35 Based on (AEA, 2011a).

36 As stated in the text, the total number of road transportation enterprises in the EU, was calculated from Eurostat data 'Annual detailed enterprise statistics for services', yielding the figure of 574,000 used here.

37 For the costs of micro and small enterprises, a separation between Eastern and Western Europe has been applied, as shown in the preceding section. Given that the division of type of enterprises (i.e. micro, small, medium and large) is similar both in the Eastern and Western Europe, an average of the annual costs for carbon footprinting between the two regions has been used. For matters of simplicity, the initial costs for setting up an administrative system are assumed to be depreciated over 10 years. In addition, the micro enterprises are assumed to require 5 working days per year, and the small enterprises respectively - 10. As an example, the annual costs for a medium company are assumed to be: € 25,000/10years = € 2,500 annually for the set-up of the system, and € 5,000-€ 7,000 annual costs for maintaining and operating, giving a range of € 7,500 – € 9,500 of annual costs. Numbers have been rounded.

Table 22 **Estimated costs of policy options on the basis of average CF costs**

Option	Cost estimation
Options 1 and 3	The administrative requirements related to these options are relatively limited (voluntary methodology of carbon footprinting). The costs are likely to be significantly lower than average, representing around 50% of the average CF costs at company level.
Option 2	The level 3 methodology (real world data) proposed under option 2 is the most complex one amongst all the analysed policy options. Therefore option 2 is estimated to have relatively highest administrative costs at company level, surpassing the average by around 20%.
Option 4	Option 4 is based on level 2 methodology (default vehicle emission factors), the costs for this option are therefore assumed to be at average.

Table 23 provides assumptions for the share of the market (for the road freight transport) applying the carbon footprinting in their business practice. This, in combination with data on the costs at a company level, delivers estimations on the total administrative costs per policy option.

Table 23 **Estimated costs of carbon footprinting per policy option for road freight transport**

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Share of companies reporting	25% of the large companies	50% of large companies	All	All
Administrative costs	~38 - 75 million	~186 - 372 million	~0.70-1.0 billion	~1.4-2.0 billion

The costs for Policy Option 1 are estimated to be the lowest, which is explained by the limited complexity of the methodology and limited share of the market applying carbon footprinting. The costs of Option 2 are higher, since it is foreseen that a larger share of the operators will join the scheme and the costs of reporting are seriously higher. In case of Option 3 and 4, all companies will bear costs, because the reporting is mandatory. Limited complexity of calculations is also the reason for relatively low costs in option 3. Under Option 4 these costs increase as a result of the required level-2 methodology.

Costs for the EU transport market; entire transport sector

Compared to road transport, the overall number of non-road transport operators is limited at the EU scale. This limits the relative impact of carbon footprinting on the companies' costs, also because the size of a shipment is usually larger than for road transport.

The transport volumes (in terms of tonne-km performed) of short sea shipping, rail transport and inland waterway transport are roughly equal to those of road transport. Assuming also similar costs per tonne-km, we can estimate that the overall costs for the non-road transport would be comparable to the total costs generated by the road mode. However, the costs per unit of transport are likely to be inferior due to lower number of shipments (services performed).

Overlap with other initiatives

The interference with other ongoing initiatives within the EU is limited. Nevertheless, two ongoing policies may be impacted to some extent:

France may need to update the methodological guidelines that are part of Decree 2011-1336 in case of policy option 2, 3 and 4.

The introduction of carbon footprinting for the Maritime transport sector shows similarities with the introduction of MRV for this sector, although the concept of MRV is less complex. Implementation of carbon footprint should therefore be coordinated with the implementation of the MRV proposal, to minimize the redundancy and additional administrative burden of different but complementary calculations.

6.7 Impact on workload of European Commission

Introduction of a new policy will have an impact on the workload of the European Commission. This impact will be twofold, as the workload is influenced by:

- **development of guidelines**: each of the policy options would require at least one common guideline describing a carbon footprint methodology;
- **monitoring and enforcement**: the efforts/costs incurred by the Commission on monitoring and enforcing the carbon footprinting system.

The impact of a given policy option will depend on how closely the Commission is involved in the design, implementation, monitoring and enforcement of the chosen carbon footprinting policy. If this involvement is extensive, naturally, the impact on the workload will be significant. On the other hand, the Commission could outsource these activities to market parties, in which case the impact would be only limited. Outsourcing, however, would entail additional costs for the Commission.

Table 24 Impact of policy options on the workload of the European Commission

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Development of guidelines	-	-	-	-
Marketing, Monitoring and enforcement	0/-	-	- -	- -

The baseline scenario assumes no EU action and therefore, all the analysed policy options will have at least a small negative impact on the EU's workload. The costs of developing guidelines will be comparable in all options, since all options require guidelines with a high level of detail.

Considering the impact of monitoring and enforcement, Option 1 requires no efforts in this area. Since this is also the case for the baseline scenario, we expect no impact on this option whatsoever. With Option 2 the reporting is voluntary, but the use of a Level 3 methodology is mandatory. Therefore, the Commission would have to monitor and enforce the use of this methodology for those companies that voluntarily provide their footprint. As the number of carbon footprints is foreseen to remain relatively limited, the negative impact of this element on the workload of the Commission will be rather insignificant. Finally, the policy options with mandatory reporting (Option 3 and 4) require the EC to actively monitor and enforce reporting by *all* transport operators. Both options are therefore expected to have a significant negative impact on the monitoring and enforcement costs of the Commission.

An indication of the magnitude of costs that may result from implementing a policy option with mandatory reporting is presented in the following text box.

Indicative cost calculation for the European Commission

To quantify the potential costs for the European Commission if a carbon footprinting system is implemented, we have reviewed the costs of several similar EC initiatives.

MRV

A relevant Impact Assessment has been developed as a part of the Proposal for a Regulation of the European Parliament and of the Council on the monitoring, reporting and verification (MRV) of CO_2 emissions from maritime transport, an impact assessment has been performed (AEA, 2013)). This assessment estimates the total cost of such a system at around € 3- 4 million per year. The cost of monitoring and enforcement at the EU-level are lower, because of the aggregation of resources and economies of scale.

These findings are rather difficult to translate to the costs that would be generated by a more detailed system covering all transport modes. The exact costs depend, however, strongly on the assumed level of verification of the information reported.

The costs of an EU transport carbon footprinting system

In order to install and maintain an EU-wide carbon footprinting system, two steps are required: (1) setting-up a system, and (2) managing and maintaining the system. The following table provides an overview of the likely elements to be part of these steps, which apply to both a voluntary reporting system as well as to an obligatory reporting system. The final column shows the costs or required FTEs. The lower figures apply to the voluntary options, the higher figures apply to the mandatory options.

	Voluntary/mandatory reporting	**Costs/FTE**
Set-up an EU wide system	Develop methodology/software	€ 2 million
	Developing, implementing and maintaining legislative proposals and instruments (option 2/3/4)	2 fte
	Inform transport operators on use of system	2-5 fte
Managing and maintaining the technical system	Enforce carbon footprinting (option 2/3/4)	10-20 fte
	Gather and sort data	1-2 fte
	Provide help desk service	1-2 fte
	Create public awareness	1-2 fte

The cost shown in the table above will differ according to whether the system is based on mandatory or voluntary reporting (the former requiring more efforts) and on other elements such as the difficulty of the methodology used, the likelihood of companies committing fraud, etc. An indication of the *annual costs* per policy option is provided in the table below[38]. Relatively higher costs are allocated to option 3 and 4, reflecting the larger amount of companies that make carbon footprint calculations.

	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Developing/maintenance methodology/software	€ 200,000	€ 200,000	€ 200,000	€ 200,000
Developing, implementing and maintaining legislative proposals and instruments	-	€ 180,000	€ 180,000	€ 180,000
Inform transport operators on use of system	€ 180,000	€ 180,000	€ 450,000	€ 450,000
Enforce carbon footprinting[39]	-	€ 900,000	€ 1,800,000	€ 1,800,000
Gather and sort data	€ 90,000	€ 90,000	€ 180,000	€ 180,000
Provide help desk service	€ 90,000	€ 90,000	€ 180,000	€ 180,000
Create public awareness	€ 90,000	€ 90,000	€ 180,000	€ 180,000
Total (rounded figures)	€ 650,000	€ 1,820,000	€ 3,350,000	€ 3,440,000

As the table shows, the expected annual costs are estimated to be between € 0.65 million and € 3.4 million.

6.8 Impact on policies of national/regional governments

This section assesses the impact of the policy options on the use of the EU initiative for GHG footprinting by national/regional governments for their own policies. It concerns the question in what way national and/or regional governments can use the system introduced by the European Commission. Although this is difficult to quantify, it is important to evaluate this impact since it influences the potential uptake of a policy option.

Carbon footprinting can enable national and/or regional governments to use reported data in multiple ways. They can use carbon footprints when acting as a demanding consumer when purchasing services and products (e.g. with an intention to act as a first mover). An example of a government using carbon footprinting is given in the following text box.

[38] The assumed gross labour costs per FTE at the EC are € 90,000 on an annual basis, and the software system is presumed to be usable for 10 years.

[39] Enforcement could be either done by EU verification or national verification, depending on how this policy is implemented.

Using carbon footprints as a scoring mechanism In the Netherlands, a GHG-performance ladder has been developed by the (state-owned) Dutch railway operator (ProRail) in 2009. The ladder is used to score the carbon footprint of companies and their suppliers and is used by the Dutch government for its procurement procedures. The higher the score of the company on this ladder, the larger the advantages that can be gained in the tendering procedure. The use of this ladder in procurement procedures is now also used by multiple organisations in different sectors.

Table 25 provides an overview of the impacts of the different policy options on national and/or regional governmental policies. A positive score implies an increased uptake of the EU initiative by national/regional governments.

Table 25 Impact of policy options on national/regional governmental policies

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
National/regional governmental policies	0	+	0	+

As it can be seen, no significant impact is expected for Option 1 with both voluntary reporting and a free choice of methodology. Governments can still require a carbon footprint for their own procurement policies, however, this is also the case in the baseline. Similarly, it will be difficult to use the carbon footprints for mandating particular behaviour (e.g. environmental zoning), as the number of carbon footprints will be limited (see Section 6.5) and information cannot be used for benchmarking due to the deployment of different methodologies.

This latter mentioned limitation is solved with the implementation of Policy option 2, in which all reporting has to be based on the same - Level 3 - methodology. Compared to the baseline, governments may therefore make better use of the harmonised information while developing their specific policies (e.g. when purchasing services and products).

In Policy options 3 and 4 reporting is mandatory and hence, carbon footprints are widely available. However, the accuracy and reliability of the carbon footprints remains low, which significantly reduces the added value and applicability of the information for national and regional governments. This is why in Option 3 the impact on national/regional policies is scored as ‘0’.
For Option 4 the score is higher because of all carbon footprints are at Level 2 and so more meaningful and applicable for other policies. However, as the Level 2 footprints provide mainly incentives for logistic optimisation and not for more efficient vehicles or driving, the score is not higher than for Option 2[40].

40 See also the discussion of environmental impacts in Section 6.10.

6.9 Impact on the economy

While Section 6.5 focused on the impacts of the policy options on the transport market, this section elaborates on the impacts on a more general, macro-economic level. This includes:

– The **impact on the GDP and on economic growth**. Macro-economic impacts are strongly related to the costs enforced on transport operators (administrative costs and potential investment costs of GHG emission reduction measures) and the savings of energy costs. However, macro-economic impacts are broader than direct costs incurred by companies. They are related to any change in transport prices for shippers and consumers, which in turn may result in overall economic effects.
– The **impact on the total external costs of transport.** If the policy options have an impact on the amount of external costs resulting from transport, this is also likely to positively impact the economy. Many external cost categories (e.g. accidents, congestion) directly result in economic costs. Other external costs categories (e.g. GHG emissions, noise, air pollution) can reduce economic costs indirectly (e.g. costs of health care).
The reduction of external costs therefore results in positive impacts on the economy.

Table 26 provides an overview of the impacts of the different policy options on the economy.

Table 26 Impact of policy options on the EU economy

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Impact on the GDP and economic growth	0	0	0	0
Total external costs of transport	0	0/+	0	0/+

In general, the impact of the policy options on GDP and economic growth are assumed neutral for all policy options, since impacts on transport prices are expected to be rather negligible. Interviewed operators indicated that the cost change per consignment is negligible[41]. Carbon footprinting has the potential to open new opportunities for efficiency gains and modal shift which in turn reduces external costs. As was mentioned above, efficiency gains (e.g. higher load factors, fuel-saving technologies) can lower the operational costs of transport operators (e.g. reduced congestion, lower number of accidents). However, the options that will have the highest impacts on the market (and resulting efficiency gains) also have the highest administrative costs (Option 2 and 4).

[41] An increase in transportation costs might derive from the quite unlikely possibility of operators passing the costs associated with implementing GHG optimisation measures on to final customers. As documented in the main text, there is little if any scope for operators to do so at present. In any case, even assuming a 2% increase in transportation costs in the European road sector, the test performed with ASTRA EC (see Annex E) shows that the impact on the economy will be limited.

The lack of quantitative data on the benefits of CF in improving efficiencies and reducing transportation costs as well as the difficulty when predicting behavioural changes are strong barriers for the estimation of economic impacts that may result from the different policy options. If carbon footprinting leads to a reduction of transportation costs in the European road sector, the estimated impacts will be rather marginally positive (see Annex E - ASTRA EC model).

The text box below provides some indication of the magnitude of the impacts based on a modelling exercise performed within this study.

Quantification of the impacts from carbon footprinting

Compiling exact figures on the behavioural changes that can be expected as a consequence of the different policy options is difficult with the available data.

To generate an indication for the order of magnitude of the impacts that may result from increased and improved carbon footprinting, a quantitative analysis has been carried out with the ASTRA EC model. A detailed description of the model can be found in Annex E.

It should be noted that the assumptions used as an input for the model represent general reactions of the sector, which are larger than the behavioural change that can be expected with the introduction of the policy options. The outcomes resulting from the model can therefore be considered as the maximum values and the actual impacts of the policy options are expected to be lower.

Calculations have been made to estimate the impacts of behavioural changes on the GDP, employment, mobility (i.e. passenger and freight transport activity), emissions and safety. In this respect, we analysed such factors as: a speed-up of fleet renewal, a reduction of transportation costs, increase of transportation costs and optimisation of route and load factors.

For each of these four elements, outcomes show that the modelled impacts are in general relatively limited. Detailed results can be found in Annex E.

Carbon footprinting can also lower the costs for society in general (e.g. lower damages from climate change, lower health costs, etc.). However, it is difficult to quantify such effects, as they are closely related to the market reactions (i.e. efficiency improvements by transport suppliers and modal shift by those demanding transport). The largest efficiency gains in the transport market are expected with Option 2 and 4, which offer the relatively highest reduction of external costs. This reduction will mainly be associated with the lowering of GHG emissions and the decrease of congestion, air pollution, noise and safety costs (resulting from modal shift and logistic optimisation).

6.10 Impact on the environment

The environmental impacts that can be expected with the policy options are highly dependent on any changes in the transport market, with respect to both the supply and demand sides. As was explained in Section 2.2, there are several measures that can reduce the GHG and air polluting emissions from transport. The most important ones include efficiency improvements of transport operations, being of a technical or operational nature, and involving modal shift.

Two main environmental impacts have been distinguished:
- GHG emissions;
- air quality impact.

GHG emissions are by far the most relevant environmental impact for this policy, as carbon footprinting informs stakeholders directly about this emission category. As explained in section 6.5.1, while the stakeholders' opinion on the current applicability of carbon footprinting as a tool for improving GHG performance is rather mixed, they see a large future potential of this policy. The range of environmental benefits, however will be conditional upon the establishment of an improved methodological framework (57% agree and 18% disagree). The stakeholders also recognise the usefulness of carbon footprinting for implementation of technical (56% agree and 7% disagree) and operational (61% agree and 6 disagree) optimisation measures.

Relevant differences between the policy options as regards the environmental impacts have been presented in Table 27.

Table 27 Impact of policy options on the environment

Option / Element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
GHG emissions	0	+	0	+
Air polluting emissions	0	0/+	0	0/+

The impact on the environment (both on GHG emissions and air polluting emissions) is closely related to the impact on the market. The larger the impact on the market, the more likely the operators will improve their efficiency and/or the shippers will decide for modal shift. As was already explained in Section 6.5, the environmental impact will mainly result from efficiency improvements applied by transport operators, and less likely to be caused by shippers choosing other transport modes.

With Option 2 a wide range of technical and operation measures is stimulated, but just in the relatively small submarket that reports carbon footprints. Those operators that *do* report their carbon footprint are incentivised to reduce emissions as the methodology is based on real world fuel consumptions. The stakeholders confirmed potential environmental impacts for an option with voluntary reporting. In the longer-term, this impact may become larger, as other companies may follow the example of front-runners.

With Option 4, all operators report carbon footprints, but the mandatory use of a methodology based on default values does not reward operators for taking other GHG emission reduction measures than logistic optimisations and modal shift. The net overall GHG reduction of Option 2 and 4 is therefore expected to be in the same order of magnitude.

For both Option 2 and 4, the impact on air pollutant emissions is somewhat lower than on GHG emissions, because:
- the technical reduction options stimulated with Option 2 do not always affect pollutant emissions but in some cases just GHG emissions[42];
- many types of modal shift (to inland navigation or diesel trains) does reduce GHG emissions much stronger than pollutant emissions.

The environmental impact of Option 1 is expected to be very limited, since only a small share of the market would calculate and report its carbon footprints. Additionally, the accuracy and comparability of results would not significantly increase, resulting in a very limited impact on demand choices and implementation of measures by operators.

For Option 3, the expected GHG emission reduction is not substantially greater, as the comparability and accuracy of carbon footprints is the same as for Option 1. Reporting of carbon footprints becomes mandatory, however due to voluntary character of calculation and measurement, carbon footprinting is not expected to lead to considerable efficiency gains.

Quantification of GHG impacts for road freight transport for options 2 and 4

A detailed magnitude of the GHG reduction cannot be estimated due to lack of quantitative information on the changes in behaviour within the industry. The impacts of other GHG reporting and monitoring systems that were described in Section 6.3, can be regarded as a first and rough estimate of the impacts of the policy options, as these systems are also focused on solving the problem of information failure.

Some illustrative calculations have been made to estimate the magnitude of the impacts that can be expected specifically for the road freight sector. The impacts for this sector are likely to be the largest, as road freight transport is the mode with the most considerable transport volumes, and the highest specific fuel consumption (per tonne-km). Table 28 shows the assumptions used for the calculation.

Table 28 Impact of policy options on GHG emissions of EU road freight transport

Option	#trips/vehicles impacted (%)		Estimated GHG reduction for impacted trips/vehicles (%)	
	Min.	Max.	Min.	Max.
2	5%	10%	10%	15%
4	20%	40%	2%	5%

Option 2

With policy option 2, it is expected that relatively few and mainly large front-running companies will use the carbon footprinting system. These companies have sufficient resources available and most of them run social responsibility programmes. It is therefore estimated that between 5 and 10% of the trips may be impacted, which represents the share of large companies in the total EU road transport market. The companies that report their carbon footprint are expected to reduce their emissions by 10-15%, which is comparable to the

42 As an example: more fuel efficient engines are not always cleaner and modal shifting does not always lead to lower emissions. However, logistic efficiency improvements lead to both lower GHG emissions and pollutant emissions.

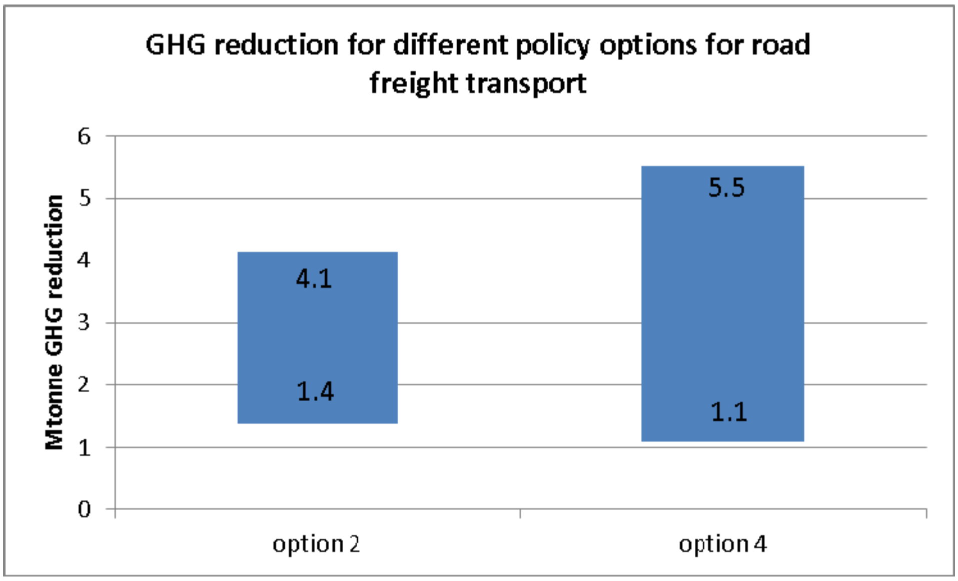
results achieved by the Dutch ‘Lean and green’ programme. This indicates that this reduction in the GHG emissions is significant when companies make a serious effort to improve efficiency of their operations. Hence, it seems reasonable to expect that companies which voluntarily report their footprint will make efforts to achieve significant reductions.

Option 4

With option 4, the share of trips impacted is larger, since the carbon footprinting is mandatory. This estimation is based on the share of vehicle trips made by companies with more than 10 vehicles. It is expected that while the SMEs (owning less than 10 vehicles) will report their legally binding carbon footprint, they will not necessarily reduce their emissions. SMEs have only limited options to improve their logistics and are generally less focussed on GHG reduction. This can be illustrated by the relatively low involvement of SMEs in the current programmes aimed at reducing GHGs[43].
The Level 2 methodology results in lower reduction potential per trip than option 2, as only logistical measures are incentivised with this option. Based on the effectiveness of other reporting systems (see Section 6.3), it is therefore foreseen that those companies which apply the measures, reduce their GHG emissions with minimally 2% and maximally 5% on average.

The reduction foreseen for the different Options is shown in Figure 13.

Figure 13 **GHG reduction in the EU road freight transport sector in 2020 (Mtonne)**



The reduction anticipated for non-road freight transport (rail/short sea/IWT) is lower, since the total GHG emissions of these sectors are themselves much lower. The emissions of non-road freight transport represent approximately 7% of the total EU freight GHG emissions. As it was already indicated above, the rail and maritime transport is operated mainly by large companies. Therefore, the potential of carbon footprinting may be relatively higher in these sectors compared to inland waterway transport, which is dominated by SMEs. When

43 An example is the UK FTA’s Logistics Carbon Reduction Scheme. Only 4% of the members have less than 10 vehicles. See section B.6 for more information on existing initiatives to reduce GHG emissions of freight transport.

taking the above into account, the GHG reduction potential for all non-road freight transport is estimated at around 0,5 Mton (2%), assuming a relative emission reduction in these sectors equal to that of road transport.

For maritime transport, the incentives provided by carbon footprinting of transport services partly overlap with those of MRV, as regards the supply side.

6.11 Social impacts

Although there are no direct social impacts resulting from carbon footprinting of transport services, we can distinguish here three major indirect impacts. They are addressed in more detail below:
- Number of jobs in the transport sector: The impact on the number of jobs is directly linked to the macro-economic impacts of the different options.
- Safety: transport safety may change following the modal split changes or vehicle-kilometres reduction (logistic optimisation).
- Health: reduction of health impacts is directly related to changes in air polluting emissions, noise and traffic safety.

Table 29 provides an overview of the social impacts that can be expected with the different policy options.

Table 29 Social impacts of policy options

Element \ Option	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Number of jobs in the transport sector	0	0	0	0
Traffic safety	0	0	0	0
Health	0	0/+	0	0/+

Since the impacts on the functioning of the market and on modal shift are assumed to be limited, no tangible social impacts are expected to result from any of the policy options in terms of the number of jobs and on the safety of transport.

Consequently, impacts on traffic safety will also be limited. Option 2 and 4 are likely to result in a modest reduction of the number of road vehicle kilometres due to improved logistic efficiency. However, there is no direct relationship between the reduction in vehicle kilometres and the traffic safety. Therefore, the net impact of these policy options on traffic safety is expected to be rather insignificant. Since the other options (1 and 3) are likely to score lower on the improvement of the logistic efficiency, traffic safety effects estimated for them will be negligible.

The impact on the amount of pollutant emissions was addressed in the previous section. Reduced air pollutants (and noise) may positively influence the health of the EU population. The scores for health impacts are evaluated equal to the ones for air pollution, since a reduction of the emission of air pollutants positively impacts the air quality and vice versa. As a result, Option 2 and 4 may have small marginal effect on health conditions, as the impact on air polluting emissions is largest with these options.

6.12 Risk identification

Each of the policy options is subject to some risks. The main risks associated with the four policy options that have been assessed in this chapter are summarised in Table 30. For each risk, we identify the probability of its occurrence and describe potential mitigation actions.

Table 30 Assessment of risks associated with implementation of carbon footprinting

Risk	Description	Most impacted options	Cause	Outcome	Probability	Impact	Mitigation
1	Poor comparability of CF information	Option 1 Option 3	– Operators perform CF calculation using different methodologies	– Reduced potential for benchmarking different operators	High	Negative. Transport buyers cannot use CF to identify transport solutions with best GHG performance	– Harmonising calculations, variables and parameters within each methodology – Requiring use of a single methodology. Selection of Option 2/4
2	Potential reluctance of stakeholders to adapt their CF calculation methodologies if EU harmonises	Option 1 Option 3	– Tool developers are unwilling to accept development of an overarching methodology	– Limited harmonisation of carbon footprint calculations	Medium	Negative. Transport buyers cannot use CF to identify transport solutions with best GHG performance	– Harmonising calculations, variables and parameters within each methodology – Requiring use of a single methodology. Selection of Option 2/4
3	Poor availability of CF information	Option 1 Option 2	– Operators perceive CF calculation as too complex – Operators perceive CF calculation as too costly – Operators perceive CF as useless – Operators perceive CF as too business-sensitive	– Low involvement of operators in implementing CF disclosure systems – Reduced potential for benchmarking different operators	Medium	Negative. Data availability required for any benchmarking activity	– Simplification of CF calculations and facilitation of CF reporting – Developing easy-to-use web tools for facilitating SMEs and micro-enterprises – Increasing the exchange of best practices on CF as a tool for improving transport efficiency
3	Lack of accuracy in available CF calculations	Option 1 Option 3	– Operators rely on inaccurate methodologies to compute CF – Calculation methodologies are incorrectly applied by operators	– Benchmarking is performed on incorrect basis – Reduced potential for benchmarking different operators	Medium	Negative. Poor reliability of CF as indicator of best GHG performances	– Reducing the scope for choosing inaccurate methodologies – Developing detailed guidelines on how to apply methodologies and perform calculations – Requiring certification of performed CF calculation. Selection of Option 2/4

Risk	Description	Most impacted options	Cause	Outcome	Probability	Impact	Mitigation
4	Poor interest of shippers, 3PLs and hauliers in CF performances of operators	All	– Poor awareness of environmental aspects – CF calculations are perceived as insufficiently reliable to play a decisive role in the decision-making process – Other service quality parameters are considered more important than CF in the decision making process	– Little relevance of CF in awarding transport contracts	Medium	Negative. CF plays no role in the transport market and therefore makes no contribution to overall objective of improving transport GHG efficiency	– Information campaigns to increase environmental awareness among transport service purchasers – Involvement of all key stakeholders in developing harmonised guidelines on CF calculation and reporting – Requirement/incentives for transport contracts to include CF information

6.13 Summary of the impacts of the policy options

In this section we have summarised the results of analysis made for the four selected policy options. All the impacts described above are aggregated in Table 31.

Table 31 Overview of the different impacts per policy option

Option / Impact/element	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Impact on carbon footprint information provided by transport operators				
Accuracy of the provided information	0	++	0	0/+
Comparability of the provided information	0/+	++	0/+	++
Share of the market that provides information	0/+	+	++	++
Impacts on transport market				
Functioning of the market	0	+	0	0/+
Supply side: efficiency of operators	0	+	0	+
Demand side: choices of consumers/shippers	0	+	0	0/+
Impacts on competition from disclosure of sensitive information	0	-	0/-	-
Administrative efforts/costs				
Large companies	0	0/-	0/-	-
SMEs and micro-enterprises	0	0	-	--
Impact on work load European Commission				
Development of guidelines	-	-	-	-
Marketing, Monitoring and enforcement	0/-	-	- -	- -
Impact national/regional governments				
National/regional policies	0	+	0	+
Impact on the economy				
GDP and economic growth	0	0	0	0
External costs of transport	0	0/+	0	0/+
Impact on the environment				
GHG reduction	0	+	0	+
Air polluting emissions	0	0/+	0	0/+
Social impact				
Number of jobs in the transport sector	0	0	0	0
Safety due to changes in modal split	0	0	0	0
Health	0	0/+	0	0/+

7 Comparison of options

The analysis presented in this chapter is based on the results of the assessment of impacts (Chapter 6) and the policy objectives defined in Chapter 4.

7.1 Introduction

The previous chapter explored various different impacts that can be expected with the respective policy options. In this chapter the results of that analysis are used to compare the policy options with respect to the objectives defined in Chapter 4. More specifically, the policy options are compared on their effectiveness and efficiency in achieving the main objective, which is to increase the GHG efficiency of transport. The analysis also includes the coherence of the selected policy interventions with the existing EU policies. All the assessment criteria are summarised in Table 32.

Table 32 Elements that will be assessed for the comparison of options

Element	Definition
Effectiveness	The extent to which the options achieve the objectives
Efficiency	The extent to which objectives can be achieved for a given level of resources/at least cost (cost-effectiveness)
Coherence	The extent to which options are coherent with the overarching objectives of EU policy, and the extent to which they limit trade-offs across the economic, social, and environmental domain

Source: European Commission (EC, 2009).

7.2 Effectiveness of the policy options

As described in Chapter 3, two intermediate problems feed the central problem of GHG inefficiency resulting from the current inability to benchmark transport services. Hence, those policy options that help resolve these two intermediate problems will automatically contribute to reducing the significance of the central problem. Consequently, the assessment on the level of contribution of the policy options to the achievement of the objectives should primarily focus on two elements, being actually the specific objectives as defined under Chapter 4:
- carbon footprint calculations are reliable and comparable;
- transport companies report on GHG emissions of transport services.

These two objectives are partially interdependent: shippers can use carbon footprinting for benchmarking if carbon footprints are available and reliable. In this case, the transport operators experience a stronger incentive to report their carbon footprint (the market demands and uses it).

If shippers do not use the carbon footprint in their transport decision, voluntary reporting will not result in a large amount of carbon footprints. However, in case of the both mandatory reporting options, the share of the market that reports its carbon footprint will be high, irrespectively of the ability of shippers to use this information.

In general, policy options that contribute most to the objective of comparable and reliable carbon footprints are preferred over other policy options. Even if the entire market participates in reporting carbon footprints, the effect on the main objective of improving GHG efficiency will be limited if the reported footprints are not comparable and reliable, as operators still cannot be compared on their performance. However, ideally, a policy option should contribute to both objectives simultaneously. Table 33 summarises the extent to which the four policy options support achievement of the two general objectives.

Table 33 **Contribution of the policy options to the general objectives, compared to the baseline**

Option / Objective	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Carbon footprints are reliable and comparable	0	++	0	+
Transport companies report their carbon footprint	0	0/+	++	++
Total effect on GHG efficiency of the transport sector	0	+	0	+

Note: The scores used are based on the legend introduced in Section 6.2.

Table 33 shows that Option 1 and 3 make only a limited contribution to the objective of reliability and comparability. Although Option 2 and 4 both result in *comparable* carbon footprints, Option 4 contributes less to the *reliability* (and accuracy) of the carbon footprints, which is the result of the use of default values. Option 2 therefore contributes more to the first objective than Option 4.

The mandatory options (option 3 and 4) contributes most to the objective of increased reporting. If reporting remains voluntary, it is expected that only a limited part of the market will report carbon footprints, especially if the reliability is low and comparison remains difficult.

When translating these impacts in their contribution to the main objective of improving the GHG efficiency of transport, a distinction needs to be made between effects on individual companies and on the entire transport market. At the company level, Option 2 will contribute most to improvements in GHG efficiency, as the uptake of a Level 3 methodology provides the largest incentives to operators for improving their own performance. With a Level 2 methodology (Option 4) such benefits are relatively lower as many GHG emission reduction measures are not captured in a carbon footprint that has been calculated with this methodology.

In assessing the impact of the policy options on the GHG efficiency of the entire transport market, the number of companies reporting their carbon footprint becomes also relevant. The market share participating in carbon footprinting will be much lower in Option 2 than in Option 4. Initially, only front-runners (i.e. large companies) will participate in voluntary reporting with the Level 3 methodology. However, because of the expected higher commitment of companies and the use of the Level 3 methodology, the GHG impacts per participating operator are expected to be relatively high. Under Option 4, the share of the market reporting is much higher, but the relative GHG impacts are expected to be lower, as small companies may have lower interest in reducing their emissions and because the level-2 methodology provides less incentives for the full range of GHG reduction measures.

The overall effectiveness of the two options is estimated to be comparable, with a slightly larger GHG reduction potential for Option 4 (see Section 6.10). The impact of Option 2 may however increase over time when the experiences of front-runners are penetrated further into the market and the market share applying carbon footprinting increases (e.g. driven by an increasing demand for carbon footprints of shippers).

7.3 Efficiency of the policy options

The efficiency criterion evaluates the cost-effectiveness of the policy options, addressing both the effectiveness of the particular scenarios and the costs associated with their implementation. The relative costs that may result from a policy option were assessed in the impact assessment on the administrative burden of transport operators (Section 6.6) and on the work load of the European Commission (Section 6.7).

The impact analysis shows that the policy options with mandatory reporting (Option 3 and 4) have the relatively highest costs (especially for SMEs). With these policy options, all transport operators will have to calculate their carbon footprint and will therefore incur at least some administrative costs.
These costs will be highest in Policy option 4, as the use of a specific methodology is enforced. In Policy option 3 on the other hand, companies themselves can choose a methodology that requires least effort (and has the best cost/benefit ratio). For both options, monitoring and enforcement is required to verify if companies report and if the correct methodology is used.

Option 1 results in relatively lower costs than the two mandatory options.
The costs for transport companies are considered to be insignificant, since the companies can choose not to report. In Option 2, the costs are very limited for the largest part of the market but considerable for those companies that calculate their carbon footprint on the basis of the complex Level 3 methodology, being mainly large companies. Therefore the overall costs of Option 2 are lower than of Option 3 or 4.

Table 34 **Cost-effectiveness of the different policy options**

Element \ Option	Option 1 Voluntary reporting/ voluntary guidelines	Option 2 Voluntary reporting/ mandatory Level 3 methodology	Option 3 Mandatory reporting/ voluntary guidelines	Option 4 Mandatory reporting/ mandatory Level 2 methodology
Administrative costs of transport operators	+	0	-	--
administrative costs for the European Commission	+	0	-	-
Total effect on GHG efficiency	0	+	0	+
Cost-effectiveness	-	+	--	0

Note: The scores used are based on the legend introduced in Section 6.2.

When combining these costs with the effectiveness that can be expected, it becomes apparent that Policy option 3 has the lowest cost-effectiveness. It results in only small improvement of the GHG efficiency, but with high costs (both for operators as well as for the Commission).

Although costs are relatively lowest in Policy option 1, this policy option is expected to have the lowest benefits in terms of GHG emission reduction and therefore does not produce significant overall cost-effectiveness. The same applies to Policy option 4. This option results in the largest GHG impacts, but also has relatively highest costs. Policy option 2 has somewhat smaller GHG impacts, but the cost are estimated (both industry and European Commission) to be much lower than that of option 4[44]. The cost-effectiveness of option 2 is therefore relatively highest.

In the long-term, due to increased uptake of carbon footprinting by the market, the effectiveness of this option may increase (i.e. GHG emission reduction), having a positive impact on the cost effectiveness.

Exclusion of SMEs?

A main concern of option 4 is the financial burden to be placed on SMEs. An alternative to Option 4 would be to implement it only for medium and large companies. In this case, it would also be possible for instance to enforce a relatively simple methodology (level-1) on SMEs. This would significantly reduce the administrative burden for SMEs. However, at the same time, it would reduce the likelihood of achieving the specific objectives that have been formulated. In case part of the market is allowed to use different and simplified methodologies, the comparability and reliability of the calculations will not improve.

It is also important to note here, that since SMEs represent a significant share of the market, the objective of increased GHG reporting would not be achieved if leaving them behind.

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44 The estimated costs of Option 2 are € 280 million. The corresponding GHG reduction is between 1.4 and 4.1 Mton. The estimated GHG reduction under option 4 is between 1.1 and 5.5 Mton. The corresponding costs € 1.6 billion. See section 6.6 and 6.10.

7.4 Coherence of the policy options with the EU objectives and policies

As explained in chapter 1, the objectives of this study are fully in line with action no. 29 of the Transport White paper[45]. However, given the nature of the policy interventions analysed here, their impacts can be also considered in a context of broader EU objectives established for the transport sector.
These general objectives are:
1. Sustainable growth of the EU economy (Europe 2020 objectives) (EC, 2010).
2. Decarbonisation of transport (Transport White Paper) (EC, 2011).

Ad 1.
The reduction of external costs of transport can positively benefit the EU economy and result in more sustainable economic growth. This benefit is likely to be the largest in Policy option 4 and 2 both including a mandatory methodology. Options 1 and 3 (voluntary methodology) will contribute least.

Ad 2.
Option 2 and 4 will contribute most to decarbonisation, since these results in the largest GHG reduction.

Coherence with policy instruments focusing on GHG reduction

As explained in Section 2.2.2, carbon footprinting is one of the policies that can contribute to increased efficiency of transport operations. All the policy options defined and analysed in this study focus on the provision of information on the GHG emissions covering entire transport chains. They can be seen therefore as complementary to the majority of other relevant existing policies (see Table 4):
- The vehicle fuel efficiency (CO_2 regulations for passenger cars, vans or HDVs, vehicle energy labelling, differentiated registration, annual taxes and fuel taxes). Or;
- Modal shift (vehicle taxes, distance based charges, infrastructure policies). Or;
- Reduction of the transport volume (fuel taxes, distance based charges).

Carbon footprinting provides information about each element listed above, since it takes both the vehicle and its operations into account, and allows the market to apply a holistic approach. On top of that, carbon footprinting may increase the awareness of transport operators thus contributing to the improvement of the effectiveness of existing policies mentioned above.

A specific added value of carbon footprinting is that it enables transport buyers to evaluate the GHG emissions of delivered services. Consequently, transport buyers can contribute to increasing the GHG efficiency of the transport system.

No significant trade-offs with existing policies are expected with the introduction of carbon footprinting policies.

Based on the results of our analysis performed in the previous chapters it appears that the more accurate real-world emissions are reflected in the reported carbon footprints, the more effective will be the policy. Therefore, looking at the specific scenarios assessed in this study, it can be concluded

[45] *"Encourage business-based GHG certification schemes and develop common EU standards in order to estimate the carbon footprint of each passenger and freight journey [..]".*

that it is Option 2, which contributes most to the further development of policy instrument package currently in place for the reduction of the GHG emissions from transport services.

Synergies with POF/OEF and MRV

POF/OEF (see section2.4) and MRV (see section 6.3) are the specific policy measures focused on the GHG efficiency, which are of particular relevance in the context of carbon footprinting.

POF/OEF

The POF/EOF initiative shows large synergies with carbon footprinting of transport services in terms of approach and objectives. Nevertheless, some important differences between these policy instruments can be identified here:

- While PEF/OEF focus on all environmental impacts, the options covered with this study focus on GHG emissions only.
- PEF and OEF focus on products or organisations, while the options identified in this study have a higher level of detail (i.e. they focus on the level of a transport service).

Therefore, carbon footprinting of transport services may be seen as complementary to the transport-specific parts of the PEF/OEF guidelines. Also in this case Policy Option 2 shows most similarities, as it defines a specific methodology to be used, but does not enforce reporting. Policy Option 3 and 4 are less coherent with the PEF/OEF policies, since they require obligatory reporting, which is not pursued by the PEF/OEF guidelines.

MRV

Carbon footprinting of transport services demonstrates also similarities with the MRV proposal focusing on measurement of emissions from maritime transport. It is therefore recommended to implement carbon footprinting in coordination with this initiative.

Coherence with other policies

Implementation of e-freight

The alignment of the definitions of data to be reported and the development of a platform that allows for easy, transparent and anonymous processing of information, is in line with the development of a standardised, paperless data exchange system in the business environment (see also Section 3.5.2).

7.5 Evaluation of the principle of proportionality

According to the impact assessment guidelines, the principle of proportionality should be addressed when comparing policy options. This principle ensures “that any Community action should not go beyond what is necessary to achieve satisfactorily the objectives which have been set” p.29 (EC, 2009). Based on the above, the following proportionality criteria will be assessed:

- assessment of costs for achieving the objectives;
- interference with national arrangements.

Assessment of costs

As it was described earlier, the mandatory reporting options (Policy option 3 and 4) result in relatively high administrative costs to transport operators, especially when the methodology used for calculating carbon footprints is also mandatory (Option 4). This is considered to be especially problematic for SMEs, as these companies do not have economies-of-scale and the administrative burden related to the implementation of carbon footprinting would represent a large share compared to their profits. In addition, especially in case of Option 3, the effect on GHG emissions is expected to be low, due to the lack of harmonisation in the carbon footprint information provided.
This option is evaluated as disproportionate therefore. Option 4, on the other hand, does result in harmonised information, which is expected to generate larger impacts on the market and contribute more to the specific objectives of the Union. Consequently, this option can be regarded as proportional.

Option 2 has the best costs and benefits ratio. The reported carbon footprints are comparable, and additionally, the Level 3 methodology incentivises transport operators to reduce their GHG emissions. The voluntary reporting limits administrative costs for the transport sector as a whole. However, it also implies that the effectiveness of this option for the entire transport market depends on the number of carbon footprints reported. Overall Option 2 can be regarded as proportional.

Finally, Option 1 does not mandate reporting nor the use of a specific methodology. The costs experienced by companies are equal to the baseline. Therefore, also Option 1 can be considered as proportional.

Added value of EU CF policies

Carbon footprinting does not interfere with any established national arrangements, except the French Decree 2011-1336. The number of national initiatives for carbon footprinting, however, may increase over time thus further hampering the harmonisation process on the market. A timely and co-ordinated EU action is therefore an efficient means and a prerequisite to develop a methodology that can be implemented by all Member States.

There is a trade-off between leaving scope for national decisions to Member States and the effectiveness of the policy options. Policy option 1 leaves most scope for national decision-making, but is the least effective. Option 2 and 4 leave less room for national decisions but deliver the highest effectiveness. In addition, a European methodology will better contribute to alignment of the methodologies, than leaving the development of methodologies to Member States.

Although carbon footprinting is relatively complex in comparison to other policy instruments that contribute to increasing transport GHG efficiency, its added value is clear. The instrument allows transport buyers to evaluate the GHG efficiency of transport services offered, which may in turn increase the demand for the best performing services. As a consequence, operators may improve the GHG efficiency of their services, to remain competitive. This will create a win-win situation on the market, since companies will be incentivised to implement GHG reduction measures, lowering costs of the transport/logistic operations.
Finally, as explained in Section 7.4, carbon footprinting may explore synergies with the already existing policies, thus improving their effectiveness.

7.6 Ranking the options

All the shortlisted options contribute to increased CF reporting and to an improved methodological framework. However, as evidenced above, compared to the baseline the options score differently in terms of effectiveness, efficiency and coherence. Table 35 evaluates the policy options against these criteria.

Table 35 Ranking the policy options in terms of effectiveness, efficiency, and coherence

Option \ Criterion	Effectiveness	Efficiency	Coherence
Option 1: Voluntary reporting/voluntary guidelines	0	-	0
Option 2: Voluntary reporting/mandatory Level 3 methodology	+	+	+
Option 3: Mandatory reporting/voluntary guidelines	0	-	0
Option 4: Mandatory reporting/mandatory Level 2 methodology	+	-	0

Note: The scores used are based on the legend introduced in Section 6.2.

Overall, Option 2 scores best when looking at the assessment criteria. It is characterized by relatively low administrative costs and a significant expected GHG reduction.

With Option 2 the share of the market reporting footprints is expected to be limited in the short-term, as initially it will only incentivise front-runners to calculate and report their carbon footprints. Since it will prevent the market to report incomplete, inconsistent or inaccurate carbon footprints, in the longer-term, other companies are foreseen to follow their example. This is expected to result in further increasing the effectiveness and hence, efficiency and coherence of this option. On the other hand, it should be stated that it is rather unlikely that SMEs will invest in carbon footprinting operations, being confronted with relatively high costs.

Carbon footprinting of services is not common practice at the moment, especially not with a Level 3 methodology and there are still many unsolved issues (e.g. allocating emissions to different clients, reporting in non-road sectors, and so on). Therefore, it is suggested that the preferred policy option be implemented by use of a step-based policy:

1. Develop or support industry with the development of guidelines for the Level 3 methodology, including the definition of default factors (e.g. to convert fuel consumption into emissions), a standardised allocation method and the needed software.
2. Small scale testing of the Level-3 methodology guidelines and software systems, both in road and non-road sectors, to ensure that data is reliable/accurate and comparable in homogeneous segments.
3. Adjusting the methodological guidelines where necessary.
4. Publishing and promoting the guidelines, with voluntary use by market actors.
5. Implementation of a framework which enforces the use of a Level 3 methodology, *if* carbon footprinting is performed.

8 Monitoring and evaluation

The monitoring indicators defined here are directly related to the policy objectives formulated in Chapter 4. The results of this chapter are mainly based on own analysis.

8.1 Introduction

The final step of the impact assessment is to assess possible options for the monitoring and enforcing of the policy options that could be implemented. A monitoring procedure is needed to assess whether the objectives for the implementation of the policy options are reached. However, there are no existing procedures in place, which could be used, since carbon footprinting at the service level is applied by only a small market share and only very limited statistical data is currently generated in this respect.

Therefore, in this chapter we develop a possible monitoring methodology and define it as a three-step process. First, we identify indicators associated with the operational objectives (Section 8.2). Second, we specify the data required for calculating these indicators. Finally, Section 8.3 describes the procedures for data collection.

8.2 Indicators for the monitoring procedures

Section 4.5 elaborated on the specific and operational objectives for the policy options. These are summarised respectively in the first and second column of Table 36. For each operational objective one or more indicators have been identified that can be used to monitor whether and to what extent the objectives are met. The objectives and the related indicators are further explained below.

Apart from the specific and operational objectives, the monitoring procedure will also include a more general goal, which is the use of carbon footprinting by the transport market as a common practice.

Table 36 Objectives and their indicators

General/specific objective	Operational objective	Indicator	Notes
Application of carbon footprinting	Carbon footprinting is a common practice in the transport market, indifferent of the size of companies	Share of operators that report the carbon footprint of their transport services, by market segment and operators' size	

General/specific objective	Operational objective	Indicator	Notes
Carbon footprinting calculations are consistent and comparable	The calculations are based on the same methodology (being Level 1, 2 or 3)	Share of operators that use a Level 1, 2 and 3 methodology	
	The equations (i.e. specific methodological choices) used in the calculations are sufficiently harmonised	Share of operators that use the reference methods	It is assumed that reference methods are specified
	The default parameters used in the calculations sufficiently harmonised	Share of operators that use the default parameters	It is assumed that reference parameters are specified
Carbon footprinting calculations are reliable and accurate	The common methodology is sufficiently sophisticated and accurate, and preferably, real world measured data is used.	Share of footprints calculated with a Level 3 methodology	
	The methodology is correctly applied	Standard deviation of the footprints within homogenous segments	Homogenous segments have to be defined
Simplified and facilitated carbon footprinting in business practice.	Operators perceive the calculation of carbon footprint as easy to use	Share of operators that indicate they perceive the methodology as easy to apply	E.g. measure with stakeholder consultation
	The costs of the calculations are limited	Average yearly costs of calculation the carbon footprint	For each methodology, segment and operator size
Increased awareness of shippers, 3PLs and hauliers	Transport decision-makers use carbon footprints as a relevant criterion	Ranked priority of GHG emissions (versus costs and quality)	E.g. measure with stakeholder consultation
	(Freight) transport contracts include requirements about carbon footprinting	Share of private contracts that incorporate clauses on carbon footprinting. Share of tenders for transport services that include carbon footprinting as a decision criterion	

8.2.1 Application of carbon footprinting

The measurement of the application of carbon footprinting is fairly straightforward: it can be measured with the share of operators in the market that calculate and report a carbon footprint. Also, the share of SMEs that report their carbon footprint is very relevant here. The logic hereof is that the implementation of carbon footprinting is more burdensome for small companies.

This indicator can distinguish various segments of operators in order to monitor the progress of carbon footprinting in more detail.

8.2.2 Carbon footprinting calculations are consistent and comparable

Three operational objectives have been specified to measure the comparability of the carbon footprints, and for each operational objective, one indicator has been defined. At the most basic level, the carbon footprints must be based on the same methodology level to be comparable. This can be measured with the share of transport operators that use a particular calculation level (1/2/3). The larger is the application of a given methodology, the more comparable carbon footprints are. Ideally, this indicator is close to a 100% for one of the calculation methodologies identified in Section 2.3.

Secondly, the equations used within one methodology should be the same (the comparability objective). Even if two operators use the same methodology level for their CF calculation, results can still be influenced by underlying methodological differences (e.g. associated with measuring vehicle fuel consumption or allocating emissions to different services/clients). The share of operators exactly following this method would need to be monitored to examine whether this operational objective is met.

Finally, the default values used should be the same in order for carbon footprints to be comparable. Default values can concern conversion factors to translate fuel/energy consumption in emissions. The recommended default parameters should be monitored and hence this objective can be measured with the share of operators that use the recommended default value(s). Carbon footprinting calculations are reliable and accurate.

Section 2.3 explained that only the Level 3 methodology will result in a reliable, real-world estimation of an operator's carbon footprint. Therefore, the first operational objective is the application of the Level 3 calculation, which can be measured with the share of operators that use this particular method. The higher this share, the more reliable the carbon footprints available to shippers/consumers will be.

In order for the Level 3 methodology to be reliable and accurate it should be correctly used. This operational objective is difficult to translate in an indicator (and hence to monitor). An audit process would be the best option, but this approach may be too cumbersome. Therefore, an alternative indicator may be defined such as the standard deviation of the carbon footprints in homogenous segments. In theory, similar operators (e.g. in type of shipments, fleet age, etc.) should register comparable carbon footprints. If the standard deviation of a homogeneous segment is large, the accuracy of the calculations may be doubtful. This indicator does require the identification of homogenous segments and of critical variables which can have an impact on the outcome of the calculation.

8.2.3 Simplified and facilitated carbon footprinting in business practice

Easy application of the methodology has been operationalised with two objectives. The first objective represents a direct measure of the extent to which operators perceive the easiness of the calculation. This can be measured as the percentage of operators agreeing with this perception.

The second operational objective refers to the costs of carbon footprinting. The indicator has been defined as the average costs of making a carbon footprint calculation. This indicator should distinguish different operator types, for example in terms of business segment and company size. It would also be valuable to monitor development of costs over time.

8.2.4 Increased awareness of shippers, 3PLs and hauliers

The last specific objective: 'increased awareness in the market' has also been operationalised to facilitate the monitoring procedures.

The first indicator monitors how adequately GHG emissions are considered in the decisions of shippers and consumers together with other criteria, such as costs and reliability of the services. The share of transport decision-makers considering GHG emissions as an additional bushiness criterion provides a good indicator of their awareness. An increase in this share means an increase in awareness.

The second operational objective represents inclusion of carbon footprint requirements in contracts and tender procedures. Relevant indicators to measure these operational objectives are the share of contracts and tender procedures that include carbon footprint requirements, respectively.

8.3 Data collection and resources

All indicators described above require the collection of data. For the majority of indicators, this data is not readily available from institutional sources or databases created for other purposes. Therefore, new procedures for data collection need to be developed.

Most of the required data needs to be collected from transport operators that apply carbon footprinting and, to a smaller extent, from transport decision-makers (e.g. shippers). In other words, the data is owned by these companies and is not available in the public domain. Therefore, it is expected that surveys would be required to gather the data. There may be some exceptions however, such as the standard deviation of the measures in homogenous segment, where available carbon footprint reports could be used. However, even so, measures are required to collect data on the characteristics of the operators that have reported their footprint (e.g. their size, segment, etc.) in order to be able to define homogenous segments.

Some of the indicators are based on specific attitudes, such as the priority given to GHG emissions in the transport decision or the perceived easiness of the calculation method. Such indicators would require detailed survey techniques for data gathering.

The main method for collecting data for the above indicators would therefore be a questionnaire administered to the operators (and the shippers if possible). Ideally, all the relevant EU operators would participate in the questionnaire, making the data fully representative. However, we estimate that such an exercise would be too complex and too expensive. A sample survey may provide reliable estimations at a much lower cost if a diverse and sufficiently large sample is used.

The recommended approach to data collection for monitoring carbon footprinting is to organise a sample survey of operators on a regular basis. In the text box some key features of such a sample survey are elaborated on. At the same time, the outcome of the survey in term of average values and standard deviations could be used to define reference intervals of representative carbon footprint size expected by different types of operators.

These intervals could serve as a basis for assessing the reliability of the values of carbon footprint publicly reported by the operators (e.g. on their websites) not involved in the survey.

Key features of a survey sample

The **sample** used for the survey should be representative for all relevant categories of transport operators (e.g. carriers, forwarders, logistics operators and others). As such it should:

- Cover all relevant groups in the different categories, e.g. large and small companies.
- Be based on the spatial level required for the monitoring and on the level of detail of the segmentation. If monitoring is performed at the EU-level, the nationality of operators can be treated as a segmentation variable. If monitoring is also performed at a national level, independent samples for each country should be envisaged.
- Contain at least 20-25 samples for each segment (category or subcategory of operators). So in case of monitoring at national levels, the sample should include 20-25 cases for each segment in each Member State. One exception is the subcategory of large operators: in most countries only a few large operators are active, hence, the sample can include only them.

The **questionnaire used in the survey** can be relatively short. The questionnaire could start with the collection of basic information about the participant (e.g. nationality, category, size, etc.) and about the elements which enter in the calculation of carbon footprint (according to the methodology applied by the operator). Hereafter, specific data can be collected for the indicators. Easy and clear definitions should be used and different questions could be defined for different categories of operators. However, in general, questions can be direct and straightforward, e.g.:

- Do you apply any methodology for calculating your carbon footprint?
- Which calculation level do you apply for estimating your carbon footprint? Aggregate emission factors (Level 1), Average emission factors by vehicle type (Level 2), real consumption data (Level 3)? (include an explanation)
- What share of your contracts (of the last 12 months) explicitly required anything related to your carbon footprint?

The questionnaire should include mainly multiple-choice questions and can be administered by e-mail or from a website. Phone interviews are also possible in specific cases.

The **time** required for the administration of a survey of this type could amount to 8 months, of which 3-4 months for the preparation of the questionnaire and the selection of the sample, 2-3 months for the data collection and 2 months for data analysis. The preparation of the questionnaire and the selection of the sample would be probably more demanding the first time the survey is implemented whereas following editions could take advantage from the past experience. In the early phase, it seems reasonable to implement the survey every 2 or 3 years. A yearly implementation would be probably too expensive, while larger time lapses would prevent to follow progress. When carbon footprinting becomes largely applied the frequency of the survey could be reduced e.g. every 5 years.

The **costs of the data collection** would comprise of four aspects:

- selection of the sample;
- preparation of the questionnaire;
- fieldwork (i.e. conducting the questionnaire and entering the data in a database) ;
- analysis of results.

Based on earlier consultations performed by the Consortium members, total costs of these four tasks can be estimated at 150 to 200 euro per interviewee. The total indicative budget would then be not less than € 300,000-400,000.

The first task is likely to be the most complex one, as lists of operators and contact details would be required, and an analysis should be made to select representative sample. Some 30% of the overall cost of the survey could be attached to this activity.

Also the preparation of the questionnaire may be especially costly if it needs to be prepared in several languages, so another 30% of the survey cost can derive from this activity.

As mentioned above, after the first edition of the survey these two tasks could take advantage of the experience and their cost could be lower.
Web-based questionnaires are significantly less expensive than direct or phone interviews but they still need the technical and administrative management. This activity would absorb 20%-25% of costs. The remaining cost would be needed for the elaboration of the results and the reporting.

9 Conclusions and recommendations

9.1 Introduction

In this chapter we present the main conclusions (Section 9.2) and recommendations (Section 9.3) of this study.

9.2 Conclusions

In recent years, evaluation of environmental performance has become increasingly popular, as evidenced by both the growing number of operators who calculate their footprint and by the multiplicity of initiatives and tools available today.
By reporting comparable and reliable information on the GHG emissions of transport operations, carbon footprinting can help reduce transport GHG emissions. In the situation of a level playing field on the market, where the information on carbon footprints can be compared and benchmarked, transport users (i.e. shippers and passengers) may be more interested to include GHG efficiency as a useful criterion in their transport decisions, and transport operators can reduce their emissions to improve their competitive position. This will create a win-win situation, since companies will be incentivised to implement GHG reduction measures, lowering in consequence costs of the transport/logistic operations.

Problems and objectives

Nonetheless, carbon footprinting of transport services is still not in widespread use, for two main reasons. Firstly, many companies do not report their carbon footprint at all. Operators see carbon footprinting as complex, time-consuming and revealing sensitive business information. At the same time, there is also a lack of incentives to undertake such activities, as shippers and passengers do not generally request carbon footprint data. Secondly, those carbon footprints that are available are often neither accurate (i.e. do not represent real-world emissions) nor comparable. This is due, on the one hand, to many of the available tools being based on default values, such as the average fuel consumption of a particular vehicle type, rather than on the measured fuel consumption of a particular vehicle and, on the other, to the fact that the various tools employ different methodologies and assumptions. This lack of harmonisation among footprinting methodologies, and the resultant patchwork of tools and approaches, makes the currently available carbon footprints incomparable, which in itself is consequently a further barrier for greater uptake of carbon footprinting by the market.

The identified problems prove to be less severe for passenger transport than for freight transport, since carbon footprinting of transport services is already carried out by several large passenger transport providers and the calculations are easier to harmonise. It is for this reason that the present study focuses mainly on freight transport.

Considering that the essence of carbon footprinting is to enable benchmarking among operators, it is very important that individual carbon footprints can be readily and fairly compared. Without additional policies implemented, it is unlikely that carbon footprints will be harmonised at the EU-level.
The objective of any policy option should therefore be twofold. Firstly, carbon footprint calculations should be consistent (and hence comparable) and accurate (and hence reliable). Secondly, the number of companies reporting their carbon footprint should show an upward trend, which in turn requires use of a simplified carbon footprint in everyday business practice and an increased awareness on the part of all market parties.

Improving carbon footprint calculations

Improving the comparability and reliability of carbon footprinting calculations is primarily a matter of ensuring uniformity of the definitions, calculation methodologies and assumptions used in those calculations. Below, we illustrate specific areas where alignment is needed. More fundamentally, though, several minimum requirements can be cited, which are also reflected in the main carbon footprinting approaches presented in Section 2.3:

- All the energy burned in the actual transport processes need to be taken into account.
- For fair comparison of all transport energy sources, calculations should be made on a well-to-wheel (WTW) basis.
- Empty trips should be taken into account.
- Non-CO_2 emissions should be taken into account, especially in the case of air transport and unconventional fuels.
- The assumptions and underling data should be fully transparent (at least of the purpose of verification).
- The methods used need to reflect the benefits of measures taken to reduce the carbon footprint as much as possible.

In addition to these minimum general requirements, the methodologies used for carbon footprint calculations need to be harmonised. For proper interpretation of results, full transparency is required with regard to the assumptions made, the data used and the allocation rules applied. This should be based on an agreed, broadly supported and harmonised methodology.

Policy options

In this study, four policy options were selected for impact assessment.
They differ on the two main dimensions: harmonisation (i.e. mandatory versus voluntary use of methodologies) and reporting (i.e. mandatory versus voluntary reporting).

Table 37 **Overview of selected policy options**

Increased reporting / Harmonisation	Voluntary reporting	Mandatory reporting
No EU harmonisation efforts	Baseline scenario	
Voluntary guidelines for CF methodology	Option 1 (mild)	Option 3 (medium)
Mandatory CF methodology Level 1		
Mandatory CF methodology Level 2		Option 4 (strong)
Mandatory CF methodology Level 3	Option 2 (medium)	

Note: The methodologies are described in detail in Section 2.3.1. A Level 1 methodology uses performance-based default values (g/tkm per vehicle type), a Level 2 methodology vehicle-based default values (g/km per vehicle type), a Level 3 methodology real-world measured fuel consumption data (company-specific).

The two options with mandatory reporting (Option 3 and 4) will obviously result in a significant increase in the use of carbon footprinting. On the other hand, only Option 2, with a mandatory Level 3 methodology (using real-world company-specific fuel consumption data), significantly improves the accuracy and reliability of the information provided.

Impacts

Options 1 and 3, with voluntary use of methodologies, are expected to have only a limited impact in terms of GHG emissions reduction. The main reason is that as long as carbon footprint methodologies are neither harmonised nor sufficiently accurate, transport decision-makers will be simply unable to benchmark. Under Options 2 and 4 this situation is remedied, by ensuring that a single methodology is employed for all carbon footprint calculations, leading to a far greater impact on the functioning of the market and, as a result, the greatest GHG emission reductions.

While policy option 4 has the advantage that all transport operators will report carbon footprints, as reporting is mandatory under this option, it does have the limitation that the reported footprints will still be based partly on fixed default values, e.g. for vehicle fuel efficiency. Consequently, the footprints calculated will not always be a true reflection of real-world GHG performance. This will limit the impact of the information reported by operators, providing mainly incentives for improved logistical efficiency.

Policy option 2 has the major advantage of ensuring that all carbon footprints reported can be compared and at the same time provide a good indication of real-world emissions. However, as this approach is more complex, it cannot be made mandatory (at least not in the short term). Market impacts will therefore be limited to large, front-running companies that have a corporate social responsibility (CSR) policy and resources to invest in carbon footprinting. Today, these are the companies most widely involved in current initiatives. This policy option prevents the market from receiving incomplete and incomparable carbon footprints that carry the risk of impeding the shift to truly low-carbon transport operators rather than accelerating it.

However, it should be highlighted that under Option 2 the share of the market reporting carbon footprints remains relatively low, at least in the short term. The majority of transport operators are SMEs, which are less likely to adopt complicated carbon footprinting practices. Hence, under the voluntary Option 2, most of the market will continue to provide no information. However, the availability of detailed methodologies is expected to be helpful for front-runners in reporting their carbon footprints and will have a relatively significant impact on their GHG efficiency. The overall impact on GHG emissions is estimated to be similar for Options 2 and 4, as shown by an illustrative calculation for the road freight sector. In addition, the uptake might increase in the longer term, as carbon footprints are recognised as valuable and reliable means for benchmarking transport services with respect to their GHG emission performance.

Policy options 3 and 4 both result in relatively higher administrative costs for the market and the Commission, as evidenced by some of the illustrative calculations for road freight conducted in this study. The costs of Option 1 are negligible, while those of Option 2 are relatively low because of the voluntary nature of this option. In general, the administrative burden on authorities represents only a small fraction of the overall administrative burden on the industry.

Comparing the options

The costs of both Options 2 and 4 can be seen as proportional to the potential impacts on the functioning of the market and on the contribution to the decarbonisation of the EU transport sector.

Comparison of the impacts of the four policy options with respect to their overall effectiveness in contributing to the objectives, their efficiency (i.e. cost-effectiveness) and their coherence with other EU policies shows that Option 2 - with a mandatory Level 3 methodology and voluntary reporting – scores relatively highest, followed by Option 4 - with mandatory reporting and a mandatory Level 2 methodology. Illustrative calculations for the road freight sector indicate that the first of these options is significantly more cost-effective.

Policy option 2 shows great similarities with the voluntary environmental footprint schemes currently being rolled out for products and organisations (PEF/OEF). Carbon footprinting of transport services can be seen as complementary to the transport-specific-parts of guidelines already developed in this context.

A specific added value of carbon footprinting is that it enables transport buyers to evaluate the GHG emissions of the transport services they use. The choices of these actors can consequently contribute to making the transport system more GHG-efficient, an opportunity not provided by existing policy instruments that mainly focus on improving the behaviour of operators.

For the recommended policy option, development of a methodological framework that allows benchmarking will be a complex process and require significant testing within the various transport sub-sectors. Among the aims should be guarantees that comparisons are fair and do not provide perverse incentives.

9.3 Recommendations

Policy option 2, with voluntary reporting and mandatory use of a Level 3 methodology, is the recommended policy option. This option has the greatest potential for reducing GHG emissions, particularly in the long term, as it incentivises the full range of emission reduction measures and is the most accurate in estimating real-world emissions. However, particularly in the short term, effectiveness will be limited due to the voluntary nature of the defined policy option. For SMEs and micro-enterprises, representing the bulk of the transport market, carbon footprinting involves administrative costs, which may be a significant burden for these companies.

Implementing this policy option will also require significant efforts. Carbon footprinting is not currently common practice, especially not with a Level 3 methodology, and there are still many unresolved issues, including emission allocation across clients and reporting in non-road sectors, for example.

Against this background, the following stepwise approach is therefore recommended:

1. Develop guidelines, software systems and reporting for a Level 3 methodology, or support the industry in going so. This should also cover definition of default factors for translating fuel consumption into emissions and other such key issues, as well as a standardised allocation method,

taking into due account the existing EU framework and, in particular, the method currently applied for Product and Organisational Environmental Footprints.
2. Conduct small scale testing of these Level 3 methodological guidelines, both in road and non-road sectors, to ensure the data are reliable/ accurate and comparable within homogeneous segments.
3. Adjust the guidelines as necessary.
4. Publish and promote the guidelines, with voluntary use by market actors.
5. Implement a framework prescribing use of this Level 3 methodology, *if* carbon footprinting is performed.

Besides the steps outlined above, issues of confidentiality also need to be taken into account, as a Level 3 methodology may reveal sensitive operator information. Additionally, it is recommended that the footprinting system is a developed in such a manner that interim data (on fuel consumption and vehicle load factors, for example) are validated by authorised verifiers to guarantee the quality and reliability of the reported data. The level of automation will need to be very high, as transport services are regularly sub-contracted, requiring significant data transfer.

It is also recommended to investigate whether the outlined policy option should be implemented at the EU-level, or whether the Commission should work to encourage uptake of a *global* benchmarking scheme, this being the preference of stakeholders. With a scheme at EU-level, the role and position of the EU and the Commission are clear. In the long term, however, globally active operators may have to calculate their footprint differently in different countries. With a global approach, activities could be performed by globally active standardisation organisations, such as ISO, implying a possibly longer and more complex process of policy development and implementation.

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Annex A Stakeholder consultation

This annex summarises the results from the stakeholder consultation. This consultation has been based on three approaches: two stakeholder workshops, an open online consultation conducted by the European Commission and bilateral interviews with selected stakeholders. The information gathered with these methods, in particular provided input to the problem definition, policy objectives and assessment of possible impacts. These four steps are described in more detail in the following sections, in chronological order.

We would like to thank all stakeholders for their valuable contribution.

A.1 First stakeholder workshop

The objective of the first stakeholder workshop, which took place in Brussels on November 29th 2013, was to outline and discuss the preliminary results of the current problems with unbiased tools and the requirements for the harmonisation and standardisation of carbon footprint methodologies.

The stakeholders invited for the workshop represented logistics service providers, transport operators, shippers and their respective associations (all modes). In total, 29 stakeholders participated in the first workshop. The results of the discussions and the stakeholders' comments are summarised below.

Carbon footprint calculation: Current status and problems
The current status of carbon footprinting (CF) of logistics can be described as follows.

- There exists a variety of methodologies, which have been implemented in a growing number of tools in an uncoordinated way. This has resulted in significant differences between tools.
  - Many tools available for the calculation of GHG emissions of transport services are currently being aligned (or have already been aligned) with the EN 16258 standard. However, there are still open questions concerning the implementation of this standard, e.g. on the mandatory inclusion of empty trips.
  - Differences in carbon footprint calculations exist between transport modes, thus an intermodal comparison is not possible and reasonable at the moment.
  - Too many different emission factors are currently used: therefore, a comprehensive and aligned set of emission factors is required.
  - Different tools may have their own primary scope, thus, a variety of tools is generally reasonable. Besides, companies should be able to make their own decision on whether they want to use their own calculation tool or a general platform.
- Currently, guidance is insufficient for transparent and reliable results.
  - A (sector-specific) guidance is needed for aligned methods and the interpretation hereof.
  - The documentation of approaches/tools is generally not transparent at the moment.
- There exists only a poor link to real-world emissions and benchmark options of logistics services.

- The calculation of real-world emissions requires reliable transport activity data (such as real fuel consumption). However, operators use different methods for collecting this activity data.
- Especially if activity data is not available, realistic default values (e.g. sector-specific) are required.
- Benchmarking of the carbon efficiency of transport services should consider the variety of offered logistics services. Therefore, only comparable services shall be benchmarked (e.g. sector-specific, timeframe specific). In this case, reasonable guidance may be offered to further enhance companies' own logistics services (e.g. enhancing energy efficiency, reducing carbon footprint).
- A fair comparison of GHG emissions of services to be practically feasible within five years is considered as optimistic by stakeholders.

– GHG reporting by companies is complex, costly and contains sensitive business information.
  - An important condition for obtaining realistic Carbon footprints of logistics services is the integration of activity data of sub-contractors. However, an open data exchange is difficult as this is sensitive information due to the fact that it may provide the possibility of interference with transport costs. Fuel consumption data exchange is evaluated to be controversial by at least 2/3 of the stakeholders.
  - Future carbon footprinting systems should enable small companies to calculate their carbon footprint as well (easy approach required with e.g. credible default values).

– Transport companies are not motivated to calculate/produce data.
  - Although a (limited) request from shippers for carbon footprints of transport services exists, the carbon footprint information is usually not used for the decision-making processes, but rather as additional information.
  - The calculation of carbon footprints of transport services will not result directly in more carbon-efficient services on its own. However, this information stimulates the consideration of this issue and enhances awareness. Besides, when publishing the carbon footprint of a service, further enhancement of carbon efficiency is directly supported, as it will can be used as an internal benchmark.

– In addition to the above, carbon footprinting of passenger transport requires additional approaches:
  - The actors are not exclusively business to business (B2B). Within passenger transport, consumers (i.e. passengers) (B2C) also have to be considered, e.g. with data acquisition or documentation and with the communication of results.
  - For combined freight and passenger transport (e.g. in aviation), it should be possible to easily and fairly allocate fuel consumption and emissions between the freight and passenger transport service.
  - Within passenger transport, additional standards may be required for the communication of carbon footprints of the transport services to prevent unfair benchmark activities. E.g. the car market label is based on TTW emissions, while the bus transport service emissions are calculated with EN 16258, covering WTW emissions.
  - The carbon footprint impact on travelling behaviour is unclear. To change behaviour additional incentives may be needed.

Policy Options
The overall policy objective is the improvement of the GHG efficiency of logistics services by benchmarking transport services on their carbon footprint.

To reach this objective, two main policy options were outlined: voluntary co-operation or enforcement.

The stakeholder discussion may be summarized as followed:
- The underlying carbon footprint methodology should built on already existing approaches and these should be harmonised (e.g. EN 16258) on a global scale. The latter is especially favoured by logistic service providers that are globally active.
- The European Commission may support industry and relevant organisations to further develop existing standards to finally result in a harmonised approach (e.g. by means of fostering cooperation, awareness raising and market-based incentives).
- Data exchange needs to be enhanced (e.g. by the European Commission) for example by the provision of an objective platform.
- Stakeholders do not favour an EU legislation that is based on the legislation implemented in France (decree no 1336) enforcing carbon footprint calculations and reporting.
- As soon as carbon footprinting has a significant impact on businesses, the verification of data will be necessary.

Integration in the project
The results of the first stakeholder workshop were integrated in the problem definition and in the identification of possible policy options. Additionally, various issues discussed in this workshop were used to design the open, web-based stakeholder consultation (addressed in section A.3).

A.2 Stakeholder interviews

With the objective to integrate the perspective of industry stakeholders into the assessment of the policy options derived, additional bilateral interviews were performed for this project. The main question discussed was if stakeholders foresee a change in their behaviour due to harmonised carbon footprinting. The interviews were semi-structured with the following topics:
- Company profile (core business, transport modes covered, geographical segments, size).
- Methodology in place (current status of calculation and reporting).
- Effects of the introduction of carbon footprint calculation, e.g.:
  - Did the introduction trigger any changes in the company?
  - Estimation of administrative costs and possibility to pass-through the costs to final customers.
- Effects of identified policy options (scenarios) as described in the report (economic, ecological, social, technological):
  - Scenario 1 - Mild approach focusing on harmonisation;
  - Scenario 2 - Medium approach focusing on harmonised and accurate carbon footprinting;
  - Scenario 3 – Medium approach focusing on reporting;
  - Scenario 4 - Strong approach focusing on both reporting and harmonisation.

The interviews were not performed with a standard list of questions, but rather with general and more open questions on the above mentioned topics. Overall, they followed the line of the impact analysis: current situation, use of carbon footprinting methodologies, possible impacts of proposed policy options, etc.

Given that the interviewees were asked mainly about the impact on *future* situations in which policy options have been implemented, it was very hard for the interviewees to quantify the expected impacts in detail.

Overall, fourteen interviews were performed. The interviewees mainly represented transport companies and shippers, and most of these organisations could be considered as large companies. The interviews were performed both face-to-face and via Skype/telephone between March and April 2014.

Summary

No single clear-cut perspective resulted from the interviews. Rather, nuanced views on the possible effects of increased carbon footprinting were presented there.

One general conclusion that came forth from the interviews is that carbon footprinting is not considered to be of significant impact in the near future (although the scale of this impact depends on the proper design of Policy Options). Possible significant positive effects are expected in the mid- to long-term, although they will be very much related to the importance consumers and shippers will attach to carbon footprinting.

Integration in the project

The different views of the interviewees have been taken into account in the impact assessment. Where useful, explicit reference has been made to the interview results.

A.3 Open stakeholder consultation

The online stakeholder consultation was conducted by the European Commission between March 21st and June 13th 2014[46]. The consultation was carried out using a web-based questionnaire that was available via the Commission's standard Interactive Policy-Making tool. The detailed outcomes of this consultation are published by the Commission in a separate report.

Summary and conclusions from the online consultation

Carbon footprinting of transport services contributes adequately to evaluate GHG performance and has a large potential for reducing GHG emissions. The possibility to benchmark different transport operations according to their GHG performance and subsequent reporting of results are regarded as important incentives for improving efficiency of the transport and logistics sector.
Today however, the effectiveness of this instrument is very much limited, mostly due to the existence of many standards and tools, making carbon footprints mutually incomparable and unsuitable for benchmarking different transport services. EN 16258 is evaluated as a step forward, but offering rather a general framework that requires further development.
Consequently, the respondents see a clear need for the alignment of carbon footprinting approaches, and the establishment of a common methodological framework, where the role of the EU is perceived as particularly meaningful. This process however, should build on the existing initiatives, take account of recent developments in this matter and steer towards a global harmonisation. The results of the survey indicate that there are several important issues to be taken into consideration while developing a harmonized and effective carbon

[46] http://ec.europa.eu/transport/themes/sustainable/consultations/2014-06-13-harmonised-carbon-footprinting-measures_en.htm.

footprinting system. The stakeholders in particular require adequate guidance on the interpretation of carbon footprinting methodologies, ask for setting up standardised parameters for the measurement and exchange of data, and recommend a future standard to be based on real-world calculations, ensuring better comparability of results. They also highlight the need to safeguard business sensitive data and to strike the right balance between the accuracy of information on GHG emissions and efforts/costs of companies measuring and reporting it.
The establishment of a harmonised methodology is considered as an important factor for the introduction of a common reporting scheme, and also the possible development of specific labelling programmes targeting technical and operational measures reducing fuel/energy consumption. In this context, the respondents prefer a voluntary reporting approach that addresses sensitivity issues of business data exchange and takes account of possible impacts on competition aspects and transport prices.

A.4 Second stakeholder workshop

The objective of the second stakeholder workshop, that took place in Brussels on July 4th 2014, was to present and discuss the preliminary results of the problem definition and the impact assessment of identified policy options. Furthermore, the results of the open online consultation were presented and reflected on. Passenger transport specific requirements were discussed in an optional part of the workshop.
More than 50 stakeholders participated in the second workshop. The outcome of the discussions and the stakeholders' comments can be summarized as follows:

- The conclusions made on the basis of the stakeholder query reflect the current status well. Although not all of the figures might be representative (e.g. the share of companies calculating their CF today is considered to be less than of the participating stakeholders, i.e. 55%).
- Calculating a carbon footprint will not necessarily reduce the GHG emissions.
- Even though the large number of existing standards are not sufficiently aligned, companies can already start to provide transparency on their carbon footprint and identify relevant reduction measures.
- The whole issue is a process that might require several years. No company can reduce GHG emissions on large scales on its own. Moreover, the whole logistical network needs to improve.
- Since this process will not be finished in the short-term, the discussion should include the perspective of the situation of the next few years, e.g. ten years. Which market/public developments need to be considered for the recommendations identified in the frame of this project?
- It is necessary to consider the handling of extra-EU transport, when discussing an EU approach. The question is how an alignment with other standards and the global market can take place and which role the European Commission may have in this process.
- Many other approaches of various initiatives need to be considered and these results could be included into this project (e.g. PEF, PCR).
- The calculation with real measured fuel data requires the availability and possibly also the ownership of the fuel data. As logistics often use sub-contracted services by small enterprises, the latter may be an issue. These small companies may not be interested or willing in providing this information to the large companies.
  - However, large companies should not put additional pressure on SMEs. An alternative could be to provide incentives for data provisions,

e.g. by offering driver training within the large company's own training activities. In addition, the data sensitivity (e.g. fuel consumption, empty runs) needs to be addressed by the large company.

- The logistics sector requires sector-specific parameters and key figures in the first step (e.g. effectiveness of the different modes, relevant vehicle categories, fuel types) as well as the precise definition of the various parameters (e.g. load in the respective modes).
- Government and other institutions may also require relevant data from carbon footprinting of logistics services for their political decisions, investments (e.g. infrastructure changes), or to identify relevant new incentives (systems) to promote the sector.
- The carbon footprint report may not necessarily require the inclusion of the whole set of data used in the calculation. Thus, the reporting of business sensitive data may be prevented.
- The European Commission may provide the basis for carbon footprinting and enable business to perform this calculation. In addition, general barriers, e.g. with reporting, may be eliminated by Commission. When carbon footprinting has become a routine and good data is available, the discussion about a mandatory scheme may be introduced.
  - However, it needs to be discussed if a mandatory reporting system offers additional benefits to stakeholders at this point, and not only an administrative burden and costs.
- Stakeholders question In which way the project plans to balance the voluntary approach (preferred by stakeholders) and the mandatory approach (favoured by the initial results of the impact assessment).
- Scenario 4 forces companies to calculate their carbon footprint on Level 2. However, it is questionable if there are any benefits for the company in calculating their carbon footprint with this level as detail, as relevant reduction measures might not be identified on this level (only with Level 3).
- Stakeholders indicate that even if a level 3 method is used for the calculations, the data may not necessarily result in comparable carbon footprints and could still impede benchmarking.
- The issues discussed in part 1-3 of the workshop are valid for the passenger sector as well.
- In the case of combined freight and passenger transport (e.g. air transport, parcel transport in coaches in rural areas) the allocation of the total transport emissions to freight and passenger transport needs a further clarification and alignment.
- In addition to the presented sub-division of the passenger sector, regular services and private tourism (e.g. charter airlines, touring coaches) are relevant too.

Integration in the project

The discussion showed that there is a distinctive difference between the overall picture deriving from the stakeholder consultation (including the online consultation) and the preliminary results of the impact analysis, presented at the meeting. This concerned mainly the high scores given to mandatory reporting and the use of level 2 methodologies (i.e. option 4). Following the remarks provided by the stakeholders, the preliminary results of the impact analysis have been adjusted accordingly when appropriate.

Annex B Overview of exisiting carbon footprinting initiatives

B.1 Introduction

This annex provides an overview of the main ongoing carbon footprinting activities, especially those with a focus on transport.
The standards (Annex B.2) and initiatives (Annex B.6) illustrated in this annex can be seen as the early adopters of carbon footprinting.

B.2 Available standards

Annex B.3 describes the standards that are relevant for transport. In Annex B.4 other standards that may provide insights for transport-related standards are discussed. Finally, Annex B.5 illustrates the COFRET project, which shares similarities with this study.

The description of each standard presents its background, scope with respect to emissions and processes, and its general approach to carbon footprint calculations.

B.3 Transport relevant standards

EN 16258

The CEN[47] standard EN 16258 *Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)* (CEN, 2012)[48] is a European standard for the calculation and declaration of energy consumption and emissions of transport services and has been published in January 2013.

The CEN standard prescribes the following steps for the calculation of CO_2 emissions:

1. Identification of transport service boundaries.
2. Calculation of the energy consumption of each leg.
3. Total energy consumption per leg.
4. Conversion of the energy consumption to GHG emissions.
5. Allocation of GHG emissions to the different beneficiaries of the transport service (for multi-customer transport).
6. Declaration/customer information.

The CEN standard sets clear boundaries on the processes to be in- and excluded in the calculations. The standard also specifies a set of default conversion factors to calculate the WTW CO_2 emissions from energy consumption. The conversion factors should either be in line with the methodology of the Renewable Energy Directive or with the default values

[47] CEN (www.cen.eu), the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries. CEN provides a platform for the development of European Standards in relation to a wide range of fields and sectors.

specified in the annex of the standard. These default values are based on the IPCC guidelines (IPCC, 2006) and on data from EUCAR/JRC/CONCAWE 2007-2008.

The CEN standard is the only standard specifically focused on carbon footprinting in transport and is therefore relatively most specific in providing guidance, which is a significant step forward. However, the standard has not solved the most persistent and complex problems facing carbon footprinting. Calculations that are in line with the CEN standard can differ on several aspects, hindering the comparability of calculations. The standard leaves room to choose for different levels of detail in the calculation. For example, it provides the opportunity to use each of the different calculation approaches that were explained Chapter 2.3 (Level 1-3). Furthermore, the level of detail of the data that is used can vary. The standard allows the use of average fleet values of the operator or specifically measured values for the provided service. Although the standard mandates a full declaration of the choices made, this makes interpretation of the results difficult. No solution is provided to the difficulties with allocating emissions in case different types of goods (e.g. heavy and volumetric) are transported.

There are several initiatives that have developed more detailed guidance that has been based on the CEN standard, such as the guidance that has been developed by Deutscher Speditions- und Logistikverband (DSLV) or by the European association for forwarding, transport, logistics and customs services (CLECAT) (CLECAT ; DSLV, 2012). CLECAT developed guidelines for *Calculating GHG emissions for freight forwarding and logistics services in accordance with EN 16258*[49].

In the Netherlands, a working group of stakeholders has developed and published a standardised guidance which is comparable to the guidelines of CLECAT and DSLV. The objective of the working group is to align the carbon footprint calculations made in the Netherlands.

Decree 2011-1336, French legislation[50]

In France, GHG reporting for passenger and freight transport by service providers is obligatory under national legislation. The decree was published in 2011 and came into force in October 2013. It affects all transport activities departing from or arriving to France. According to the French government, the provision of CO_2 information could raise awareness in the transport sector and could help stakeholders to make better choices that result in more carbon-friendly measures.

According to the legislation, the GHG information should be made available to the customers. For freight transport, the timing for the transfer of information can be agreed upon between the service provider and customer.
This agreement can include both ex-ante or ex-post transfer. In the absence of an agreement, the information must be provided within two months after the execution of the service. For passenger transport the information should be

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49 European association for forwarding, transport, logistics and customs services CLECAT; Deutscher Speditions- und Logistikverband e.V. DSVL (Ed.) (CLECAT ; DSLV, 2012)): Calculating GHG emissions for freight forwarding and logistics services in accordance with EN 16258. Terms, Methods, Examples. Online http://www.clecat.org/images/CLECAT_Guide_on_Calculating_GHG_emissions_for_freight_forwarding_and_logistics_services.pdf

50 http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000024710173, http://www.cofret-project.eu/downloads/pdf/French_CO2%20info_Presentation.pdf

provided at the moment of ticket purchase or during the trip (in case of season-ticketing for example).

The calculation methodology prescribed is based on the CEN standard EN16258 which already has been discussed above. The emission factors to be used specified in a ministerial order from the Minister of Transport.

The Decree also prescribes the level of precision to be used in the calculation[51]:
- Level 1: default values fixed by the Minister for Transport;
- Level 2: average values determined by the transport company;
- Level 3: values measured specifically by the transport company for each service;
- Level 4: values based on real data.

The level of detail that must be used depends on the characteristics of the transport service operator. The use of Level 1 calculations is obligatory:
- for service providers with less than fifty employees;
- to assess sub-contracted activities, where sub-contractors do not supply the GHG information for the sub-contracted services within the necessary timeframe, or when this information clearly has errors;
- for service providers with fifty or more employees that report before the 1st of July 2016.

It should be noted that the French decree no. 2011-1336 of 24 October 2011 stipulates that a report shall be drawn up before the 1st of January 2016. This report will present the results of the application of the legislation in general and investigate the deadline of the 1ste of July 2016 for service providers with fifty or more employees.

GHG protocol[52]
The Green House Gas Initiative is a multi-stakeholder partnership between the industry and non-governmental institutions that is administered by the World Resource Institute WRI (Washington, USA) and the World Business Council for Sustainable Development WBCSD (Geneva, Switzerland). In 1998 the Green House Gas Initiative started to develop a standard for calculating and publishing greenhouse gas emissions caused by companies, with the objective that this methodology will be internationally approved.

In 2001 this methodology has been published as the 'Corporate Accounting and Reporting Standard' (WRI : WBCSD, 2011a)or the so-called GHG protocol.
By means of a three-year multi-stakeholder process (started in 2008), this GHG protocol has been further developed on two aspects: product life cycle and corporate value chain (Scope 3). The first drafts of the Technical Working Groups have been published in 2009.

In 2010 the draft standards have been tested by different road haulage companies from different segments, which provided feedback with respect to practicality and usability. More feedback on the drafts has been provided by a Stakeholder Advisory Group, which comprised of more than 2.300 participants.

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51 http://www.developpement-durable.gouv.fr/IMG/pdf/Info_CO2_Methodological_Guide.pdf

52 http://www.ghgprotocol.org/

In 2011, the two standards have been published as a result:
- product life cycle accounting and reporting (WRI ; WBCSD, 2011);
- corporate value chain (Scope 3) standard (WRI ; WBCSD, 2011b).

The Corporate value chain (Scope 3) standard (referred to as 'Scope 3 Standard' from here onwards) is the most relevant standard with respect to transport services.

In the Scope 3 Standard all six GHG emissions identified with the Kyoto protocol are included in the emission calculation. The emission calculation refers to the whole value chain, covering the company's own (Scope 1 & 2) as well as sub-contracted processes (Scope 3), including all transport and location-related processes (e.g. transhipment, storage, administration, commuting). GHG emissions can be calculated by using default values or company values.

A detailed description of the transport carbon footprint calculation according to the Scope 3 Standard has been published in the "Technical Guidance for Calculating Scope 3 Emissions" (WRI ; WBCSD, 2011c)in 2013, including the provision of relevant default data and parameters. The description provides mainly high level methodological guidance on the calculation of GHG emissions from transport. Contrary to the EN 16258 standard, that contains a set of energy conversion factors (e.g. kg CO_2e/l fuel), the GHG protocol does not provide any default data to use.

B.4 Other standards for carbon footprinting of products and organizations

In recent years, several ISO standards on carbon footprinting methodologies have been set up since the 1990s. These standards have been further specified for transport movements in later years.

ISO 14064, ISO 14065 and ISO/TR 14069

In 2005, the GHG protocol has been used by the International Organization for Standardization (ISO) to develop a general framework for quantifying and reporting GHG emissions. In 2006 and 2007, the international standards ISO 14064 and ISO 14065 have been published as a result. The aim of the standards is to provide companies and governmental institutions an internationally accepted framework for quantifying, reporting and monitoring the reduction of GHG emissions. Part one of ISO 14064 focuses on GHG emissions at the company level, while part 2 focuses on the product level and part 3 on verification of both previously mentioned parts.[53] ISO 14065 describes the requirements for GHG emission validation and verification bodies.[54] In 2013, the additional ISO/TR 14069[55] has been published to provide guidance on the application of ISO 14064-1.

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[53] ISO 14064-1:2006: Greenhouse gases - Part 1 - Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.; Norm ISO 14064-2:2006: Greenhouse gases - Part 2 - Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.; Norm ISO 14064-3:2006: Greenhouse gases - Part 3 - Specification with guidance for the validation and verification of greenhouse gas assertions.

[54] ISO 14065:2007: Greenhouse gases - Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition.

[55] ISO/TR 14069:2013: Greenhouse gases -- Quantification and reporting of greenhouse gas emissions for organizations -- Guidance for the application of ISO 14064-1.

These standards offer only a general framework for carbon footprint calculations. While the GHG emissions to be covered are defined, processes and calculation procedures are not.

ISO/TS 14067

The ISO/TS 14067 - *Carbon footprint of products – Requirements and guidelines for quantification and communication* – (ISO, 2013), has been developed with the aim to increase transparency in the quantification and reporting of life cycle carbon footprints of products, including GHG emissions from production, recycling and waste disposal. The document was published in 2013. It has been based on ISO 14040 and 14044, which focus on GHG emissions of products.

PAS 2050

In parallel to the ISO activities, Carbon Trust and the British Environmental Ministry (Defra - Department for Environment, Food and Rural Affairs) have developed a methodology for quantifying GHG emissions of products and services. It has been published as Public Available Specification (PAS) 2050 *Specification for the assessment of the life cycle greenhouse gas emissions of goods and services* (BSI, 2011) by the British Standards Institution (BSI) in 2008 and was updated in 2011. Before the publication of the standard, a stakeholder consultation process (1,5 year) had taken place and included more than 1.000 stakeholders (Seuring & Müller, 2008)[56].

The methodology, described in PAS 2050:2011, includes all six greenhouse gases identified with the Kyoto protocol[57] and uses a life cycle approach. The emission calculation is based on company data for those processes the company owns, operates and/or controls. Other processes can be calculated with default values.

PAS 2050 focusses on life cycle analysis of products and services. Transport is one of the processes that has to be included in the calculation. However, the methodology on how transport emissions should be calculated is not described in detail.

Product and Organisation Environmental Footprint (PEF/OEF[58])

Both the Organisation Environmental Footprint (OEF) and the Product Environmental Footprint (PEF) provide a life-cycle approach to quantify the environmental performance of products and organisations, respectively. The methodology has been developed by the Joint Research Centre of the European Commission and DG Environment in order to have a harmonised methodology for environmental footprinting. Already existing methods, like the International Reference Life Cycle Data System (ILCD) Handbook[59], ISO 14040-44, PAS 2050, and the GHG protocol have been used as a starting point.

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56 http://ec.europa.eu/environment/eussd/pdf/Deliverable.pdf; page 15.

57 I.e. CO_2, CH_4, N_2O, HFC, PFC, SF_6 (see United Nations (1998): Kyoto Protocol to the United Nations Framework Convention on Climate Change. New York).

58 http://ec.europa.eu/environment/eussd/smgp/dev_pef.htm

59 http://eplca.jrc.ec.europa.eu/uploads/2014/02/JRC-Reference-Report-ILCD-Handbook-Towards-more-sustainable-production-and-consumption-for-a-resource-efficient-Europe.pdf

The final methodologies were published in an Annex of the Commission Recommendation (2013/179/EU) on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. Transport is part of the PEF/OEF. The recommendation states that the vehicle type, load factor, empty running, allocation, fuel production, infrastructure, and additional resources and tools (e.g. cranes) should be taken into account. PEF/OEF has a broader scope than benchmarking GHG emissions of transport services, since it focuses on the entire life cycle chain of products and organisations, and has a broader coverage than only GHG emissions.

The PEF and OEF umbrella methods are applicable to any product, service or sector (including transport) and measure several environmental impacts (including GHG emissions). They do not contain a set of formulas to be used for analysing transport. However, currently PEFCRs (Product Environmental Footprint Category Rules) and OEFSRs (Organisation Environmental Footprint Sector Rules) are being developed for 25 product groups (batteries and accumulators, decorative paints, hot and cold water supply pipes, household detergents, intermediate paper product, IT equipment, leather, metal sheets, non-leather shoes, photovoltaic electricity generation, stationery, thermal insulation, T-shirts, Uninterruptable Power Supply, beer, coffee, dairy, feed, fish, meat, pasta, packed water, pet food, olive oil and wine) and 2 sectors (retail and copper). Transport is one of the activities taken into consideration in the measurement of the environmental footprint of these products and sectors. Accordingly, the pilots are expected to result in more detailed instructions on the way of dealing with transport, which would be consistent across the PEFCRs and OEFSRs. Furthermore, in the case of products where transport would turn out to contribute significantly to the overall environmental impact of the product or sector, the requirements regarding the quality of the analysis on transport would be higher. In any case, the rules would be sufficiently prescriptive to guarantee the reproducibility of results.

Footprinting initiative to fix the rules regarding the measurement of the environmental footprint of the transport service or transport companies, respectively. PEFCR or OEFSR may be therefore considered while further exploring and detailing relevant approaches under the preferred policy option for the carbon footprinting at the level of transport services.

B.5 COFRET - European R&D project

COFRET[60] is a FP-7 financed European project that focusses, amongst other aspects, on the inventory and review of existing carbon footprint methodologies. The project identifies gaps and ambiguities in the calculation guidelines and prioritises suggestions for the improvement of the comparability of approaches.

The results of the COFRET assessment were published in December 2011 and covered 18 methodologies, 38 calculation tools, 12 databases and 34 other items. In total 102 carbon footprinting-related items have been assessed.[61] The COFRET consortium concluded that the existing methods, tools and databases were all suitable for the calculation of the carbon footprint of

[61] See COFRET Deliverable 2.1, Existing methods and tools for calculation of carbon footprint of transport and logistics.

logistical services, but that an overall harmonisation of the various initiatives was missing. Although standards[62] have been published after the COFRET project had started, this situation has not changed significantly as it has been evidenced in the updated market analysis of this project.

While this study analyses policy options for promoting the harmonisation of carbon footprint methodologies, COFRET mainly focused on the methodology levels and investigated existing gaps and tasks to be dealt with in a future harmonisation process. COFRET assessed several methodologies with EN 16258 as a reference.[63] In addition, the gap analysis focussed on: ISO 14064, ISO/TS 14067, GHG protocol, GreenFreight Europe and ecoTransIT. COFRET's general conclusions on the gap analysis are the following:

- EN 16258 provides an intermediate step: it establishes a general standard, covering all transport modes and both freight and passenger transport. "In that sense the standard is a 'one-size fits all' product"[64]. The options left open for interpretation may be reasonable at this stage and are addressed in the standard. Examples are the level of detail of the input data and optional allocation principles. "The EN 16258 as it is now, is a good starting point for the calculation of GHG emissions in transport."[78] A future harmonisation process for developing a comprehensive carbon footprint methodology for freight and passenger transport should focus on the uptake of nodes into the calculation and the definition of the level of detail of the required input data.
- COFRET ends late 2014. As a final result COFRET initiated an ISO International workshop agreement (IWA) "International harmonized method(s) for a coherent quantification of CO_2 emissions of freight transport", hosted by the DIN.[65] The harmonisation aspects discussed at the IWA-kick off meeting (July 8th, Berlin) were in line with the results of the stakeholder consultation performed in the framework of this study.

B.6 Available initiatives/programmes within the transport sector

In addition to the standards developed by standardisation bodies, like CEN and ISO, the transport sector also initiated different market-driven initiatives to determine the carbon footprint of transport activities in a harmonised way. The most relevant and active initiatives are discussed in this section.

SmartWay USA[66]

The SmartWay initiative was developed by the Environment Protection Agency (EPA) in the United States, in co-operation with industry stakeholders, environmental groups, American Trucking Associations, and Business for Social Responsibility. The initiative was launched in 2003 and still exists.

In 2010 this public-private partnership covered approximately 30% of all road freight volume in the United States. More than 3,000 US shippers, truck and rail carriers are registered in the initiative.

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62 EN 16258, ISO/TS 14067.

63 See COFRET Deliverable 3.2 "Gap analysis".

64 See COFRET Deliverable 3.2 "Gap analysis", page 32.

65 See http://www.logistik.din.de/cmd;jsessionid=IDAMNSWXQ8QXNXQZ3PXNG7GC.4?cmsrubid=215022&2=&menurubricid=215022&level=tpl-artikel&menuid=215000&languageid=en&cmstextid=227463&cmsareaid=215000

66 http://www.epa.gov/smartway/

The program consists of four components, of which the SmartWay Transport Partnership[67] is the most relevant one for carbon footprinting. In this partnership, freight carriers and shippers have committed themselves to benchmark their operations, to track fuel consumption, and to improve fuel efficiency on a yearly basis. Experts indicate that the market coverage is about 8% when taking into account the number of companies, and 22% when looking at transport performance.
SmartWay distinguishes five types of freight transport companies: freight shippers, logistics companies (including 3PLs/4PLs), truck carriers, rail carriers, and multi-modal carriers. For each type, SmartWay provides so-called 'tools' to assess the GHG emissions, energy use, and air polluting emissions resulting from their transport services. Each year, the partner companies submit their data to the tool, which in turn assesses (1) freight operations, (2) calculates fuel consumption and carbon footprints, and (3) tracks fuel-efficiency and emission reductions.[68] Truck operators are benchmarked on their fuel-efficiency performance and are allocated to one of the five carrier bins per market segment. This information is made available to shippers for negotiation purposes.

The SmartWay initiative supports other international stakeholders to implement the approach of this freight sustainability program worldwide. So far, there exist similar initiatives and activities in Europe (Green Freight Europe, see below) and Asia (Green Freight Asia)[69].

GreenFreight Europe (GFE)[70]

The industry-driven GreenFreight Europe (GFE) initiative has been initiated by Heineken, the Dow Chemical Company, DHL and TNT in 2009 and is managed by the European Shippers' Council and the Dutch Shippers' Council (EVO) (secretariat). The programme, launched in March 2012, aims to establish a pan-European system for collecting, analysing, and monitoring GHG emission from road freight transport. As such, it is comparable to the SmartWay initiative described above. In addition to monitoring and reporting of GHG emissions, GFE focuses on best practice sharing, access to verified green technologies and on the development of a certification for green transport service providers. More than 110 multi-national carriers, shippers and logistics service providers participate in the initiative.

The methodology for the carbon footprint is not specified and any of the calculation methods defined in the CEN standard are allowed. The initiative uses standard conversion factors that are currently based on DEFRA.
The performance of an individual operator is estimated with a limited number of performance metrics (e.g. tonne-km). Every carrier receives feedback on its average company performance and on how this performance compares with the average of all companies that have reported. No data is exchanged between associated partners.

67 http://www.epa.gov/smartway/documents/publications/overview-docs/420f13017.pdf

68 SmartWay: Logistics Partner 2.0.12 Tool: Quick Start Guide. 2012 Data Year - United States Version Online http://www.epa.gov/smartway/forpartners/documents/logistics/tool-guide/420b13030.pdf

69 http://greenfreightasia.org/

70 http://www.greenfreighteurope.eu/

At the moment, the activities of GFE mainly concentrate on road transport. However, extension to other land transport carriers and/or all transport modes is being discussed. Cooperation is already sought with initiatives that focus on other transport modes (e.g. partnership with ecoTransIT World Initiative since February 2014).

GFE provides a single platform hosted by an independent third party (Energy Saving Trust, EST). All members have access and provide data at least once a year on the following aspects:
- Carriers: e.g. fuel, km, fleet profile. To enable the calculation of GHG emission performance.
- Shippers: e.g. shipments, carriers used. To enable the calculation of the GHG emission performance of transport operations performed for shippers participating in GFE.

Lean and Green[71]
Lean and Green is a Dutch non-profit network for sustainable mobility, run by the public-private network organisation Connekt and was launched in 2008. Currently, the program is extended to other countries, including Italy, Belgium and Germany.

Lean and Green's objective is to encourage business organisations and governments to become more sustainable by taking measures that result in lower environmental impacts and in lower costs. This involves freight as well as passenger transport. The Lean and Green concept covers two steps:
1. 'Lean and Green Award' for companies which can prove their ability to reduce CO_2 emissions by 20% in a period of five years with a plan of action.
2. Lean and Green Star for companies which can prove that they have actually achieved their plan's objective.

The lean and green award and star are shown on the operator's truck fleet, illustrating the company's ambition and achievements. In addition to illustrating commitment, lean and green may also play a role in the negotiation of contracts.

Today, the Dutch network covers more than 300 Lean and Green Award- and Star members. Involved organisations are currently working on the development of a continuous incentive to reduce CO_2 emissions.
Lean and Green focusses on self-assessment. The programme requires individual monitoring of CO_2 emissions to prove compliance with the emission reduction target. However, the company can use any carbon footprint methodology he wants.

Logistics Carbon Reduction Scheme (LCRS)[72]
The Logistics Carbon Reduction Scheme (LCRS) in the United Kingdom is a voluntary, industry-driven, approach endorsed by the UK government to monitor, report and reduce CO_2 emissions from road freight transport.
The Freight Transport Association (FTA) administers the CO_2 scheme, which has been launched in 2009 and which can be freely joined by commercial vehicle operators.

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71 http://lean-green.nl/lean-and-green/

72 http://www.fta.co.uk/policy_and_compliance/environment/logistics_carbon_reduction_scheme/index.html

With the fuel consumption data supplied by the scheme's participants, the logistics sector is able to show the contribution of the sector towards national GHG reduction targets. The members of the LCRS have committed themselves to an 8% reduction in the carbon intensity of the sector by 2015 compared to 2010. With this initiative, the sector aims to show the government that reduction targets can be met with voluntary agreements rather than binding regulations or taxations.

Currently 96 companies are involved in the reduction scheme, which together represent more than 60,000 commercial vehicles. As such, the market coverage is approximately 15%. In order to provide insight in their environmental performance, participating vehicle operators should provide annual information on their fuel consumption, activities and vehicle numbers. Conversion factors approved by the UK government (DEFRA) are used to determine CO_2 equivalents.

The aggregated data is published in the Logistic Carbon Review. This annual report shows the overall progress made by the logistics sector. Individual achievements are confidential and not published. However, the system enables users to benchmark their performance with industry averages.[73]

The Network for Transport Measures Environment (NTM)

The Network for Transport Measures or Nätverket för Transporter och Miljön (NTM) is a non-profit organisation, initiated in Sweden in 1993. Its main aim is to establish a common database of values with which the environmental performance of transport services can be assessed and improved.

To promote and develop environmental work in the transport sector, NTM aims for a common and accepted method for the calculation of emissions, the use of natural resources and for other external effects from freight and passenger transport.

The work of NTM includes several services and tools for shippers and transport providers, including:

- NTMCalc is a tool that enables the assessment of freight and passenger transport's environmental performance in terms of emissions and use of resources;
- NTMEcap, a tool for evaluating the environmental performance of transport services in order to drive improvements;
- NTMBest practice includes data on various improvement measures and their improvement potentials.

In the calculations different data sources are used per transport mode:

- for road transport, data is based on the Handbook Emission Factors for Road Transport (HBEFA[74]) and ARTEMIS[75];
- data for rail is based on EcoTransIT[76];
- for water transport, data is based on shipping companies operating in Lighthouse;
- for air transport, FOI (Totalförsvarets forskningsinstitut[77]) is used.

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73 http://www.fta.co.uk/export/sites/fta/_galleries/downloads/logistics_carbon_reduction_scheme/lcrs_information_pack.pdf

74 http://www.hbefa.net/d/index.html

75 http://www.trl.co.uk/artemis/

76 http://www.ecotransit.org/

The NTM distinguishes three methodologies with varying levels of detail:
- Level 1: calculates emissions for the entire company assuming all transport is performed with one specific vehicle;
- Level 2: distinguishes different vehicle types with different engine types, fuel types and load factors for each vehicle type;
- Level 3: the most detailed calculation including calculations for each single vehicle of the company.[78]

NTM offers calculation tools for the first two levels. Level 3 calculations can only be performed with the company's own software.

The Clean Cargo Working Group (CCWG)[79]

The Clean Cargo Working Group, established in 2003, is a working group of Business for Social Responsibility (BSR) and is a business-to-business initiative focused on improving the environmental performance of marine container transport globally.

With tools created by the CCWG, ocean freight carriers can measure, evaluate and report the environmental performance of their businesses, collaborate with other stakeholders to improve this and can influence the development of tools, standards and methodologies.

According to the CCWG, 60% of the volume of the global container fleet is represented by carriers participating in the working group. Currently, the CCWG has 30 members, including eleven of the largest world liner fleet operators.

Within the data collection process, the following data is obtained per vessel:
- capacity in TEUs;
- number of reefer plugs;
- distance;
- fuel consumption HFO and fuel consumption MDO/MGO;
- timeframe.

Based on this information the CO_2 emissions are calculated by the use of the following general formula:

$$\frac{\text{(total kg fuel consumed for containers * 3114.4 gCO}_2\text{/kg fuel)}}{\text{(maximum nominal TEU capacity * total distance covered)}}$$

The calculation methodology for dry containers is in line with standards and guidelines of the International Maritime Organisation (IMO).

Ocean freight carriers can easily report their environmental performance in a default, which enables shippers to make informed decisions.

77 http://www.foi.se/en/

78 http://alexandria.tue.nl/extra1/afstversl/tm/te%20Loo%202009.pdf

79 https://www.bsr.org/reports/BSR_CCWG_TradeLaneEmissionsFactorsReport.pdf

Green Logistics

'Green Logistics'[80] is a German industry-based R&D-project that ran from 06/2010 to 03/2015. It was funded by the German Federal Ministry for Research and Education and is embedded in the Efficiency Cluster Logistics Ruhr[81].

The objective of 'Green Logistics' is to provide a methodology for comprehensively determining the ecological effects of logistics systems and processes on a usage-related, standardised basis. It also aims to develop methods and instruments for the assessment of associated elements, ranging from storage to distribution to reverse logistics.
Twelve partners - DB Mobility Logistics, Deutsche Post, Fiege Deutschland, Fraunhofer Institute for Material Flow and Logistics, Goodman Germany/Arcadis Deutschland, Lufthansa Cargo, Schmidt-Gevelsberg, TÜV Rheinland, United Parcels Service Deutschland, Vanderlande Industries, and Wuppertal Institute for Climate, Environment and Energy - are working together on this topic. The results are continuously discussed within a stakeholder group of nineteen companies, including logistics service providers, shippers and technology suppliers.

It is planned to publish the methodology in 2014, which will cover GHG emissions and local air pollutants that are relevant for the logistics sector.
The methodology will cover all transport modes and also covers logistics buildings and intra-logistics processes. It will offer a standardised procedure for the screening and definition of an appropriate assessment scope.
The developed methodology is currently being discussed with other initiatives, such as GreenFreight Europe, the Clean Cargo Working Group, and the GHG protocol.

80 http://www.green-logistics-network.de/

81 http://www.effizienzcluster.de/de/index.php

Annex C Analysis of the level of harmonisation of existing practices

C.1 Introduction

For the purpose of the study, we have investigated the level of harmonisation among existing carbon footprinting tools. This Annex presents results of this analysis, including information on the stakeholders' perception and the proposed future steps that will be required for harmonisation purposes.

C.2 Indicators for harmonisation of carbon footprinting

Section 2.3 explained the different methodological approaches for determining the carbon footprint of logistical services. The extent to which carbon footprinting can have an impact on GHG emissions depends, amongst other aspects, on the level of harmonisation of the methodologies used, since this results in comparable footprints that can be used for benchmarking.
When approaches are harmonised, carbon footprinting can play a more significant role in the decision-making process of policy makers and businesses (e.g. shippers, passengers).

Four issues can be identified that are relevant to obtain harmonised carbon footprints that can easily be used for benchmarking in the future:
- comparability of system boundaries and scope;
- comparability of calculation methodology;
- transparency and declaration rules;
- credibility and usability.

Each of these four issues has been analysed in detail for the purpose of this study by using relevant indicators. The work made under the EU research project COFRET (see Annex B.5) has been considered, updated and integrated into these analyses where possible.

In the following sub-sections, the indicators used for the analysis are introduced and their assessment framework is described.

C.3 Comparability of system boundaries and scope

The main focus of this analysis is the carbon footprint at the service level. However, this leaves room for interpretation, both in terms of the logistical service (i.e. what the service covers), and of the carbon footprint itself (i.e. what it actually represents). To assess the comparability of the system boundaries and scope of the carbon footprints at the service level, six indicators have been defined and analysed.

Transport modes

Transport services can cover any transport mode, such as road, rail, maritime/inland waterway or air transport. Therefore, the different initiatives have been analysed with respect to the transport modes they cover.
For passenger transport services, road entails both cars and busses/touring cars. In addition, the tram, metro and ferry have been distinguished.

For each relevant transport mode, the analysis focuses on whether the tool covers a particular transport mode: yes (+) or no (-).

Geographical scope

Many logistical supply chains have a global scope. Passenger transport has an international character as well, in many cases. Therefore, the geographical scope of a tool can affect the outcome of such services. If a tool incorporates default values based on national characteristics and for example takes local circumstances into account (e.g. urban traffic conditions), the geographical scope of the carbon footprinting tool can be of limited use for such international transport services.
This can become a problem when the tool uses:

- national emission factors (e.g. the national electricity mix);
- routing options (e.g. using maps) for calculating the carbon footprint;
- considers national technologies/restrictions (e.g. vehicle weight, train lengths, ship sizes).

Some tools enable worldwide calculations, while others are primarily focussed on specific countries or regions.

The analysis considers this issue by assessing if the approach is either national, European, international (not being European) or even global.

Carbon dioxide (CO_2) vs. carbon dioxide equivalent (CO_2e) emissions

The term ‘carbon footprint’ is interpreted and used in different manners. Some tools cover only CO_2 emissions, while others also include other GHG emissions. The latter is generally expressed by carbon dioxide equivalent emissions (CO_2e). CO_2e emissions often include nitrous oxide (N_2O) and methane (CH_4) emissions. The other GHG emissions are then translated into CO_2e emissions with their global warming potential (GWP), which has been defined by the Intergovernmental Panel on Climate Change[82]. One gram of methane has a climate impact that is 25 times larger than the impact of one gram CO_2 for example. Hence, the GWP of methane can be expressed as: 25 g CO_2/g CH_4. Likewise, the GWP of N_2O is 298 g CO_2/g N_2O.

The tools and initiatives have been assessed on whether they cover the calculation of CO_2, CH_4, N_2O and/or CO_2e emissions.

Tank-to-wheel (TTW) vs. Well-to-wheel (WTW)

Transport activities cause GHG emissions during the usage phase of a transport mode (tank-to-wheel), but upstream processes (i.e. the production of fuel and generation of electricity) also result in GHG emissions. When GHG emissions cover both phases, a well-to-wheel (JRC, IET, 2011) approach is used. Obviously, WTW emissions are higher than TTW emissions for the same service. The difference between a WTW approach and a TTW approach is

[82] The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

approximately 19% for diesel for example (JEC, 2011), although this figure is subject to some discussion with respect to the allocation of the Well-to-tank (WTT) emissions to different products. Either way, WTW and TTW emissions cannot be fairly compared. Figure 14 shows the linkages between the different phases and processes.
The analysis assesses whether the initiative covers TTW or WTT emissions.

Figure 14 Different life cycle phases to be included in a lifecycle analysis (LCA) of transport services

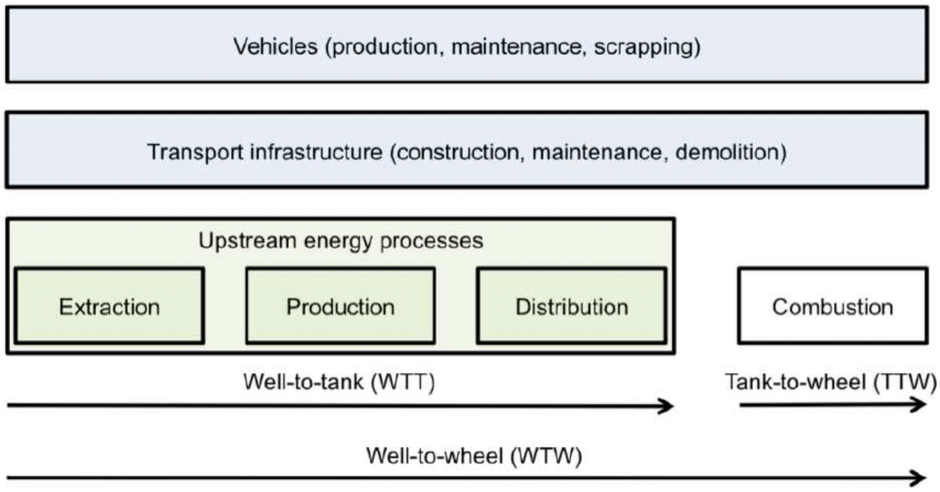


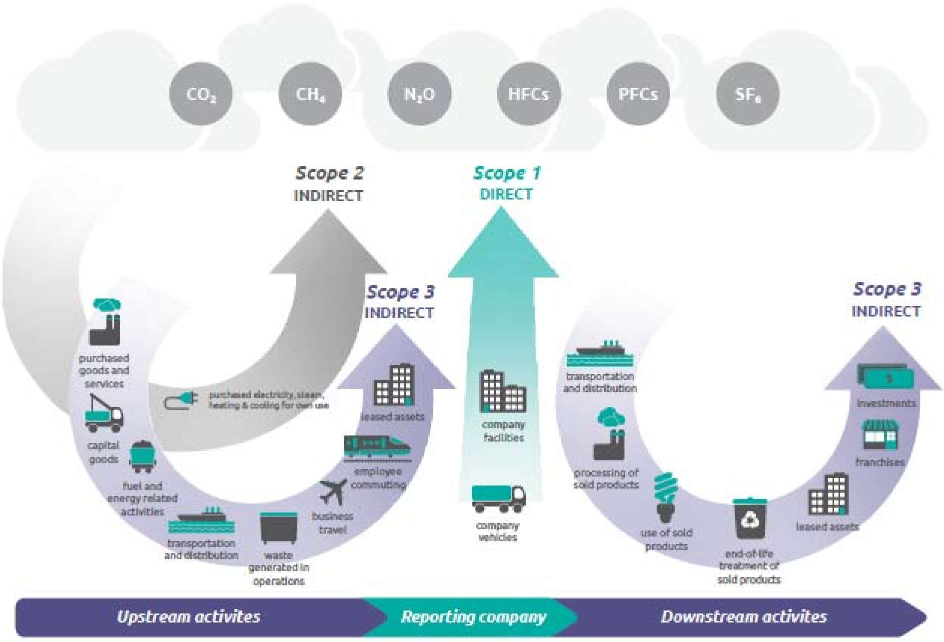
Figure taken from MIT, (MIT, 2013).

Transport and other upstream processes

Several upstream processes are part of the (freight) transport service (e.g. sub-contracted processes), and could be included in the carbon footprint. The Greenhouse Gas Protocol has identified three scopes, as shown in Figure 15[83]. Scope 1 covers the company's direct emissions: those emissions that result from what the company owns or controls, for example its own boilers, vehicles, process technologies for chemical production processes, and so on. Scope 2 emissions are indirect emissions caused by the consumed energy that was delivered by a third party, and covers electricity, heating, cooling and process steam. All other indirect emissions are Scope 3. As such, Scope 3 emissions result from the company's acquisition of raw materials, products or services (upstream) and of its distribution and additional processing of products (downstream).

83 GHG Protocol Scope 3 Standard [World Resources Institute; World Business Council for Sustainable Development (2011): Greenhouse gas protocol. Corporate value chain (Scope 3) accounting and reporting standard: supplement to the GHG protocol corporate accounting and reporting standard.

Figure 15 Overview of GHG Protocol scopes and emissions across the value chain[84]



The carbon footprint calculation of transport services can vary in the scope applied and can cover:
- transport performed by the company's own fleet (e.g. own fuel consumption);
- transport performed by sub-contractors (i.e. Scope 3 transport processes);
- auxiliary transport processes (e.g. shunting, taxing, and idling) and pre- and end-haulage processes (e.g. in intermodal transport chains or logistics networks) that are necessary for the transport service;
- auxiliary processes at logistical sites (e.g. transhipment, warehousing);
- auxiliary processes resulting from the life-cycle of vehicles and infrastructure (e.g. production and maintenance).

The analysis evaluates whether the tool covers transport and/or other upstream processes with yes (+) or no (-). If a scope can be included but is not mandatory, it is scored as 'optional'.

Emissions other than greenhouse gases

In addition to GHG emissions, other environmental impacts are increasingly being considered by companies nowadays. For transport, local air pollutants are especially relevant, such as nitrous gases (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matters (PM). Although these emissions are not directly connected to carbon footprints, they have been included in some tools and are therefore part of the analysis.

The analysis assesses whether these additional emission categories are included: yes (+) or no (-).

[84] Source: Figure 1.1 of GHG Protocol Scope 3 Standard [World Resources Institute; World Business Council for Sustainable Development (2011): Greenhouse gas protocol. Corporate value chain (Scope 3) accounting and reporting standard: supplement to the GHG protocol corporate accounting and reporting standard.

C.4 Comparability of calculation methodology

0 has shown the large number of standards that is available for the ecological assessment of products and services. Tools for calculating carbon footprints usually use one (or more) of these standards. In terms of comparability of results it is preferable that all tools are based on the same standard. However, this is still no guarantee for comparable results, as these standards usually leave room for interpretation (e.g. with respect to the level of data accuracy, input data, and allocation rules).

To assess the comparability of the different tools, the analysis evaluates the applied calculation methodology with the indicators described below.

Calculation approach

As described in Section 2.3 there are three main methodologies for the carbon footprint calculation:

- Level 1: default performance-based emission factors;
- Level 2: default vehicle emission factors;
- Level 3: measured vehicle fuel consumption.

The analysis assessed which methodological level is applied in the tool: Level 1, 2 or 3. Note that although the analysis specifies the standard on which the tool is based as well, the precise implementation of this particular standard into the tool has not been verified in detail.

Additionally, the (main) input data that is required for each tool is also listed, e.g. whether real user-dependent vehicle fuel consumption is required or not.

Default values

The tools using a Level 1 or 2 methodology (using default performance-based or vehicle emission factors), will include sets of default values on the:

- GHG emission per defined transport service (e.g. per tonne-kilometre, TEU-kilometre) depending on transport mode and technology applied;
- GHG emission per kilometre, depending on transport mode, technology applied, and load factor (e.g. weight, volume, space).

Several sets of default values have been published, varying in transport modes, technologies and in the extent to which they are up-to-date.

The analysis evaluates the implemented data sets with default values. Important in this light, is the number of vehicle/vessel sizes that is distinguished in the dataset. The original HBEFA dataset offers 11 types of truck sizes for example, including solo trucks (<7.5 t, 7.5-12 t, 12-14 t, 14-20 t, 20-26 t, 26-28 t, 28-32 t, >32 t) and truck-trailer/articulated trucks (<28 t, 28-34 t, >34-40 t). Some carbon footprinting tools have aggregated these truck classes into tool-specific vehicle classes with average fuel consumption factors.

The analysis therefore reflects the numbers of classes that is distinguished, which can indicate different aggregation approaches even if tools are based on the same original dataset.

Routing

When distances are used for the calculation, the distance between origin and destination needs to be specified either by the user or by the tool.
However, the distance from origin to destination is not always available, for example when (part of) the transport service is sub-contracted. This can be

solved with routing functions incorporated in the tools, which can for example be based on Google Maps. However, the option to specify the real distance is desirable in when this information is available.

The flexibility with respect to the real transport distance is analysed and specified in the analysis with the following scores:
- tool's routing: the tool calculates the relevant distance;
- default route: the tool offers a specific number of pre-set routes, no calculation is performed;
- via points;
- real distance.

Allocation of logistical processes

The carbon footprint that results from a tool can be based on various aggregation levels, such as:
- corporate carbon footprint: GHG emissions of the whole company, e.g. of the logistics service provider;
- carbon footprint of a logistical service: GHG emissions for an average logistical service of the transport provider;
- carbon footprint of a consignment: GHG emissions allocated to a shipper/consignment.

As already discussed in Section 2.3.2, most shippers will be interested in the emissions of their specific consignment.

The carbon footprinting tools have been analysed with respect to their level of allocation. The analysed options are the following (yes (+), no (-)):
- company (e.g. logistics service provider);
- transport mean (e.g. vehicle, ship);
- shipment (e.g. container, consignment);
- client, i.e. user of logistics service(s).

The analysis does not evaluate the applied allocation principles, as this information type is very complex and often not available.

C.5 Transparency and declaration rules

The level of transparency provided to users of carbon footprinting tools determines how easily they can assess the background of a carbon footprint and can understand results. This also enables the user to assess the level of comparability of different tools. In order to be able to compare tools, the following information is required at least and has been evaluated:
- **Applied scope of carbon footprint:** is a description available on the scope of the carbon footprint?
- **Data used:** is a reference included for the default values used?
- **Allocation rules used:** is it clear which allocation principles have been used? For example, does the initiative describe the allocation of empty trips in the explanatory text?
- **Assumptions and simplifications made:** does the calculation methodology include simplifications or assumptions and are these described properly?

The analysis evaluates if information is provided (+) or not (-).

C.6 Credibility and usability

Four indicators have been defined to assess the credibility and usability of different tools.

Accessibility

One of the main indicators for usability is the accessibility of a tool. Some tools are free to use, while other tools charge an access fee or licence. In addition, the access means (e.g. internet) can also vary between tools.

The analysis distinguished three levels of accessibility:
- free: all users can access the tool for free;
- partially free: some parts of the tool require payment of an access fee or require a license;
- access fee/license: the tool can only be used if a fee is paid or if a license is purchased.

Consensus of relevant stakeholders

Many tools are developed with the involvement of stakeholders during different stages of the development. By doing so, a high level of consensus amongst relevant stakeholders can be obtained, which can result in a frequent use of the tool in practice.

The analysis distinguishes whether the stakeholder process involved:
- a small group of stakeholder (small) e.g. one company or project team;
- a larger group of stakeholders (medium) e.g. project team with further stakeholder involvement, various companies within an initiative, but no free involvement;
- open and free integration of any stakeholder (high).

Applicability independent of company's size

Companies differ in size and business model. A widespread use of a carbon footprinting tool can only be realised when the tool is suitable for different company profiles. The analysis distinguishes between private and business (including SMEs) use.

Sufficient frequency of actualisation

When carbon footprinting results are used as input in decision-making processes, the results should be representative for the current situation. Therefore a tool should be updated frequently. In the analysis the last year of actualisation is listed therefore.

C.7 Evaluation of tools

This section contains the results of the analysis on each of the identified indicators described in the previous section. Freight and passenger transport have been described separately.

Note that some tools offer free versions as well as licensed versions. The characteristics of these versions are not necessarily the same, as the free version can be a simplified version of the licensed one for example. The free versions have been studied in this analysis. For a few tools, more detailed and user-friendly versions are available for registered users (e.g. NTMcalc, ecoTransit).

The indicators used for the analysis are summarised in Table 38. If no details are available to evaluate a specific indicator, it is scored as 'not specified' (n/s).

Table 38 **Evaluation criteria for carbon footprinting tools**

Issue	Indicator	Evaluation
Comparability of system boundaries and scope	Transport mode	Yes (+), no (-)
	Geographical scope	National, European, international, global
	Greenhouse gas emissions (CO_2 vs. CO_2e)	Yes (+), no (-)
	Upstream energy processes (TTW vs. WTW)	Yes (+), no (-)
	Transport processes	Yes (+), no (-), optional
	Other upstream processes	Yes (+), no (-)
	Emissions other than GHG	Yes (+), no (-)
Comparability of calculation methodology	Calculation approach	Embedded standard (specified) Level of calculation: 1, 2, 3 Input data (specified)
	Default values	Data sets (specified) Number of technology types
	Routing	tool's routing, default route, via point, real distance
	Allocation of empty trips	Yes (+), no (-)
Transparency and declaration rules	Information provided on applied scope of carbon footprint	Yes (+), no (-)
	Information provided on data used	Yes (+), no (-)
	Information provided on allocation rules used	Yes (+), no (-)
	Information provided on assumptions and simplications made	Yes (+), no (-)
Credibility and usability	Accessibility	Free/partially free/access fee or licence required
	Consensus of relevant stakeholders	Low/medium/high involvement
	Applicability independent of company's size	Private/business
	Sufficient frequency of actualisation	Last year of actualisation

C.8 Results for freight transport

Eight relevant carbon footprint calculation tools have been identified and analysed for the freight transport sector. The analysis has been based on the results from COFRET[85] and Green Logistics[86]. Note that there are also many tools that have been developed and are owned by companies. These tools are confidential and not publicly available (e.g. Dachser, DB Schenker, Deutsche Post DHL, Kuehne+Nagel, Metro Group Logistics, UPS).

The analysis therefore focussed on publicly available tools, which are presented in Table 39.

85 http://www.cofret-project.eu/

86 http://www.green-logistics-network.de/

Table 39 Introduction of carbon footprinting tools for freight transport

Tool	Description	MS	Standard embedded
Carbon FTA[87]	This tool has been developed by the Heriot-Watt University (UK) and was funded by **FTA Freight Transport Association Ltd**. It is an Excel based tool whose embedded methodology has not been specified explicitly. The main objective is to give companies the possibility to quantify CO_2 emission reduction potentials within a company's freight transport operation.	UK	n/s
Fleet Carbon Reduction Tool[88]	This tool has been developed by **CENEX** (UK). According to their guidance document, the tool enables the "estimation of the carbon reduction performance of different transport fuels and technology options in real-world fleet applications"[89]	UK	In-house
ecoTransIT World[90]	This tool has been developed within a consortium of companies (e.g. **RMCon, Öko-Institut, DB-Schenker**) led by the **IFEU Institute** (Heidelberg, Germany). It is a tool for the ecological assessment of intermodal transport chains and offers a publicly available tool and a licenced solution for large data amounts.	D	EN 16258
Map & Guide professional[91]	A software tool for route planning, which has been extended with an ecological assessment in 2011 by **PTV AG** (Germany).	D	EN 16258, decree 1336
Martrans Ship Emissions Calculator[92]	This tool was developed and published by the **National Technical University of Athens** and **Laboratory for Maritime Transport** in 2008.	GR	In-house
NTMcalc Freight[93]	This tool enables the ecological assessment of freight transport. It has been developed by the Swedish non-profit organisation **Network for Transport and Environment (NTM)** in cooperation with a consortium covering well-known international logistic service providers.	SE	EN 16258
WRI Mobile Combustion GHG Emissions Calculator Tool[94]	This tool was published by the **Greenhouse Gas Protocol Initiative**. The latest version (2.5) was made available in June 2013. The tool enables carbon footprint calculations of transport systems.	US	GHG protocol

87 http://www.fta.co.uk/policy_and_compliance/environment/decarbonisation_tool.html

88 http://www.cenex.co.uk/consultancy/guidance/fleet-carbon-reduction

89 http://www.cenex.co.uk/wp-content/uploads/2014/02/2011-05-Cenex-fleet-carbon-reduction-tool-technology-comparison.pdf, page 1

90 http://www.ecotransit.org/calculation.en.html

91 http://www.mapandguide.de/

92 http://www.martrans.org/emis/index.htm

93 http://www.ntmcalc.org/index.html

94 http://www.ghgprotocol.org/calculation-tools/all-tools

Tool	Description	MS	Standard embedded
WPCI Carbon Footprint Calculator[95]	This tool has been developed by the Port of Los Angeles in cooperation with the **International Association of Ports & Harbors (IAPH)** and **World Ports Climate Initiative (WPCI)** and offers the calculation of GHG emissions of ports and its interlinked landside processes. It is a web-based calculator and has been published with two parts: the "Carbon Footprint Calculator for Port's Municipal Sources", covering Scope 1 and 2 emissions and the "Carbon Footprint Calculator for Port's Scope 3 Sources".	US	GHG protocol

Issue 1: System boundaries and scope

The system boundaries of the carbon footprint calculation tools show large varieties, both with respect to the transport modes and geographical scope covered, as summarized in Table 40.

Three tools (ecoTransIT, NTMcalc and WRI Mobile Combustion GHG Emission Calculator) cover all five freight transport modes and provide the possibility to cover global transport chains.

Table 40 Indicators transport modes and geographical scope of freight transport CF calculators

Name	Transport mode					Geographical scope
	Road	Rail	Air	Marine	Inland Waterways	
CARBON FTA	+	-	-	-	-	n/s
CENEX Fleet Carbon Reduction Tool	+	-	-	-	-	Global
ecoTransIT World	+	+	+	+	+	Global
Map&Guide	+	-	-	-	-	European
Martrans Ship Emissions Calculator	-	-	-	+	-	Global
NTMcalc Freight	+	+	+	+	+	Global
WRI Mobile Combustion GHG Emissions Calculator Tool	+	+	+	+	+	USA, UK
WPCI Carbon Footprint Calculator	+	+	-	+	+	Global

As shown in Table 41, most tools calculate all relevant GHG emissions and also indicate the resulting CO_2 equivalent emissions. Four tools only cover CO_2 emissions.

The table also evidences that all tools included in the analysis provide the calculation of transport processes (i.e. TTW emissions). Five tools consider upstream emissions as well and provide WTW emission results.

95 http://wpci.iaphworldports.org/carbon-footprinting/calc-1_2.html

Table 41 Indicators CO_2 vs. CO_2e emissions and TTW vs. WTW

Name	Greenhouse gas emissions					Upstream energy processes	
	CO_2	N_2O	CH_4	F-gases[96]	CO_2e[97]	TTW	WTW
CARBON FTA	+	-	-	-	-	+	n/s
CENEX Fleet Carbon Reduction Tool	+	-	-	-	-	+	+
ecoTransIT World	+	-	-	-	+	+	+
Map&Guide	+	+	+	-	+	+	n/s
Martrans Ship Emissions Calculator	+	-	-	-	-	+	n/s
NTMcalc Freight	+	+	+	-	+	+	+
WRI Mobile Combustion GHG Emissions Calculator Tool	+	+	+	-	+	+	-
WPCI Carbon Footprint Calculator	+	-	-	-	-	+	n/s

Most tools concentrate on transport processes only, as shown in Table 41. Some tools also provide the possibility to calculate Scope 3 emissions, i.e. the emissions that result from sub-contracted processes. Only the WPCI Carbon Footprint Calculator obliges the calculation of Scope 3 transport emissions.

Auxiliary processes are rarely covered, except for the WRI Mobile Combustion GHG Emissions Calculator. The ecoTransIT project team is currently extending the tool to also include such processes (and transhipment processes)[98].
Pre- and end-haulage processes in intermodal transport chains and in logistical networks are covered by most of the tools.

Finally, Table 42 shows that only one tool (WPCI Carbon Footprint Calculator) offers the calculation of GHG emissions other upstream processes, such as location-related processes. The project team of NTMcalc Freight is currently analysing the potential integration of infrastructure emissions.

96 E.g. through leakage of refrigerants.

97 CO_2e includes at least CO_2, N_2O, CH_4.

98 E.g. case studies are performed by DB Schenker concerning those processes in the German F&E project Green Logistics (case study 'ecoModal A').

Table 42 Indicators Transport and other upstream processes

Name	Transport processes			Other upstream processes	
	Scope 3	Auxiliary[99]	Pre-/end-haulage		
CARBON FTA	Optional	-	Optional	-	
CENEX Fleet Carbon Reduction Tool	n/a	-	n/a	-	
ecoTransIT World	Optional	-	Optional	-	
Map&Guide	Optional	-	Optional	-	
Martrans Ship Emissions Calculator	-	-	-	-	
NTMcalc Freight	Optional	-	Optional	-	
WRI Mobile Com-bustion GHG Emissions Calculator Tool	Optional	-	Optional	+	Commuting
WPCI Carbon Footprint Calculator	+	Optional	Optional	+	Transhipment, un-/loading, administration

Roughly half of the tools provide the calculation of other environmental impacts, as indicated in Table 43.

Table 43 Emissions included other than greenhouse gases

Name	CO	NO_x	PM	SO_2	Other
CARBON FTA	-	-	-	-	-
CENEX Fleet Carbon Reduction Tool	-	-	-	-	-
ecoTransIT World	-	+	+	+	NMHC
Map&Guide	+	+	+	+	HC, NMHC, NH_3
Martrans Ship Emissions Calculator	-	+	-	+	-
NTMcalc Freight	+	+	+	+	HC
WRI Mobile Combustion GHG Emissions Calculator Tool	-	-	-	-	-
WPCI Carbon Footprint Calculator	-	-	-	-	-

Issue 2: Calculation methodology

The majority of tools bases its methodology on EN 16258 or on the GHG protocol. Two of them use their own methods and for one tool no public information is available about the standard embedded. All three calculation levels are used and some tools offer multiple methods.

Depending on which level of calculation is used by the carbon footprint calculator, different input data is required for the specification (modelling) of the logistical service to be assessed. This may:

– only refer to the real consumption of an energy carrier or;
– require several specifications based on a set of offered technologies (e.g. means of transportation, fuel types, speed, and load factor).

99 E.g. shunting, taxing, idling.

Table 44 **Calculation approach of the carbon footprint tools**

Name	Embedded standard	Level of calculation	Input data for calculation (extract)
CARBON FTA	n/s	3	Vehicle class, vehicle consumption, fuel type, distance
CENEX Fleet Carbon Reduction Tool	Individual	2	Fleet specification, drive cycle
ecoTransIT World	EN 16258	1-3	Transport mode, load unit, distance, start/end point, via points, type of good
Map&Guide	EN 16258, decree 1336	2	Fleet specification, start/end point, via points
Martrans Ship Emissions Calculator	Individual	2,3	Ship type, ship size, fuel type, distance, stops, load
NTMcalc Freight	EN 16258 (ongoing)	1-3	Vehicle class, distance, load
WRI Mobile Combustion GHG Emissions Calculator	GHG protocol	1-3	Transport mode, vehicle type, fuel consumption, distance
WPCI Carbon Footprint Calculator	GHG protocol	1-3	Fuel consumption, speed, distance

Remark on level of calculation: Method using (1) default performance based emission factors, (2) vehicle emission factors, and (3) measured vehicle fuel consumption.

The applied datasets used in the respective tools are specified in Table 45. The list shows, that even for the same transport carrier, different data sets are used, e.g. for road both DEFRA and HBEFA are used.

Moreover, the column 'Type of transport means' in shows that the offered numbers of technologies varies. This implies that different aggregation approaches have been used with a particular original dataset. The HEBFA dataset is for example aggregated in 5 (ecoTransIT) or 12 (NTMcalc Freight) truck classes.

Table 45 **Default values**

Name	Data sets used	Type of transport means
CARBON FTA	Road: DEFRA	Road #5
CENEX Fleet Carbon Reduction Tool	Road: DEFRA	n/s
ecoTransIT World	Road: HBEFA 3.1, rail: own data, marine: IMO GHG, inland waterways: Planco, air: EEA EMEP	Road 5#, rail 5#, marine 25#, inland waterway 4#, air 34#
Map&Guide	Road: HBEFA 3.1	Road >8#
Martrans Ship Emissions Calculator	EMEP/CORINAIR, IMO GHG Study	Marine 26#
NTMcalc Freight	Road: HBEFA, rail: UIC/ecoTransIT modified, sea: IMO EEDI, air: PIANO	Road 12#, rail 5#, marine 6#, air 6#
WRI Mobile Com-bustion GHG Emissions Calculator Tool	DEFRA, EPA, IPCC	Road >10#, rail 6#, marine 10#, air 12#
WPCI Carbon Footprint Calculator	Port of Los Angeles Inventory of Air Emissions Report	Road 6#, rail 1#, marine 20#, inland waterway 1#

Finally, the possibility to specify the real distance of a transport service is incorporated in the majority of the tools. In addition, two of these tools (i.e. ecoTransIT, NTMcalc Freight) also have an own routing option in case the distance information is not available.

Table 46 **Applied routing in the carbon footprint tools**

Name	Tool's routing	Default route	Via point	Real distance
CARBON FTA	-	-	-	+
CENEX Fleet Carbon Reduction Tool	-	-	-	+
ecoTransIT World	+	-	+	-
Map&Guide	+	-	+	-
Martrans Ship Emissions Calculator	-	+	-	+
NTMcalc Freight	+	-	-	+
WRI Mobile Combustion GHG Emissions Calculator Tool	-	-	-	+
WPCI Carbon Footprint Calculator	-	+	-	+

As described beforehand, the calculation can be performed for various levels, such as per company or per service. Two tools (ecoTransIT, NTMcalc Freight) offer the possibility to allocate emissions to a specific client or shipment and therefore have the highest aggregation level.

Table 47 **Allocation options**

Name	Declaration of carbon footprints per			
	Company	Transport mean	Shipment	Client
CARBON FTA	+	+	n/s	n/s
CENEX Fleet Carbon Reduction Tool	+	+	n/s	n/s
ecoTransIT World	+	+	+	+
Map&Guide	+	+	n/s	n/s
Martrans Ship Emissions Calculator	-	+	-	-
NTMcalc Freight	+	+	+	+
WRI Mobile Combustion GHG Emissions Calculator Tool	+	+	-	-
WPCI Carbon Footprint Calculator	+	-	-	-

Issue 3: Transparency and declaration rules

As evidenced in Table 52, most tools provide information on their methodologies and assumptions. However, the manner in which this information is provided varies substantially. In some cases, the methodology is well documented, but sometimes it is completely lacking.

Table 48 Indicators on transparency and declaration

Name	Applied scope of CF	Data used	Allocation rules used	Assumptions, simplifications made
CARBON FTA	+	+	No allocation	-
CENEX Fleet Carbon Reduction Tool	+	+	No allocation	+
ecoTransIT World	+	+	+	+
Map&Guide	+	+	-	-
Martrans Ship Emissions Calculator	+	+	+	+
NTMcalc Freight	+	+	+	+
WRI Mobile Com-bustion GHG Emissions Calculator Tool	+	+	No allocation	+
WPCI Carbon Footprint Calculator	+	+	+	+

Issue 4: Credibility and usability

Tools differ with respect to their credibility and usability as well. Some tools can be accessed for free on internet or downloaded (e.g. Excel-tool). Tools modelling more complex logistic systems, usually charge a fee.

Table 49 shows that many tools have been developed for a limited group of stakeholders. Only two tools (NTMcalc freight and WRI) have offered an open and free participation to the stakeholders. All tools are designed for business use.

Finally, it should be noted that all tools have been recently reviewed and updated with the latest developments as regards the methodology (e.g. with the CEN standard).

Table 49 Indicators related to credibility and usability

Name	Accessibility	Stakeholder involvement	Applicability	Actuality
CARBON FTA	Free	Low	Business	2011
CENEX Fleet Carbon Reduction Tool	N/s	Low	Business	2011
ecoTransIT World	Free basic version & license	Medium	Business	2013
Map&Guide	License	Low	Business	2013
Martrans Ship Emissions Calculator	Free	Medium	Business	2008
NTMcalc Freight	Free basic version & membership	High	Business	2010
WRI Mobile Combustion GHG Emissions Calculator Tool	Free	High	Business	2013
WPCI Carbon Footprint Calculator	Free basic version & license for full version	Medium	Business	2010

C.9 Passenger transport

Several tools exist for passenger transport and the ten most popular ones have been included in the analysis. Such tools are often used for carbon offsetting activities or are linked to travel planners of public transport operators.

Table 50 summarises the tools that have been analysed.

Table 50 Introduction of carbon footprinting tools for passenger transport

Tool	Description	MS
Bilan Carbone[100]	The **Association Bilan Carbone** (ABC) was founded in July 2011 and developed this tool, which is the most-widely used GHG emission accounting system in France. The tool was developed between 2004-2011 and has been promoted by ADEME until 2011. The tool plays a significant role in the implementation of **French legislation**. Note that it also covers freight transport. However, as there are more internationally applied tools for the freight sector, this tool has been analysed for passenger transport only.	FR
Carbon footprint[101]	**Carbon footprint** is a private business offering carbon footprinting software to businesses and a free carbon footprinting tool for individuals.	UK
Carbon Fund[102]	**Carbon Fund** is a non-profit carbon offsetting organisation in the United States. Its website provides different GHG calculators including some calculators for cars, flights and train/bus.	US
Ecopassenger[103]	Ecopassenger is an internet-based tool and was developed by the **UIC** in cooperation **UIC members**, **Ifeu** (the German Institute for Environment and Energy) and **IVEmbH** (routing system and software). Ecopassenger is the passenger version of EcoTransIT: both tools have been developed by a roughly the same team.	EU
ICAO[104]	The **International Civil Aviation Organisation** (ICAO) has developed a calculation methodology for CO_2 emissions from air travel and can be used in offset programmes.	World
Native energy[105]	**Native Energy** is a carbon offsetting organisation founded in 2000 in Vermont, the United States and provides carbon accounting software.	US
NS[106]	The Dutch railway operator NS **(Nederlandse Spoorwegen)** included the option to calculate CO_2 emission savings in its online route planner.	NL
Routerank[107]	**Routerank** is a business, which provides software for carbon footprinting calculations.	Switzerland
STREAM[108]	STREAM is a guideline initiated by different transport organisations and operators	NL

100 http://www.associationbilancarbone.fr/en

101 http://www.carbonfootprint.com/

102 https://www.carbonfund.org/

103 http://ecopassenger.com/

104 http://www2.icao.int/en/carbonoffset/Pages/default.aspx

105 http://www.nativeenergy.com/travel.html

106 http://www.ns.nl/over-ns/campagnes/maatschappelijk-betrokken/energie.html

107 http://www.routerank.com/nl/

Tool	Description	MS
	and was developed by **CE Delft**. The STREAM project covers both passenger and freight transport in separate reports.	
Transport Direct[109]	**Transport Direct** is a multimodal route planner in the United Kingdom offering the option to also calculate GHG emissions of planned trips.	UK
Travel footprint[110]	Travel Footprint is owned by the **Clear Zones Partnership** initiated by the London Borough of Camden and offers an online tool to calculate travel emissions. The tool, developed by Ecolane Transport Consultancy, has been funded by Transport for London and the Department of Environment, Food and Rural Affairs (DEFRA).	UK

The results of the analysis are presented below.

Issue 1: System boundaries and scope

Only two tools include the whole range of passenger transport modes. As is shown in Table 51, passenger cars, rail, air and bus are almost always included in the tools, while trams and metro are less often covered. In most cases the transport modes are included as single-mode options. Some transport operators, especially those included in route planners, can provide GHG emissions for multi-modal journeys.

Table 51 Indicators passenger transport modes and geographical scope of passenger transport CF-calculators

Name	Transport mode							Geographical scope
	Car	Rail	Air	Bus	Tram	Metro	Ferry	
Bilan Carbone	+	+	+	+	+	+	+	To and from France
Carbon Footprint	+	+	+	+	+	+	-	Worldwide
Carbon Fund	+	+	+	+	-	-	-	US
Ecopassenger	+	+	+	-	-	-	-	EU
ICAO	-	-	+	-	-	-	-	Worldwide
Native energy	+	+	+	+	-	-	-	US
NS	+	+	-	-	-	-	-	NL
RouteRANK	+	+	+	+	+	+	-	worldwide
STREAM	+	+	+	+	+	+	-	NL
Transport Direct	+	+	+	+	+	+	+	UK
Travel footprint	+	+	+	+	-	+	-	UK

With respect to the geographical scope of the tools, only one tool is limited to national routing. The majority of tools also include international journeys (mainly flights) in the calculations. Most tools are based on national data, using country-specific default values for the emissions resulting from electricity generation for example.

108 CE Delft, STREAM Personenvervoer 2014, http://www.cedelft.eu/publicatie/stream_passenger_transport_2014/1481

109 http://www.transportdirect.info/Web2/Home.aspx?&repeatingloop=Y

110 http://www.travelfootprint.org/

Table 52 shows that most tools only include TTW CO_2 emissions. Only a few calculation tools cover other GHG emissions and therefore report CO_2e emissions (e.g. Travel Footprint).

Table 52 Indicators CO_2 vs. CO_{2e} emissions and TTW vs. WTW

Name	Greenhouse gas emissions					Upstream energy processes	
	CO_2	N_2O	CH_4	F-gases[111]	CO_2e[112]	TTW	WTW
Bilan Carbone	+	-	-	-	+	+	+
Carbon Footprint	+	-	-	-	+	+	-
Carbon Fund	+	-	-	-	-	+	-
Ecopassenger	+	-	-	-	-	+	+
ICAO	+	-	-	-	-	+	-
Native energy	+	-	-	-	-	+	-
NS	+	-	-	-	-	+	-
RouteRANK	+	-	-	-	+	+	+
STREAM	+	-	-	-	+	+	+
Transport Direct	+	-	-	-	-	+	-
Travel Footprint	+	+	+	-	+	+	+

Most tools do not take into account other upstream processes, such as the production and maintenance of vehicles and infrastructure. Scope 3 emissions are optional in the Bilan Carbone tool. Travel Footprint also covers the emissions associated with the vehicle life-cycle (incl. vehicle manufacture, assembly and disposal), and RouteRank includes other upstream emissions broader than those related to energy generation).

Table 53 shows that three of the tools also cover air pollutants in their calculation.

Table 53 Emission included other than greenhouse gases

Name	CO	NO_x	PM	SO_2	Other
Bilan Carbone	-	-	-	-	-
Carbon footprint	-	-	-	-	-
Carbon Fund	-	-	-	-	-
Ecopassenger	-	+	+	-	VOC
ICAO	-	-	-	-	-
Native energy	-	-	-	-	-
NS	-	-	-	-	-
RouteRANK	-	-	-	-	-
STREAM	-	+	+	+	VOC
Transport Direct	-	-	-	-	-
Travel footprint	-	+	+	-	-

111 E.g. through leakage of refrigerants.

112 CO_2e includes at least CO_2, N_2O, CH_4.

Issue 2: Calculation methodology

Table 54 summarises the main characteristics of the tool with respect to their calculation methodology.

In general, most carbon footprinting tools work with average values for vehicles including an assumption for the occupancy rate, which can be classified as Level 1. This can be explained by the fact that passenger transport often covers the public transport modes, and the users of this tool generally do not know what is the vehicle performance details. On the contrary, users have better knowledge of their own car and can better indicate the performance and occupancy rate. Travel Footprint is the only tool with the possibility to calculate fleet emissions based on actual fuel consumption and can therefore also be classified as Level 3.

Table 54 Calculation approach of the carbon footprint tools

Name	Embedded standard	Level of calculation	Input data for calculation (extract)
Bilan Carbone	N.a.	1-3	Distance, vehicle type
Carbon Footprint	In line with DEFRA's Voluntary Reporting Guidelines	1	Origin-destination, # trips, class, mileage, vehicle type or vehicle efficiency, bus and rail: # km,
Carbon Fund	N.a.	1	Type of vehicle (year, make, model, specs), annual mileage, # of passengers
Ecopassenger	N.a.	1	Origin-destination, vehicle type
ICAO	2006 IPCC Guidelines for National Greenhouse Gas Inventories	1	Origin-destination, #passengers, class, type of trip
Native energy	GHG protocol	2	Origin-destination or actual mileage, vehicle size or vehicle fuel efficiency, frequency of trip, trip type
NS	N.a.	1	Origin-destination of rail trip
RouteRANK	N.a.	1	Origin-destination, type of car, fuel type
STREAM	N.a.	1[113]	Distance, vehicle type
Transport Direct	N.a.	1	Origin-destination (route planner), distance, mode, # occupants
Travel footprint	Based on Life Cycle Assessment of Vehicle Fuels and Technologies (2006)	1-3	Origin-destination, fuel consumption, vehicle type in combination with fuel type, #occupants, diet (walking/cycling), use of vehicle (urban, domestic, etc.), age of bus

Remark on level of calculation: Method using (1) default performance based emission factors, (2) vehicle emission factors, and (3) measured vehicle fuel consumption.

[113] Level 2 and 3 are possible as well.

As explained earlier, Level 1 and Level 2 calculations use default values. However, as not all tools make use of the same set of default values, as shown in Table 55. Some datasets are used more frequently, such as the dataset of the IPCC and of Ecoinvent.

The right column 'type of transport means' presents the level of aggregation by indicating the number classes included in a tool. In line with the argumentation above there exists more variety in the types of personal travel modes (e.g. car and motor cycles), as users are better able to specify these transport modes.

Table 55 Default values

Name	Data sets used	Type of transport means
Bilan Carbone	ADEME's 'Base Carbone' database, CORINAIR and MEET, OACI,	No tool, database of emissions factors should enable the user to calculate each option
Carbon Footprint	Department for Environment, Food and Rural Affairs (DEFRA) – UK, World Resource Institute (WRI), Greenhouse Gas (GHG) Protocol, Vehicle Certification Agency (VCA) – UK, US Environmental Protection Agency (EPA) – USA, US Department of Energy (DOE) – USA, Green House Office – Australia, Standards Association (CSA) GHG Registries - Canada	Car: high number due to detailed input , motor cycle #4, van #10 Airplane, bus and train: vehicle type determined by tool
Carbon Fund	EIA, EPA Climate Leaders, IPCC	Car: high number due to detailed input Airplane, bus and train: vehicle type determined by tool
Ecopassenger	Ecoinvent 2006, Railenergy database, Eurelectric 2005, COPERT 4 model/LAT 2006, Rail Diesel project/UIC 2005/; UmweltMobilCheck/IFEU 2006/EMEP/CORINAIR Emission Inventory Guidebook – 2006	Average car, airplane and train
ICAO	Airlines multilateral schedules database (AMSD), EMPE/CORINAIR	Airplane (type determined by tool)
Native energy	GHG Protocol, U.S. Department of Transportation, Federal Highway Administration, Highway Statistics (Washington, DC: Annual issues), Intergovernmental Panel on Climate Change (IPCC)1999,	Car #2 Bus, airplane and trains: vehicle type determined by tool)
NS	MilieuCentraal	Rail, compared to car #12
RouteRANK	EcoInvent, IFEU Heidelberg	Car #3
STREAM	Eocinvent, Taakgroep Verkeer, Ecotransit	No tool, report should enable the user to calculate each option
Transport Direct	DEFRA, RAC Motoring Services(2012)	Car #2, average bus, train, coach, and airplane
Travel Footprint	Based on Life Cycle Assessment of Vehicle Fuels and Technologies (2006), European Cleaner Drive	Car #5,, fuel type #7 motor cycle #7, bus #9, train #6, plane #3

	Rating system	

In order to make a realistic estimation of the carbon footprint the applied routing is also important. A calculation based on real distances will result in the most accurate result. However, a tool's own routing enables the user to operate the tool if he/she has no knowledge of the distance travelled.

Table 56 shows that in most tools, the routing is based on an own methodology. This is Google Maps in most case, in combination with correction factors. Correction factors intend to adjust the routing of Google Maps to generate a more realistic estimation of the distance travelled.

Table 56 **Applied routing in the carbon footprint tools**

Name	Tool's routing	Default route	Via point	Real distance	No routing
Bilan Carbone	-	-	-	-	+
Carbon Footprint	+	-	-	-	+
Carbon Fund	+	-	-	-	-
Ecopassenger	+	-	-	-	-
ICAO	+ (GCD + correction)	-	-	-	-
Native energy	+ (Google + 15% for detouring)	-	-	+	-
NS	+	-	-	-	-
RouteRANK	+	-	-	-	-
STREAM	-	-	-	-	+
Transport Direct	+	-	-	-	-
Travel Footprint	+	-	-	-	+

Calculation tools for passenger transport can generate carbon footprints on three main levels: per company, transport mean or for per client. Carbon footprinting tools appear to mainly present their outcomes at the client level (e.g. at the passenger level), as shown in Table 57. This is the most relevant level for passengers as most users will be individual travellers.

Table 57 **Allocation options**

Name	Declaration of carbon footprints per		
	Company	Transport mean	Client
Bilan Carbone	-	-	+ (per pkm, per transport service)
Carbon Footprint	+ (not free)	-	+
Carbon Fund	-	-	+
Ecopassenger	-	-	+
ICAO	-	-	+
Native energy	+ (not free)	+	+
NS	-	-	+
RouteRANK	+ (not free)	-	+
STREAM	+	+	+
Transport Direct	-	-	+
Travel Footprint	+ (fleet)	+	+

Issue 3: Transparency and declaration rules

Table 58 shows on which aspects of their methodology and assumptions tools have provided information. As was the case for freight transport, most tools provide information on all aspects and hence, the level of transparency is relatively high. Especially larger initiatives, like Ecopassenger and Travel Footprint mostly provide a detailed methodology description, while smaller initiatives generally have a more limited description and list of references. Although the applied scope is often not mentioned for these tools, it can be concluded from the calculation results that only TTW emissions are included.

Table 58 Indicators on transparency and declaration

Name	Applied scope of carbon footprint	Data used	Allocation rules used	Assumptions and simplifications made
Bilan Carbone	+	+	+	+
Carbon Footprint	-	+	+	+
Carbon Fund	-	+	+	+
Ecopassenger	+	+	+	+
ICAO	+	+	+	+
Native energy	+	+	-	+
NS	+	+	+	+
Routerank	+	+	+/-	+/-
STREAM	+	+	+	+
Transport Direct	+	+	+	+
Travel Footprint	+	+	+	+

Issue 4: Credibility and usability

The accessibility of the tools is quite high, as most tools can be accessed freely. This results from the fact that most tools are aimed to inform users of public transport or are aimed at carbon offsetting. Most tools also offer a version for businesses, which requires a licence.

Table 59 Indicators related to credibility and usability

Name	Accessibility of tool/standard	Consensus of relevant stakeholders	Applicability independent of company's size	Sufficient frequency of actualisation
	Free/partially free/access fee or licence required	High or low involvement of stakeholders		Year of last actualisation
Bilan Carbone	Database distinguished different levels of access (some parts are only accessible for	+	+ (obligation)	Annually/continuously as laid down in legislation

Name	Accessibility of tool/standard	Consensus of relevant stakeholders	Applicability independent of company's size	Sufficient frequency of actualisation
	trained people)			
Carbon Footprint	Partially free	n.a.	+	+ (2013)
Carbon Fund	Free	n.a.	+ <20 employees also)	N.a.
Ecopassenger	Free	high	n.a.	N.a.
ICAO	Free	Medium	N.a.(only relevant for individual passengers)	Annually
Native energy	Partially free	N.a.	+	N.a.
NS	Free	N.a.	N.a. (only relevant for individual passengers)	N.a.
RouteRANK	Partially free	N.a.	+	N.a.
STREAM	Free	Medium	+	New publication in 2014
Transport Direct	Free	N.a.	N.a.	2010 (DEFRA data)
Travel Footprint	Free	High	+	Working on update

C.10 Towards a harmonised carbon footprint methodology

C.10.1 Evaluation of the tools

The analysis in the previous section will be summarised for each of the four main categories needed for future harmonisation.

In general, it is important to point out that the focus of this study is on carbon footprinting at the *service level*. This is a complex topic in particular for the freight transport, where only few tools can allocate the emissions to different clients. For passenger transport this is much easier and hence, most tools allocate emissions to the service level.

Comparability of system boundaries and scope

In general, large differences in the scope of the tools have been identified. While some of the tools cover all relevant transport modes, others focus on a specific mode, making comparison of different modes very difficult.

For freight transport, most tools cover both TTW as well as WTW emissions, while most tools for passenger tools are limited to TTW emissions. For some tools (both passenger and freight-related), the methodological description is not clear on the inclusion of upstream emissions, while this is important for a fair comparison across modes. Especially, tools covering only one mode do not clearly indicate the inclusion of upstream energy processes.

Most of the freight tools cover all GHG emissions and hence, only a few tools still concentrate on CO_2 emissions. The geographical scope of the tools is very different, and linked to the default data used in the tools. Passenger tools mostly focus on a specific country and include international emissions in case of international modes (air, rail).

These main conclusions indicate that a lot of effort is still need to harmonise carbon footprinting tools. The relative differences are larger in freight transport than in passenger transport.

Comparability of calculation methodology

Most of the tools are based on the CEN standard or on the GHG protocol, which is beneficial for their comparability. However, even when based on the same standard, calculation methods still differ significantly. All three methodological levels have been incorporated in at least some tools, and each tool uses different vehicle fuel consumption databases, vehicle classes, and default values. The deviations are particularly large for the non-road transport modes.

In some of the tools, the real distance travelled is used as input value, while in other tools (especially those that focus on passenger transport) calculate the distance and routing with integrated navigation systems. This can also cause divergences.

As was the case for the boundaries of the carbon footprints, a lot can still be gained in the alignment of the methodologies that have been applied.

Transparency and declaration rules

For some tools, a clear and complete description of the methodology and assumptions is missing. EcotransIT World has found a well-balanced approach for transparency. The tool and general methodology are available to the general public, but the software that can be integrated in the company's IT-system requires a membership.

The passenger tools are generally more transparent than freight tools and do usually describe the calculation methodology applied.

Reflection of reality

One main point of criticism about the carbon footprints of transport services has been the insufficient reflection of real world emissions. All tools that have been evaluated use at least some default data, in some cases only as a back-up option. This is caused by the limited availability of real world data, which is especially problematic for non-road modes. At the same time, most tools are built upon the same databases. For road freight transport, HBEFA 3.1 and DEFRA are the only databases incorporated in the tools for example. However, various ways of interpretation and aggregation (vehicle classes, road types, gradients) can lead to a different use of the datasets.

C.11 The stakeholders' opinion

The necessity for harmonising existing approaches for carbon footprint calculations of logistical services was discussed with the stakeholders during one of the stakeholder workshops (held in Brussels on November 29th 2013). Stakeholders agreed that the reliability and comparability of tools and methodologies is insufficient and results in a distorted level playing field between and within transport modes.

The reliability and comparability of tools and methods are considered to be insufficient because the results are a poor reflection of real world emissions, the verification and transparency of underlying data is unclear[114], and because the tools vary in scope[115].

Stakeholders have the following requirements for carbon footprint calculators:
- use of a harmonised methodology;
- use of a Level 3 calculation methodology that allows benchmarking;
- a higher level of detail for existing standards on a global level;
- develop solutions that integrate the whole logistical services and associated processes into the company’s transport management and IT-systems; and
- develop clear (possibly sector-specific) guidance for usage.

The following benefits of harmonised benchmarking of carbon footprints were outlined by the stakeholders:
- possibility to monitor emissions of complex logistical processes;
- possibility to benchmark emissions and improve carbon efficiency;
- increased awareness for carbon management and low carbon solutions.

C.12 Next steps to harmonise carbon footprints

Based on the extensive analysis presented in this annex, it can be concluded that alignment is still needed in several areas.

With respect to the scope and methodology of carbon footprints, decisions need to be made on the inclusion or exclusion of specific:
- geographical areas, and their related specification;
- transport modes;
- routing methodologies implemented in navigation software;
- logistics operations and logistics chain elements, i.e.:
  - transport processes;
  - auxiliary and location-related processes;
  - administration, business travel, commuting.
- phases of the life-cycle:
  - energy processes (WTT/WTW);
  - production, maintenance, and end-of-life phase of equipment (e.g. means of transport, transhipment technologies) and facilities (e.g. warehouses).
- other GHG emissions;
- verification requirements when company-specific calculations and real-world data are exchanged (Scope 3);
- up-to-date use of a particular default datasets for the complete carbon footprint, depending on the calculation level chosen;
- integration of Scope 1 to 3 processes according to the GHG Protocol
- an allocation method with satisfying rules for:
  - modes;
  - services (e.g. passenger vs. freight, mass vs. volume goods), loading units, shipment’;
  - roles within supply chain (e.g. responsibility for empty runs);

[114] Set of emission factors and default values, used activity data, accuracy level of data used.

[115] Well-to-tank, tank-to-wheel ; scope 1-3; non-transport processes; national/European/global scope.

- allowances concerning the usage of renewable energy and material, recycling processes;
- marginal accounting.

Transparency and verification
Besides the verification and validation of calculated carbon footprints (e.g. by external parties), the interpretation and possible comparison of results requires a significant level of transparency of the carbon footprints.

The future methodology should, therefore, be accompanied with a generally accepted set of declaration rules for carbon footprint calculations covering issues such as:
- applied scope of carbon footprint;
- data used;
- allocation rules used; and
- assumptions and simplifications made.

Credibility and usability
The process of harmonisation and development of a generally accepted carbon footprint methodology for logistics services should, furthermore, aim at the following aspects:
- consensus of relevant stakeholders:
  - companies along the supply chain (shippers and logistics/transport service providers);
  - government and standardisation organisations;
  - science and non-governmental organisations.
- applicability independent of company size:
  - global players such as large logistics service providers;
  - small and medium sized enterprises.
- harmonised implementation of a method within calculators, e.g.:
  - specification of minimum criteria;
  - auditing scheme for tools.
- free and accessible availability of methodology and guidance, dependent on:
  - target group/stakeholder;
  - language.
- sufficient frequency of actualisation.

Annex D The costs of carbon footprint reporting

This annex provides some examples of the fees charged by carbon footprint initiatives and tools. The tables below indicate that fees are often dependent on the annual turn-over of the company, although different categories are distinguished. It also can be seen there that some initiatives/tools do not demand a fee from very small companies.

Table 60 Green Freight Europe annual fees

Green Freight Europe		
Type of company	Annual turn-over	Annual fee
Very small	< 2.5 M €	0 €
Small	2.5 M € to 7.5 M €	1,500 €
Medium	7.5 M € to 15 M €	3,000 €
Large	> 15 M €	6,000 €

Table 61 EcoTransIT World annual fees

EcoTransIT World		
	Annual turn-over	Annual fee
User license for EcoTransIT as Software as a Service (SaaS)	< 150 M €	6,500 €
	150 M to 1B €	8,000 €
	> 1B €	9,500 €
Member of the EcoTransIT World Initiative	< 150 M €	9,000 €
	150 M to 1B €	10,500 €
	> 1B €	12,000 €

Table 62 Clean Cargo Working Group annual fees

Clean Cargo Working Group[116]		
Type of company	Annual turn-over	Annual fee
Associate Membership	Only available to companies with annual gross revenues of less than US$1 Billion, or to non-company organizations (e.g., NGOs, non-profits, and academic institutions)	US$ 2,500
Corporates	<1 B US$	US$ 5,000
	1-5 B US$	US$ 11,000
	5-10 B US$	US$ 16,500
	10-20 B US$	US$ 22,000
	20-50 B US$	US$ 27,500
	> 50 B US$	US$ 33,000

[116] Clean Cargo Working Group has developed industry-leading calculation and reporting methodologies for carriers in the maritime sector to report environmental performance data to their customers. It includes data from 16 of the world's leading ocean carriers and more than 2,300 ships, representing more than 60 percent of global ocean container capacity.

One of the interviewees, representing a company with €B 1.2 turn-over, 6,000 employees, and 18.3 trillion tonne-km, declared total costs of € 12,000 for the EcoTransit affiliation plus an additional € 40,000-50,000 for the implementation of an IT-system.

Another interviewee, representing a company with €M 70 turn-over and 300 employees experienced costs of € 20,000-25,000 for setting-up the carbon footprinting system and an additional € 5,000-7,000 for data monitoring and reporting.

Some other interviewees indicated to use an in-house developed tool which is often based on XLS systems. This requires a lot of manual work in terms of data-gathering from different sources.

Passing costs on to clients?

In theory, a company could pass on the costs related to carbon footprinting to its consumers. However, evidence from literature seems to suggest that this is unlikely in practice. Lieb and Lieb (Lieb & Lieb, 2010)indicate that 77% of the buyers will not purchase a logistical service that costs 5% more than its competitors but that proved to be more environmentally sustainable. Hence, transport operators will be careful with raising their transport price.

Evidence can also be found in a study of Wolf and Seuring (Wolf & Seuring, 2010). They report a case study between a 3PL and one of its customers. This particular customer was interested in receiving an emission calculation of its shipment for establishing a CO_2 footprint. The 3PL was able and willing to provide this information, which was initially done free of charge. However, as the number and complexity of the calculations increased, the 3PL asked for a reimbursement of the related costs. The shipper agreed to pay for these costs, which were negligible compared to other expenditures of the company (total costs were € 10,000 per year). However, in the next contract negotiation, the shipper withdrew its acceptance and demanded that any additional costs due to the carbon footprint were not charged in the transport price. Hence, the 3PL had to pay these costs to maintain the customer.

The interviewees consulted for this study confirmed that the costs of carbon footprinting are unlikely to be passed on to their clients.

Annex E The ASTRA model

E.1 Introduction

In this annex, model calculations made with the ASTRA model to roughly estimate the impact of carbon footprinting are presented. This is preceded by a model description.

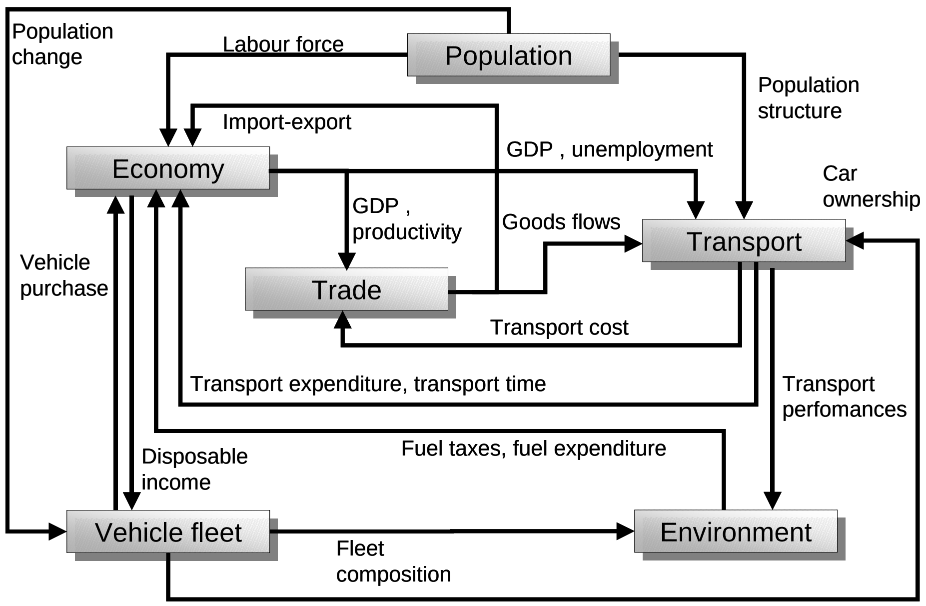
E.2 The model

ASTRA (ASsessment of TRAnsport Strategies) is an integrated assessment model developed and maintained by Fraunhofer-ISI and TRT. It has been applied since more than 10 years for strategic policy assessments in the transport and energy field. ASTRA is based on the System Dynamics approach and was built in Vensim®. The model covers EU-27 Countries plus Norway and Switzerland and runs until 2050[117].

For this application the ASTRA-EC version has been used. ASTRA-EC has been developed within the 'ASSIST project', in which a dedicated version of the ASTRA model was built for the European Commission.

ASTRA-EC includes different modules. The main models are: a population module, an economic module, a trade module, a transport module, a fleet module, and an environmental module. Their relationships are shown in Figure 16.

Figure 16 The ASTRA model



Source: TRT/Fraunhofer-ISI.

117 For detailed information on ASTRA the reader is referred to the ASTRA website: http://www.astra-model.eu/index.htm

A key feature of the ASTRA-EC as an integrated assessment model is that the modules are linked together. Changes in one system are thus transmitted to other systems and can feed-back to the original source of variation.
For instance, changes in the economic system immediately feed into changes of the transport behaviour and alter origins, destinations and volumes of European transport flows. In turn, micro and macro effects are related, and hence, changes in the transport system feed back into the economic system e.g. changes in consumption behaviour of households or changes in the sectorial inter-change of intermediate goods and services.

Since all modules are part of the same dynamic structure, the whole model is simulated at the same time. The most appealing consequence is that there is no need of iterations to align the results of the various modules. All parts of the model are always consistent with each other throughout the whole simulation.

As ASTRA is a strategic model, the various covered domains are aggregated. For instance, ASTRA does not include a representation of the logistics chain nor does it include a description of the structure of transport sector (e.g. number of operators, their size, etc.). The modelling of passenger and freight transport modes results from computing the modal split of geographically distributed transport demand (e.g. local demand within one region or international demand between two countries) amongst the available alternatives. The modal split depends mainly on transport costs and transport times associated with each alternative. In turn, transport costs depend on various elements like operating costs (e.g. driving cost, energy cost), load factors, charges, and so on. Transport times depend on infrastructure performance and are affected by congestion.

The elements affecting transport costs and times are exogenous parameters that can be used to simulate the impact of policy measures (or other exogenous changes). For instance, a policy measure affecting the efficiency of the logistics chain can be modelled through an increase of the load factors of freight vehicles. These exogenous changes have an impact on the model results. The changes stem from the variables immediately affected by the exogenous changes (e.g. the modal split reactions are directly influenced by a variation in transport costs) and propagate throughout the model via the complex linkages and feedback effects modelled. Examples of second-order effects generated in the model are explained below:

- A modal shift implies a different transport performance by mode, which results in different levels of energy consumption and emissions. Changes in the consumption of energy also have an economic impact as a different share of income is absorbed by transport. Therefore the amount of resources available for other consumptions will be impacted as well. Since value-added by the sector is not the same, this consumption shift can generate an effect on economic growth and employment.
- A modal shift also implies a different level of investment in transport means (e.g. in trucks, rail rolling stock) which also has consequences for economic growth (e.g. due to different levels of productivity for those sectors producing transport means).
- A change in transport costs influences the Total Factor Productivity of the economy and therefore the economic growth. In turn, economic growth affects transport demand.
- Improved load factors reduce the vehicles-km corresponding to a given amount of demand and reduce the transport cost per unit. Modal split and environmental and economic second-order effects may occur as a result.

ASTRA is therefore capable to provide a range of different indicators to assess the impact of policy measures, provided that such measures can be meaningfully translated into a change of one or more input parameters of the model.

Given the expected impacts of the Policy Options on carbon footprinting, the use of ASTRA for the sensitivity analysis was focused on modifying three main parameters of the model, resulting in four tests:

- the speed of the renewal of the fleets is increased (light and heavy duty vehicles as well as buses) in order to simulate a faster renewal of the fleet;
- the operating costs of trucks are reduced in order to simulate an improved efficiency of transport operators due to carbon footprinting;
- the operating costs of trucks are increased in order to simulate increased administrative costs for transport operators;
- the average load factors of trucks are increased in order to simulate a higher efficiency in the logistics chain through an optimisation of routes.

E.3 Test results

The results of the four tests are described in the next sub-sections.

Test 1 – Speed-up of fleet renewal

This test has been performed to assess what impacts might derive from an increased awareness of the environmental performance of transport, which can potentially lead to a faster fleet renewal. It is assumed that, from 2015 onwards, operators will renew their vehicle fleet 5%/year faster than in the reference scenario[118].

The results show that in this case, the composition of the fleet changes in the initial years of the simulation[119], while in the longer-term the renewal of the fleet occurs in both the simulation and in the reference. A faster renewal of the fleet has a positive effect on the economic growth, as higher levels of investment result and demand for products in some other sectors also increases. However, the overall strength of the impulse generated by the acceleration of the disposal of older road vehicles is small[120]. Therefore, the impact on GDP and employment is negligible, as is also shown in the following tables.

Table 63 Impact on GDP – Comparison with reference case

	2020	2030	2040	2050
GDP EU-27	0.0195%	0.0302%	0.0540%	0.0538%

118 In modelling terms, the increase of the renewal rate is differentiated according to the average age of the vehicle fleet: higher for older vehicles and lower for newer vehicles.

119 The reference scenario considered for the modelling tests is the reference scenario calibrated in the ASSIST project (Krail, et al., 2014). This scenario is consistent with the latest projections reported by European Commission (EC, 2013).

120 Furthermore ASTRA – like other mainstream economic models – does not model preferences for liquidity or financial investments and therefore any increase of consumption or investment in one sector is balanced by a reduced consumption or investment in other sectors. The net effect on the economy results from different contributions of sectors to the value-added. However, in the case of the scenarios simulated in this sensitivity analysis this aspect is not significant. The effect on the economy is negligible as the strength of the impulse generated by a faster renewal of the commercial fleet is weak.

Table 64 **Full time equivalent employment EU-27- Comparison with reference case**

	2020	2030	2040	2050
Employment	0.0056%	0.0051%	0.0063%	0.0049%

The small increase of economic activity results in an equally small increase of transport activity, as shown in the tables below. The strength of the growth differs between countries, as their economic structure differs. Since the initial mode shares are also different in each country the impact is not uniformly distributed across transport modes. However in practical terms, both the overall demand and the modal split can be considered as unchanged.

Table 65 **Impact on passenger transport activity EU-27 [pkm] – Comparison with reference case**

	2020	2030	2040	2050
Car	0.00092%	0.00050%	0.00030%	-0.00002%
Bus	-0.00003%	0.00006%	-0.00006%	-0.00021%
Train	0.00159%	0.00120%	0.00111%	0.00039%
Air	0.00142%	0.00069%	0.00052%	-0.00003%
Slow	0.00011%	0.00012%	0.00021%	0.00024%
Total	0.00090%	0.00052%	0.00037%	0.00002%

Table 66 **Impact on freight transport activity EU-27 [tkm] – Comparison with reference case**

	2020	2030	2040	2050
Road	0.0067%	0.0080%	0.0116%	0.0134%
Rail	-0.0185%	-0.0013%	0.0034%	0.0093%
Maritime	-0.0052%	-0.0014%	-0.0005%	-0.0003%
IWW	0.0000%	0.0000%	0.0000%	0.0000%
Total	-0.0002%	0.0034%	0.0060%	0.0075%

Air polluting and GHG emissions are slightly reduced as a consequence of the faster renewal of the fleet although this impact is very small (see Table 67). The reduction of the different air pollutants differs as the contribution of commercial vehicles to these emissions is different. The impact is relatively largest for PM and NOx and the largest effect appear in the beginning of the modelling (as this is also when the fleet composition changes).

The economic value of the CO_2 emissions savings is comparable to the relative amount of emission reduction[121], and therefore very small as well (see Table 68).

[121] The difference between the change of CO_2 emissions and the change of their economic value is that in ASTRA the latter is computed on the wheel-to-wheel emissions, including also the production of fuel.

Table 67 **Impact on environmental emissions EU-27 - Comparison with reference case**

	2020	2030	2040	2050
CO_2	-0.055%	-0.048%	-0.032%	-0.018%
CO	-0.170%	-0.084%	-0.070%	-0.047%
NO_x	-0.938%	-0.947%	-0.732%	-0.588%
VOC	0.017%	-0.068%	-0.098%	-0.068%
PM	-1.046%	-0.812%	-0.821%	-0.682%

Table 68 **Economic value of CO_2 emissions EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Total EU-27	-0.0432%	-0.0353%	-0.0198%	-0.0119%

The impacts on safety are negligible as well and derive from the changes in modal split.

Finally, the small growth in transport demand and in particular of road traffic has a negative impact on road safety, as the number of accidents has increased. However, the difference with the reference scenario is negligible.

Table 69 **Impact on safety EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Fatalities	0.0026%	0.0020%	0.0014%	0.0010%
Seriously injured	0.0021%	0.0013%	0.0009%	0.0007%
Slightly injured	0.0026%	0.0015%	0.0011%	0.0008%

Test 2 - Reduction of transportation costs

This second test simulates the potential impact of a 5% reduction in transport costs, which may result from an increased efficiency of transport operations and leads to a reduction of customers' transportation costs. This reduction is assumed to become effective from 2015 onwards and is applied to the road sector only. Similar assumptions for maritime transport have not been simulated because a large share or the maritime transport demand does not have many alternative modes to choose from. Therefore any small change of costs would not significantly change the transport choices and consequently, also broader effects on the economy and environment would be negligible.

As it can be expected, the most relevant impact of the cost reduction is a modal shift to road transport (buses and trucks). However, this shift is limited. Changes in passenger transport demand remain basically the same.

Table 70 **Impact on passenger transport activity EU-27 [pkm] - Comparison with reference case**

	2020	2030	2040	2050
Car	-0.01584%	-0.01619%	-0.01616%	-0.01622%
Bus	0.19183%	0.19793%	0.19700%	0.19435%
Train	-0.00981%	-0.00177%	-0.00025%	0.00099%
Air	0.00027%	-0.00056%	-0.00098%	-0.00123%
Slow	-0.00660%	-0.00680%	-0.00731%	-0.00825%
Total	0.0020%	0.0018%	0.0017%	0.0019%

Table 71 **Impact on freight transport activity EU-27 [tkm] - Comparison with reference case**

	2020	2030	2040	2050
Road	0.0566%	0.0633%	0.0652%	0.0673%
Rail	-0.2125%	-0.2100%	-0.2096%	-0.2071%
Maritime	-0.0653%	-0.0637%	-0.0625%	-0.0621%
IWW	0.0000%	0.0000%	0.0000%	0.0000%
Total	-0.0143%	-0.0113%	-0.0104%	-0.0094%

The overall demand for freight transport decreases slightly. Two contrasting effects have occurred. On the one hand, average distances of road freight shipments are generally lower than those of rail shipments (e.g. combined transport includes the legs to and from intermodal centres in addition to the rail route). This effect tends to reduce the overall transport activity. On the other hand, there is a small positive effect on the economic growth, as reduced transport costs have a positive impact on the total factor productivity. All other things being equal, less expensive transport means higher economic productivity. More growth in turn results in more transport activity.

In this test, there is no great reduction in transport costs. At the same time, transport costs do not play any major role in productivity. The impact on GDP is therefore very small and the impact on employment even lower (see the tables below). The resulting increase in freight transport demand is consequently very small, and is offset entirely by the reduction in demand caused by the modal shift effect mentioned above.

Table 72 **Impact on GDP EU-27 – Comparison with reference case**

	2020	2030	2040	2050
GDP EU-27	0.0168%	0.0231%	0.0308%	0.0314%

Table 73 **Full time equivalent employment EU-27- Comparison with reference case**

	2020	2030	2040	2050
Employment	0.0029%	0.0026%	0.0027%	0.0035%

The combination of lower freight demand and a modal shift towards road modes (which generally has higher emissions per vehicle-km than non-road modes) results in a small change of emissions. Changes however are considered as negligible. For CO_2 the balance is slightly negative (i.e. emissions are somewhat higher) but difference in terms of economic value is visible only at the second digit level.

Table 74 **Impact on environmental emissions EU-27 – Comparison with reference case**

	2020	2030	2040	2050
CO_2	0.004%	0.008%	0.009%	0.011%
CO	-0.015%	-0.014%	-0.014%	-0.014%
NO_x	-0.001%	0.007%	0.008%	0.011%
VOC	0.013%	0.018%	0.023%	0.027%
PM	-0.018%	-0.016%	-0.018%	-0.021%

Table 75 **Economic value of CO_2 emissions EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Total EU-27	-0.0005%	0.0058%	0.0052%	0.0093%

The impacts on safety are negligible as well and result from changes in modal split (or actually from the small reduction in transport activity).

Table 76 **Impact on safety EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Fatalities	-0.0174%	-0.0170%	-0.0168%	-0.0168%
Seriously injured	-0.0222%	-0.0226%	-0.0226%	-0.0226%
Slightly injured	-0.0189%	-0.0194%	-0.0194%	-0.0192%

Test 3 – Increase of transportation costs

This test is mainly performed to assess the impacts that could result if transport service providers would pass-on their administrative costs (and other costs resulting from the implementation of optimisation measures).
A 5% increase in transportation costs is assumed from 2015. The assumed increase in transportation cost should be interpreted as an extreme situation since, as already described in previous annexes, the cost per consignment are negligible and the likelihood that operators pass-on cost increases is small.

Not surprisingly, the results of this test are roughly symmetrical with the results of the previous test.

Road transport loses some market share, especially in freight transport. Passenger demand is unchanged, while freight transport demand increases slightly, which is the result of a shift to non-road modes (especially rail). CO_2 emissions are reduced slightly and GDP and employment are negatively affected because of the reduction in the Total Factor Productivity. However, all impacts are very small and in practical terms it can be concluded that no significant changes result in comparison with the reference scenario.

Table 77 **Impact on passenger transport activity EU-27 [pkm] - Comparison with reference case**

	2020	2030	2040	2050
Car	0.01669%	0.01610%	0.01583%	0.01580%
Bus	-0.19234%	-0.19811%	-0.19770%	-0.19453%
Train	0.01047%	0.00803%	0.00852%	0.00564%
Air	0.00224%	0.00137%	0.00049%	0.00074%
Slow	0.00633%	0.00658%	0.00714%	0.00813%
Total	-0.0012%	-0.0013%	-0.0013%	-0.0016%

Table 78 **Impact on freight transport activity EU-27 [tkm] - Comparison with reference case**

	2020	2030	2040	2050
Road	-0.0712%	-0.0797%	-0.0831%	-0.0835%
Rail	0.3016%	0.3057%	0.2959%	0.2880%
Maritime	0.0684%	0.0664%	0.0662%	0.0662%
IWW	0.0000%	0.0000%	0.0000%	0.0000%
Total	0.0162%	0.0132%	0.0111%	0.0107%

Table 79 **Impact on environmental emissions EU-27 - Comparison with reference case**

	2020	2030	2040	2050
CO_2	-0.013%	-0.016%	-0.018%	-0.019%
CO	0.010%	0.010%	0.010%	0.009%
NO_x	-0.004%	-0.015%	-0.016%	-0.021%
VOC	-0.027%	-0.030%	-0.037%	-0.041%
PM	0.018%	0.013%	0.017%	0.018%

Table 80 **Economic value of CO_2 emissions EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Total EU-27	-0.0065%	-0.0086%	-0.0115%	-0.0126%

Table 81 **Impact on safety EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Fatalities	0.0165%	0.0159%	0.0156%	0.0155%
Seriously injured	0.0214%	0.0217%	0.0216%	0.0215%
Slightly injured	0.0179%	0.0183%	0.0180%	0.0177%

Table 82 **Impact on GDP - Comparison with reference case**

	2020	2030	2040	2050
GDP EU-27	-0.0223%	-0.0290%	-0.0355%	-0.0370%

Table 83 **Full time equivalent employment EU-27 - Comparison with reference case**

	2020	2030	2040	2050
Employment	-0.0035%	-0.0033%	-0.0029%	-0.0032%

Test 4 - Route and load factors optimization

This test simulates the impacts of an optimisation of the road freight sector by assuming:

- reduced transport costs of 5% and increased load factors of 5% for long-distance traffic;
- increased load factor of 15% for short-distance traffic.

These are very extreme assumptions since it is assumed that long-distance transport increases its load factor and reduces its costs simultaneously.

With these assumptions, the total freight transport activity will slightly reduce. This is the net effect between increased economic activity (positive) and lower average distances of road transport (negative). The former effect is not strong enough to overcome the latter. Indeed, the induced improvement of economic growth is stronger than in test 2 via the higher Total Factor Productivity and would generate a small increase of GDP and employment. Also the shift to road freight transport is modest and is in the order of 1% more tonne-km at most.

The higher load factors would reduce the number of road freight vkms despite the increase of demand. Therefore, the impact on emissions and safety is small but clearly positive.

Table 84 Impact on freight transport activity EU-27 [tkm] - Comparison with reference case

	2020	2030	2040	2050
Road	0.8802%	0.9653%	1.0063%	0.9966%
Rail	-3.2212%	-3.1076%	-3.1921%	-2.9722%
Maritime	-1.0280%	-0.9859%	-0.9747%	-0.9793%
IWW	0.0000%	0.0000%	0.0000%	0.0000%
Total	-0.2199%	-0.1690%	-0.1603%	-0.1522%

Table 85 Impact on GDP EU-27 - Comparison with reference case

	2020	2030	2040	2050
GDP EU-27	0.2118%	0.3067%	0.3600%	0.3746%

Table 86 Full time equivalent employment EU-27 - Comparison with reference case

	2020	2030	2040	2050
Employment	0.0283%	0.0402%	0.0397%	0.0436%

Table 87 Impact on environmental emissions EU-27 - Comparison with reference case

	2020	2030	2040	2050
CO_2	-2.388%	-2.479%	-2.443%	-2.435%
CO	-1.396%	-1.469%	-1.461%	-1.470%
NO_x	-1.326%	-1.768%	-1.927%	-2.150%
VOC	-2.927%	-3.045%	-3.186%	-3.251%
PM	-1.154%	-1.286%	-1.446%	-1.572%

Table 88 Economic value of CO_2 emissions EU-27 - Comparison with reference case

	2020	2030	2040	2050
Total EU-27	-1.9012%	-1.9653%	-1.8659%	-1.8086%

Table 89 Impact on safety EU-27 - Comparison with reference case

	2020	2030	2040	2050
Fatalities	-0.5783%	-0.5364%	-0.5363%	-0.5468%
Seriously injured	-0.4784%	-0.4453%	-0.4453%	-0.4491%
Slightly injured	-0.5795%	-0.5370%	-0.5343%	-0.5356%