LEAN & GREEN EUROPE

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Carbon Productivity in Global Supply Chains

Measure to improve

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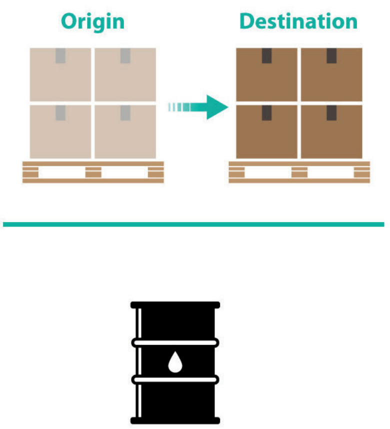
1 Introduction

The increasing demand for decarbonization of transport and logistics has led to the development of several methods to estimate the GHG emissions of any given supply chain, each with their own pro's and con's. These estimates are useful to report internally and externally what the footprint is, and to raise the awareness of the size of the GHG emissions.

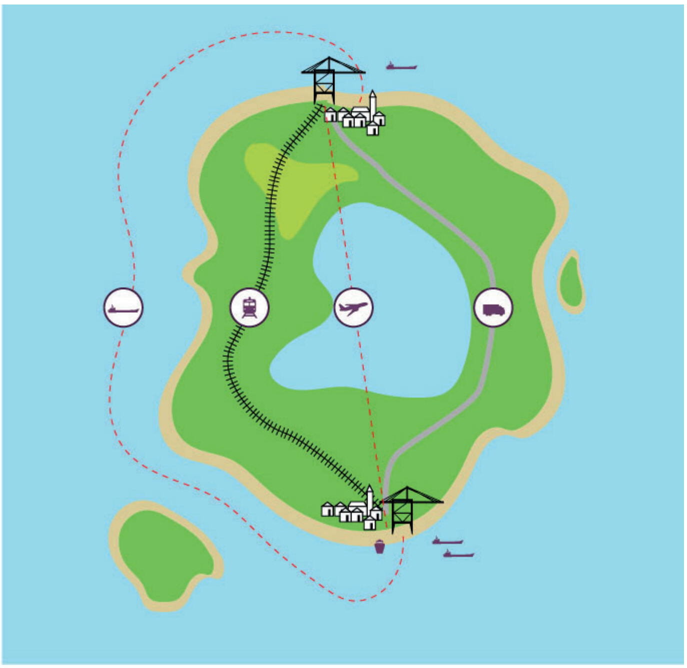
The next step is measure the carbon productivity of the supply chains, both in detail per part and integrated at a global level. Carbon productivity is defined as the ratio between the useful transport of goods, and the GHG emissions generated by that transport demand. This ratio is the key performance indicator to be monitored.

Fig 1. Carbon productivity: the ratio between useful transport of goods, and GHG emissions



Useful transport of goods is in essence independent of the means of transport or the route taken. The demand for the transporter is to take goods from the origin and bring them to a given destination.

Fig 2. Useful transport as translation between origin and destination, by different means and routes



The economic activities that demand the movement of goods from an origin to a destination are the driving force in a global supply chain. As the economy grows and becomes more diversified, this demand will grow as well. At the same time the Paris (COP21) agreements set a goal of more than 60% reduction of the absolute level of GHG emissions in 2050, compared to 1990.

The combination of increased demand for transport of goods due to economic growth and the demand to reduce GHG emissions associated with the same transport can be expressed in a desired carbon productivity increase, for instance a factor 6[1].

The challenge is to measure the carbon productivity in global supply chains so targets can be set, improvements can be designed, changes implemented and the effects monitored. This requires measuring in all parts of the world, in all kinds of circumstances and levels of development, in layered and diverse supply chains with many actors, in a manner that these measurements can be added and combined and compared to generate a view of the total supply chain.

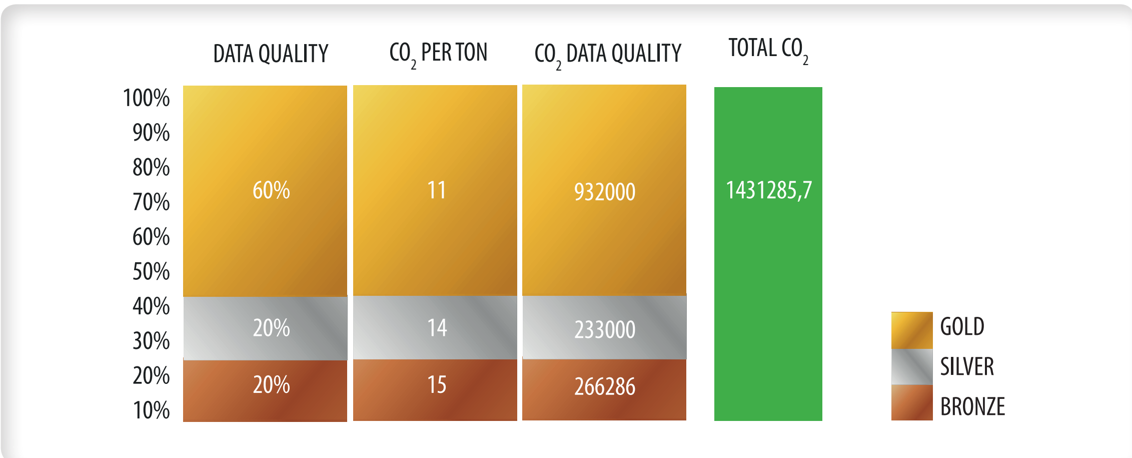
1 *In the Netherlands this leads to a target to increase the carbon-productivity by a factor 6 between 2015 and 2050. In other countries the target may be smaller (less growth) or much higher, if the assumed economic growth is high.*

This is theoretically easy to define. In practice it is very difficult to execute for lack of practical approaches, lack of easy-to-use- tools and a high threshold for participating. Lean & Green[2] has developed and applied a practical and easy to implement method for measuring and analyzing carbon productivity in global supply chains, called Lean Global Analytics (LGA). LGA has been developed and applied within the Lean & Green community, for SME's who operate nationally up to multinationals with global and diverse supply chains. The practical challenges involved have resulted in a set of online-tools that lower the threshold for participating. These tools are made available for everyone who is interested, even if you are not part of the Lean & Green community.

2 The input and output

The basis of LGA is to use the fundamental drivers of the business: combine the desired movement of goods, as expressed in freight orders, with the amount of fuel used to fulfill this demand. In practice this means collecting itemized freight bill data for a given period (for instance a month), and measuring the total amount of fuel used in the same period. The combination is fed into the online LGA calculator with gives output that can be shared and combined at will. As an example of the output the following two graphs show first a consolidated view of a supply chain, and secondly a detailed analysis of a distribution network.

Fig 3. Consolidated view of a supply chain



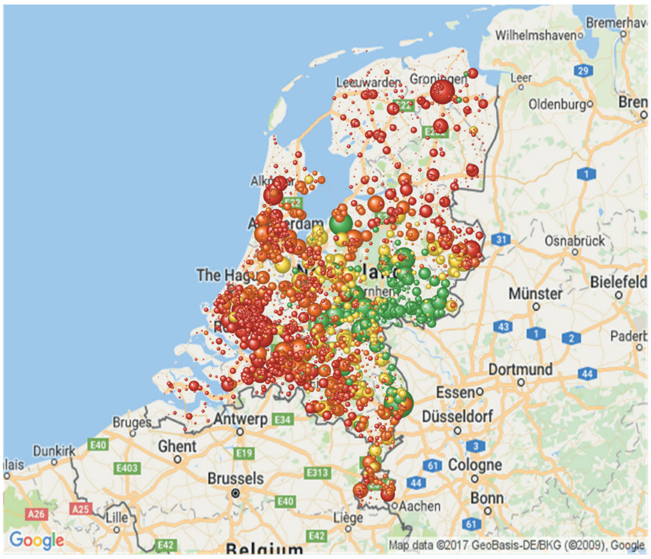
The consolidated view shows the absolute GHG emission per tonne, and the GHG emission per tonne[3]. km_{GCD}[4]. The fractional division in Gold, Silver and Bronze shows what quality of data used to calculate the consolidation in one view.

2 *Supported by the "Topsector Logistiek", a Dutch government supported program for innovations in Logistics*

3 *The unit can be freely chosen to match the practice of the supply chain: TEU for containers, pallets, rollcontainers or volume can all be relevant units. As long as the choice is consistent over the supply chain.*

4 *GCD stands for Great Circle Distance. GCD is the distance between origin and destination "as the bird flies over the sphere that is Earth", and as such an expression of the value in the movement of goods. The actual path traveled may be quite different, but the deviations and detours do not add value from the perspective of the shipper.*

Fig 4. Detailed analysis of distribution network



The detailed view for a part of a supply network, in this case a distribution network in the Netherlands, shows the volume delivered per customer location (size of the circle) and an indication of the absolute GHG emission per unit (rollcontainer) per customer location in color: green is lower third percentile, yellow middle, red top third percentile. This view is used to identify the (mis-)match between customers, volume delivered per customer and the structure of the distribution network.

3 How does LGA work in practice?

As an example we take a supply chain originating in the Netherlands, shipping goods in 40 ft (2 TEU) containers from Eindhoven (Netherlands) to Ibadan (Nigeria).

Fig 5. Global supply chain example

The empty containers are collected in Rotterdam harbor (NL), and returned after filling in Eindhoven to the sea-terminal by truck.The sea-terminal loads them upon a container vessels that sails to Laos (NG). The sea-terminal in Laos unloads the vessel. A local trucking company brings the full container from Laos to Ibadan, and returns the empty container, which is assumed to be returned to Rotterdam harbor.

The trucker in the Netherlands has all the IT systems that are needed to collect the data and generate the output. The same applies to the sea-terminal, so both can service the shipper directly with high quality data.
This may very well not the case for the containership, the terminal in Laos and the local trucker.

In this example we assume that a freight forwarder arranges these 3 step. The freight forwarder is by definition aware of the freight details, and combines this with assumed or measured fuel data for each step.

Take for example the trucker between Laos and Ibadan.

The most basic level is that the forwarder uses assumptions on distance traveled and specific fuel consumption without consulting the trucker (level Bronze).
The next better level is that the forwarder gets general information from the trucker on the class of the vehicle (level Bronze).
Even better is when the trucker is willing to give measured specific fuel consumption of his fleet for container trucking, based on yearly kilometers driven, and total fuel used per year. (level Silver).

The forwarder uses the same kind of approach for the sea-terminal (GHG emission per move), and the container vessel (GHG emissions per TEU per sea mile travelled).

The forwarder now can combine the detailed cargo information per container with the collected emission data in the LGA calculator. The detailed processed output is used both for their own analysis and delivered to the shipper as well. The shipper now can combine 3 outputs (forwarder, sea-terminal Rotterdam and trucker in NL) to analyze the complete supply chain.

It is possible to start without having much measured data in (parts of) the supply chain, and improve the data quality over time. The more actors in the supply chain collect and analyze their own data, the better quality of data becomes available.

If a small subcontracted trucker just wants to service his customers with better data a simple entry-level tool is available. A forwarder that manages many supply global chains for its customers' needs much more sophistication, so detailed processed data sets can be combined and exported. This is supported by the Global tool.

The standardization of method (and tools) allow for the combination of processed data sets from various parties, with different quality levels.

A detailed processed and combined data set has a structure similar to this small example.

Fig 6. Example of processed and combined data set for analysis

Date nr	Shipment	Source	Leg	Modality	Origin country	Origin postal code	Destination country	Destination postal code	Quantity	Unit	GCD	Kg CO_2	Unit.km (GCD)	CO_2/ Unit	CO_2/ Unit.km (GCD)	Data Quality
2-1-2017	1023412	LSP ABC	1	Trucks	NL	6041AB	NL	3072AP	20	Ton	150	204,9	3.000	10,2	0,0683	Gold+
2-1-2017	1023412	TH Rotterdam	2	Terminal	NL	3072AP	NL	3072AP	20	Ton	0	7,0	0	0,4		Silver
2-1-2017	1023412	North Sea NL	3	Short Sea	NL	3072AP	NG	234001	20	Ton	2143	1.295,7	42.860	64,8	0,0302	Bronze
2-1-2017	1023412	TH Lagos	4	Terminal	NG	234001	NG	234001	20	Ton	0	7,0	0	0,4		Bronze
2-1-2017	1023412	Unknown	5	Trucks	NG	234001	NG	200283	20	Ton	252	292,9	5.040	14,6	0,0581	Bronze
2-1-2017	1023413	Warehouse 123	1	Warehouse	NL	6041AB	NL	6041AB	10	Ton	0	12,0	0	1,2		Gold
2-1-2017	1023413	LSP ABC	2	Trucks	NL	6041AB	NL	3331LK	10	Ton	104	143,2	1.040	14,3	0,1377	Gold+
2-1-2017	1023414	Warehouse 123	1	Warehouse	NL	6041AB	NL	6041AB	15	Ton	0	13,0	0	0,9		Gold
2-1-2017	1023414	LSP ABC	2	Trucks	NL	6041AB	NL	3331LK	15	Ton	104	143,2	1.560	9,5	0,0918	Gold+
2-1-2017	1023415	LSP ABC	1	Trucks	NL	6041AB	NL	3072AP	40	Ton	150	314,8	6.000	7,9	0,0525	Gold+
2-1-2017	1023415	TH Rotterdam	2	Terminal	NL	3072AP	NL	3072AP	40	Ton	0	14,0	0	0,4		Silver
2-1-2017	1023415	North Sea NL	3	Short Sea	NL	3072AP	GB	NW10 7XF	40	Ton	346	356,0	13.840	8,9	0,0257	Silver
2-1-2017	1023415	TH London	4	Terminal	GB	NW10 7XF	GB	NW10 7XF	40	Ton	0	21,0	0	0,5		Silver
2-1-2017	1023415	LSP XYZ	5a	Trucks	GB	NW10 7XF	GB	CB3 9DR	20	Ton	85	156,0	1.700	7,8	0,0918	Gold
2-1-2017	1023415	LSP XYZ	5b	Trucks	GB	NW10 7XF	GB	CB23 7DU	20	Ton	80	134,0	1.600	6,7	0,0838	Gold

4 How to use LGA for improvement?

The advantages are:

- It becomes practical to measure and compare Global Supply Chains. Over time, of between competing supply chains, or between parts of supply chains
- It becomes practical to combine data from various sources and analyze in a consistent manner, even with different level of quality of data
- The analysis can be done at will, at any time, and aimed at the question at hand.
- It allows for an analysis that will quickly show the outliers, up to the customer and delivery location level
- It becomes possible to give customers specific and auditable information on the GHG emission associated with the delivered products
- It becomes practical to identify the outliers that deserve attention, and get detailed information that helps to identify what improvement is possible and how it can be achieved
- The information quality indicators show how good the information position is, and where improvements in data quality are needed.
- Targets can be set in data quality improvement, and monitored.
- It becomes practical to estimate the effect of a foreseen improvement, and monitor the result after implementation.
- It is easy to show and prove to governments and other stakeholders the level of control on the carbon footprint and the improvements made, and to deliver footprint indicators
- It is easy to participate in improvement initiatives such as Lean & Green locally, regionally and globally
- The threshold for forwarders, transporters, terminals and warehouses to start measuring themselves more in detail, and to start to initiate improvements themselves is much lower

Other publications in this series

2013 (1) Giving significance to big data in supply chains

2015 (2) Metrics for continuous improvement of the supply chain performance

2016 (3) Analytics

2016 (4) Introduction to the calculation of CO_2 emissions for paticipation in Lean & Green

2017 (5) **Carbon productivity in global supply chains**

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