CARBON PRODUCTIVITY IN GLOBAL SUPPLY CHAINS

MEASURE TO IMPROVE
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 pros and cons. 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.
The economic activities that demand the movement of goods from an origin to a destination are the driving force in a global supply chain. Thus, as the economy grows and becomes more diversified, this demand for movement will also grow. 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 that 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. And this must be performed in such a manner that these measurements can be added and combined and compared to generate a view of the total supply chain.

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.

\(^1\) In The Netherlands this leads to a target to increase the carbon-productivity by a factor of six between 2015 and 2050. In other countries the target may be smaller (less growth) or much higher, if the assumed economic growth is high.
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. It is applicable for companies ranging from SMEs who operate nationally, right 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 which 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\(^3\). kmGCD\(^4\). 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’. As such it is 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.
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.
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 by truck to the sea terminal after being filled in Eindhoven. At the sea terminal they are loaded on to a container vessel that sails to Laos (NG). At the sea terminal in Laos the vessel is unloaded. A local trucking company takes the full containers from Laos to Ibadan, and returns the empty containers, which are 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 be 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 best 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 traveled).

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 large amounts of measured data in (parts of) the supply chain, and to then improve the data quality over time. The more actors in the supply chain who collect and analyze their own data, the better the 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.
<table>
<thead>
<tr>
<th>Date</th>
<th>Shipment</th>
<th>Source</th>
<th>Leg</th>
<th>Modality</th>
<th>Origin country</th>
<th>Origin postal code</th>
<th>Destination country</th>
<th>Destination postal code</th>
<th>Quantity</th>
<th>Unit</th>
<th>GCD</th>
<th>KgCO2</th>
<th>GCD/Unit.km CO2/Unit.km CO2</th>
<th>CO2/Unit.km CO2</th>
<th>Delta Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1-2017</td>
<td>1023412</td>
<td>LSP ABC</td>
<td>1</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>20</td>
<td>Ton</td>
<td>150</td>
<td>260,9</td>
<td>1.000</td>
<td>10,2</td>
<td>Gold+</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023412</td>
<td>TH Rotterdam</td>
<td>2</td>
<td>Terminal</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>20</td>
<td>Ton</td>
<td>5</td>
<td>7,0</td>
<td>1</td>
<td>0,6</td>
<td>Silver</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023412</td>
<td>North Sea NL</td>
<td>3</td>
<td>Short Sea</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>20</td>
<td>Ton</td>
<td>2143</td>
<td>1,295,7</td>
<td>2,890</td>
<td>66,8</td>
<td>Bronze</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023412</td>
<td>TH Lagos</td>
<td>4</td>
<td>Terminal</td>
<td>NL</td>
<td>244001</td>
<td>NL</td>
<td>244001</td>
<td>20</td>
<td>Ton</td>
<td>5</td>
<td>7,0</td>
<td>1</td>
<td>0,4</td>
<td>Bronze</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023412</td>
<td>Unknown</td>
<td>5</td>
<td>Trucks</td>
<td>NL</td>
<td>244001</td>
<td>NL</td>
<td>244001</td>
<td>20</td>
<td>Ton</td>
<td>2552</td>
<td>292,9</td>
<td>0,049</td>
<td>16,8</td>
<td>Bronze</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023413</td>
<td>Warehouse 127</td>
<td>6</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>601348</td>
<td>10</td>
<td>Ton</td>
<td>12,0</td>
<td>12,0</td>
<td>0</td>
<td>1,2</td>
<td>Gold</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023413</td>
<td>LSP ABC</td>
<td>7</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>33333K</td>
<td>15</td>
<td>Ton</td>
<td>126,2</td>
<td>840</td>
<td>14,3</td>
<td>13,77</td>
<td>Gold+</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023414</td>
<td>Warehouse 127</td>
<td>8</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>601348</td>
<td>15</td>
<td>Ton</td>
<td>13,0</td>
<td>13,0</td>
<td>1</td>
<td>0,9</td>
<td>Gold</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>LSP ABC</td>
<td>9</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>33333K</td>
<td>15</td>
<td>Ton</td>
<td>126,2</td>
<td>840</td>
<td>14,3</td>
<td>13,77</td>
<td>Gold+</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>LSP ABC</td>
<td>10</td>
<td>Trucks</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>20</td>
<td>Ton</td>
<td>150</td>
<td>314,8</td>
<td>0,000</td>
<td>7,9</td>
<td>Gold+</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>TH Rotterdam</td>
<td>11</td>
<td>Terminal</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>40</td>
<td>Ton</td>
<td>5</td>
<td>14,0</td>
<td>0</td>
<td>0,4</td>
<td>Silver</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>North Sea NL</td>
<td>12</td>
<td>Short Sea</td>
<td>NL</td>
<td>0041AB</td>
<td>NL</td>
<td>3072AP</td>
<td>40</td>
<td>Ton</td>
<td>348</td>
<td>356,0</td>
<td>3,843</td>
<td>8,9</td>
<td>Silver</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>TH London</td>
<td>13</td>
<td>Terminal</td>
<td>GB</td>
<td>NW10 7XF</td>
<td>GB</td>
<td>NW10 7XF</td>
<td>40</td>
<td>Ton</td>
<td>5</td>
<td>21,0</td>
<td>1</td>
<td>0,5</td>
<td>Silver</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>LSP XYZ</td>
<td>14</td>
<td>Trucks</td>
<td>GB</td>
<td>NW10 7XF</td>
<td>GB</td>
<td>CB2338</td>
<td>20</td>
<td>Ton</td>
<td>85</td>
<td>146,9</td>
<td>700</td>
<td>7,8</td>
<td>Gold</td>
</tr>
<tr>
<td>2-1-2017</td>
<td>1023415</td>
<td>LSP XYZ</td>
<td>15</td>
<td>Trucks</td>
<td>GB</td>
<td>NW10 7XF</td>
<td>GB</td>
<td>CB23 1D01</td>
<td>20</td>
<td>Ton</td>
<td>85</td>
<td>134,0</td>
<td>600</td>
<td>8,7</td>
<td>Gold</td>
</tr>
</tbody>
</table>

Fig 6. Example of processed and combined data set for analysis
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 to analyze that data in a consistent manner, even with different level of quality of data
• The analysis can be performed 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 to get detailed information that helps to identify possible improvements and how they 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 to monitor the result after implementation.
• It is easy to show and prove to governments and other stakeholders the level of control over 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 their own data in more detail, and to start to initiate improvements themselves is much lower
Lean & Green Europe is Europe’s leading community for sustainable logistics. Lean & Green Europe combines corporate responsibility for reducing footprints with continuous improvement of operational performance and value for customers. Lean & Green Europe develops community-driven practical tools and guidelines for applying international emission calculation standards. Lean & Green members include > 500 shippers, carriers, logistics service providers, ports, terminals and retailers.

Lean & Green Europe
Ezelsveldlaan 59
2611 RV Delft
www.lean-green.eu

For comments or more information please contact us at info@lean-green.eu

Other publications in this series:

#1 2013 Giving significance to big data in supply chains
#2 2015 Metrics for continuous improvement of the supply chain performance
#3 2016 Analytics
#4 2016 Introduction to the calculation of CO₂ emissions for participation in Lean & Green
#5 2017 Carbon productivity in global supply chains
#6 2018 Data maturity levels

100% Collaboration 0% Emission