

BOMBARDIER

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Life Cycle Analysis replacing existing data servers

Client

Bombardier Transportation Netherlands B.V.
Roger Hall

Author:

Noël Verberg, Dé CO₂ Adviseurs



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1 Introduction

As part of achieving Level 5 on the CO₂ Performance Ladder, Bombardier Transportation Netherlands B.V. performs an analysis on the GHG (Green House Gas) generating chain. This document describes the life cycle analysis of replacing the current data servers.

Activities Bombardier Transportation Netherlands B.V.

A short description of the organization follows below. More information is available at the website of Bombardier:

<https://www.bombardier.com/en/transportation.html>

Bombardier Transportation Netherlands B.V. is part of its Canadian parent company Bombardier Inc. In 1937 Bombardier Inc. started their activities as a producer of snowmobiles to transport people through the rough landscape in Canada. These days, Bombardier is market leader in the field of production of airplanes and trains. Bombardier has 60 production locations in 27 countries all over the world.

Bombardier Transportation Netherlands B.V is a part of Bombardier Transportation Canada Inc. and has been based in Amsterdam since 1999. In 2017 the company had on average 49.5 full-time employees. Bombardier Transportation Netherlands B.V. focusses mainly on the railroad signaling and maintenance. Dutch railroad administrator ProRail is the biggest client of Bombardier in the Netherlands. Furthermore, sustainability is very important for Bombardier. Based on these two factors, Bombardier Transportation Netherlands B.V. has decided to certify via the CO₂ Performance ladder.

What is a life cycle analysis? (LCA)

A life cycle analysis is a way to visualize the whole chain of emissions which are the result of a product or service. Meaning the whole chain, the whole life cycle of a product or service. From the extraction of the resources until the end of life of a product.

Goals of this LCA

The most important goals for this LCA are identifying CO₂ reduction possibilities, defining the reduction goals and monitoring progress.

Based on the insight on Scope 3 emissions and the life cycle analysis a reduction goal is defined. Within the energy management system, a clear focus is set on reducing scope 3 emissions. Spreading information to partners and other important players, part of a similar chain of activities, is an important part of this



goal. Bombardier Transportation Netherlands B.V. will actively try to involve their most important partners within the sector in achieving its reduction objectives.

Declaration of ambition level

Bombardier Transportation Netherlands B.V. performs in the middle class in sustainability in the sector compared to other companies. Bombardier Transportation B.V. depends on its suppliers and promoters. As the company has only little influence, it is not possible to be outstanding in this field.

Reading guide

In this report, Bombardier Transportation Netherlands B.V. presents the LCA of replacing old data units. The structure of this report is as follows:

Chapter 2: Scope 3 emissions & choice in LCA

Chapter 3: Identifying the links in the chain

Chapter 4: Quantifying the emissions

Chapter 5: Reduction opportunities

Chapter 6: Bibliography



2 Scope 3 & choice LCA

Before determining which chain analysis is performed, the table below provides a clear overview of the Product-Market Combinations on which Bombardier Transportation Netherlands B.V. has the most impact on reducing CO₂ emissions.

Product-market combinations	Relative importance of CO ₂ emissions on the sector and influence of the activities (Big/Medium/Small/Not Available)		Order
Sectors and activities	Sector	Activities	
	<i>CO₂ emissions company compared to CO₂ emissions sector (B/M/S/NA)</i>	<i>The possible effect of innovative designs on CO₂ emissions of the project (B/M/S/NA)</i>	
Governmental organizations - Stabling Yards	S	S	5
Governmental organizations - Mass transit	M	M	2
Governmental organizations - Main line railway	S	M	4
Governmental organizations - Products	S	S	7
Governmental organizations - EBI cab	M	M	3
Governmental organizations - Services	S	S	6
Private Sector - EBI cab	M	B	1



The underlying calculations can be found in Appendix 4.A.1 Qualitative dominance analysis.

Selection of the LCA

In accordance with the CO₂ Performance ladder 3.0 Bombardier Transportation Netherlands B.V. has to choose an emission source, for an LCA, out of the following top 2.

- ✓ Private sector – EBI Cab
- ✓ Governmental organizations – Mass transit

Bombardier Transportation Netherlands B.V. chose to conduct an LCA for the category “Governmental organizations – Mass transit”. Bombardier Transportation Netherlands B.V. is a big player in services of server-units for datacenters. For the coming years Bombardier Transportation Netherlands B.V. is looking for opportunities to put servers in service which use less energy than the existing servers. The old servers from IBM (VPU) are being replaced with new servers from Kontron (VPU_N). This LCA is about replacing the servers for EBILock product. One unit consists of several servers, depending on wishes and requirements of the client. For the calculations in the following chapters we used an average of 2 servers per unit.

Scope LCA

For this LCA Bombardier Transportation Netherlands B.V. is focusing on the following issues:

Upstream:

- ✓ Emissions of production of the new servers
- ✓ Transportation of the new servers to The Netherlands

Downstream:

- ✓ Assembling of the new servers
- ✓ Energy usage of the current and new servers
- ✓ Disposal of the current and new servers

Primary & Secondary data

In this LCA mainly primary data is used. This data is provided by Bombardier Transportation Netherlands B.V.

Primary data	Energy usage of the servers, production emissions, travel distance, way of disposal, way of assembling
Secondary data	CO ₂ emission factors from www.co2emissiefactoren.nl



Allocation data

No use is made of allocation of data.

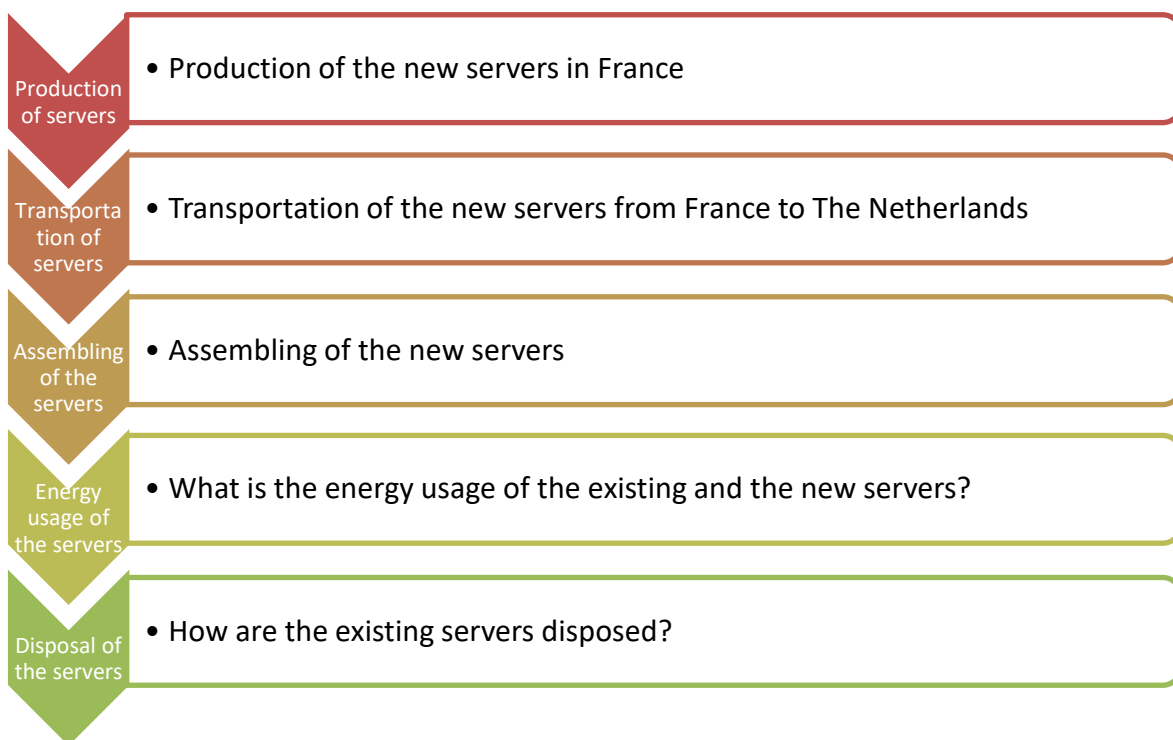


3 Identifying links in the chain

The business activities of Bombardier Transportation Netherlands B.V. are part of a chain of activities. For example, materials that are purchased have to be produced first and transported to Bombardier Transportation Netherlands B.V. (upstream). The assembling, use and disposal of completed "products" or "works" also involve energy use and emissions (downstream). In order to illustrate the CO₂ emissions from these activities, we will show the various chain steps in the section below.

Chain steps

The following steps in the chain will be of interest for this LCA.



The analysis of these activities will show a comparison of the old and the new servers. The new energy servers use less electricity which affects the total amount CO₂ emissions. In the graphic below, the various steps of the life cycle are shown.



When Bombardier Transportation Netherlands B.V. chooses to not replace the existing servers, there will be no emissions emitted by production, transportation, assembling and disposal.



Supply partners in the chain

There are various partners in the chain which have an influence on the emitted CO₂ in total. Below the most significant partners are described.

- ✓ *Kotron S&T AG:* Kotron is the manufacturer and supplier of the new servers. According to their website, they keep in mind their impact on climate change and Greenhouse Gas (GHG) emissions.
- ✓ *IBM:* IBM is manufacturer and supplier of the old servers.
- ✓ *UPS:* The servers are being transported to The Netherlands via the transport company UPS. UPS is aware of its social influence regarding sustainability and CO₂. Therefore, UPS is also keeping track if its CO₂ emissions and reduction.
- ✓ *Bombardier Transportation Netherlands B.V.:* The employees of Bombardier Transportation Netherlands B.V. are responsible for the assembling and disposal of the old and the new servers.
- ✓ *GVB:* One of Bombardier Transportation Netherlands B.V. biggest clients is the public transport company of Amsterdam. It controls all the tram lines in the city. GVB is also actively engaged with CO₂ reduction.
- ✓ *ProRail:* One of Bombardier Transportation Netherlands B.V. biggest clients is ProRail. ProRail is in charge of all the railways in Holland which makes them a powerful supply chain partner. ProRail is also actively engaged with CO₂ reduction and the CO₂ performance ladder.



4 Quantifying of emissions

Based on the description of the chain as shown in chapter 3, the quantification of CO₂ emitted during the various phases in the chain is determined per phase. Each section describes a part of the chain and the associated CO₂ emissions. A comparison will be made between continuing the use of the installed servers and installing new servers now.

Production of the servers

The current servers were produced at IBM factory in Singapore. IBM could not provide us with the energy consumption per hour while producing of the server, with regard to this it was equaled to the energy consumption for production of one DELL server and equals to 0,2 kWh. The new servers are being produced in France. For these servers, Kotron also could not provide us with the energy consumption which was released while production. We have decided to equate the emissions that are released during production of the new servers with the current servers. In the following calculations we multiplied the emitted emissions of the servers by 2 because at the two current projects, that is the average number of servers being used.

New server	Energy consumption	Energy consumption (assumed production time: 1 hour)	Amount	Emission factor	CO2 Emissions (in KG)
VPU_N	200 watt	0,2 kWh	2	0,649	0,2596

As shown in the table above, the total amount of emitted CO₂ emissions for one unit (two servers) is a little over a quarter of a kilogram CO₂ (based on a production time of 1 hour). Because there is no data available about the energy consumption of the production of the servers, we used data from Dell. They could provide us with the energy usage while production of other components. If other data is available, this LCA will be adjusted to the right numbers.

Transport of the units

The new servers are being produced at a Kotron factory in Toulon, France. Kotron provided us with extra data about the servers. We know one server weighs approximately 12 kilograms each. The transport to Holland will be done via road transport. For the calculations below, we used a small truck (<10 tons) as means of transport.

New server	Vehicle	Toulon - Amsterdam (KM)	Weight per server (KG)	Amount	Emission factor	CO2 Emissions (KG)
VPU_N	By truck	1321	12	2	0,432	13,70

The emissions emitted during transport to Holland are 13,7 kilograms per two servers.



Assembling of the servers

The assembling of the servers has to be done manually, therefore, there is no CO₂ emitted during assembling. There is CO₂ emitted during commuter traffic, however, these emissions are so low they are negligible.

Energy use of the servers and units

The energy consumption of the servers when they are in use, produces the most CO₂ emissions of all chain steps. The tables below show the difference in energy consumption of the old and the new servers. For the calculations below, we used an average number of servers per cabinet used at the projects "Hoekselijn" and "Amsterdam-Utrecht". The calculations are based on the fact that one data unit consists 2 servers (2 x IBM VPU, 2 x Kontron VPU_N).

Old server	Energy consumption (per hour)	Emission factor	Day	Year	25 Years
IBM VPU	2 kWh	0,649	31,2	11.370,5	284.262,0

Old unit (2 servers)	Energy consumption (per hour)	Emission factor	Day	Year	25 Years
IBM VPU	4 kWh	0,649	62,3	22.741,0	568.524,0

The emitted CO₂ of an existing unit that was in use for one day is 31,2 kilograms. The lifespan of the servers are approximately 25 years. If we assume that an unit is in use for 25 years, the emitted CO₂ is almost 569 tons.

New server	Energy consumption (per hour)	Emission factor	Day	Year	25 Years
Kontron VPU_N	0,1725 kWh	0,649	2,7	980,7	24.517,6

New unit (2 servers)	Energy consumption (per hour)	Emission factor	Day	Year	25 Years
Kontron VPU_N	0,345 kWh	0,649	5,4	1.961,4	49.035,2

The total amount of CO₂ emitted by a new unit that is going to be in use for 25 years is a little under 50 tons CO₂. This is, compared to the old units a reduction of 91%.



Disposal of the servers

Usually, the servers are never being disposed entirely. The servers are repaired as long as it could be maintained. If they are getting disposed, the components which are still functional will be taken out. The rest is disposed at GVB. For this process, there is no data available. As the actual disposed material is such a small amount, it is regarded as non-significant in the chain and is thus disregarded. If more information becomes available at a later stage, it will be added to the analysis, but this question does not form a priority.

Overview of CO₂-emissions in the chain

The total amount of emitted CO₂ emissions for the use of one new unit for 25 years is 50,28 tons CO₂. The emissions are attributable to the following chain steps.

Overview of CO₂ emissions of one new unit:

Phase	CO ₂ Emissions (in tons)
Production (of 2 servers)	0,00026
Transport (of 2 servers)	0,0137
25 years in use (of 2 servers)	49
Total:	49

The emitted CO₂ of production and transportation is nothing compared to the CO₂ which is emitted by use of the servers.

Overview of CO₂ emissions of one existing unit:

Phase	CO ₂ Emissions (in tons)
Production (of 2 servers)	-
Transport (of 2 servers)	-
25 years in use (of 2 servers)	568,5
Total:	568,5



5 Improvement opportunities

To make a good comparison, Bombardier Transportation Netherlands B.V. used the project “Hoekselijn” and “Amsterdam-Utrecht” for this LCA. In total, there are currently two projects where the old servers could be replaced. The average number of servers per cabinet in these projects is two. So, for the calculations we used an average of two servers per cabinet. Bombardier Transportation Netherlands B.V. has the capabilities to replace 20 servers in total.

Possibilities for CO₂-reduction in the chain

Bombardier Transportation Netherlands B.V. calculated the amount of CO₂ which will be saved if the old servers will be replaced. The table below shows the savings per server *per year*.

Number of servers being replaced	CO ₂ emissions (in tons)		
	Old	New	Savings per year
1	11,37	0,98	10,39
2	22,74	1,96	20,78
3	34,11	2,94	31,17
4	45,48	3,92	41,56
5	56,85	4,90	51,95
6	68,22	5,88	62,34
7	79,59	6,86	72,73
8	90,96	7,85	83,12
9	102,33	8,83	93,51
10	113,70	9,81	103,90
11	125,08	10,79	114,29
12	136,45	11,77	124,68
13	147,82	12,75	135,07
14	159,19	13,73	145,46
15	170,56	14,71	155,85
16	181,93	15,69	166,24
17	193,30	16,67	176,63
18	204,67	17,65	187,02
19	216,04	18,63	197,41
20	227,41	19,61	207,80

Scope 3 objective: The objective is set to replace 8 servers of the possible 20 servers in 2021. If Bombardier Transportation Netherlands B.V. is able to accomplish this objective, it will save 83 tons CO₂ in the chain per year.



Uncertainties and opportunities for improvement in information

To gain more insight in the chain, there will be some points of improvement.

- ✓ The energy consumption of the production of the new servers: this LCA assumes the production consumption of the new servers is the same as the other servers from Dell. Kotron could not provide Bombardier Transportation Netherlands B.V. with better production data.
- ✓ There is no data available about the production time of the servers. We assumed a production time of 1 hour.
- ✓ Transport to the Netherlands: We used the fastest route from the factory in France to the office of Bombardier Transportation Netherlands B.V. (1321 KM). The number of kilometers and thus the fuel consumption can actually be higher or lower. Transportation company UPS can provide us with the actual data by using a better kilometer registration.
- ✓ Hours in use of the servers: in this LCA Bombardier Transportation Netherlands B.V. assumes the servers were in use for 25 years, 24 hours a day, 7 days a week. Clients of Bombardier Transportation Netherlands B.V. could provide the actual number of hours.
- ✓ Transport of Bombardier Transportation Netherlands B.V. to client: the distance driven in the Netherlands has not been taken into account. This will not be much, but for the completeness of the LCA it is important to have insight in these kilometers
- ✓ Disposal of the servers: currently there is no insight in which parts and how many parts of the servers are reused and disposed. Bombardier Transportation Netherlands B.V. should create more insight on this part.



6 Bibliography

Source / Document	Characteristic
<i>Handboek CO₂-prestatieladder 3.0, 10 juni 2015</i>	<i>Stichting Klimaatvriendelijk Aanbesteden & Ondernemen</i>
<i>Corporate Accounting & Reporting standard</i>	<i>GHG-protocol, 2004</i>
<i>Corporate Value Chain (Scope 3) Accounting and Reporting Standard</i>	<i>GHG-protocol, 2010a</i>
<i>Product Accounting & Reporting Standard</i>	<i>GHG-protocol, 2010b</i>
<i>Nederlandse norm Environmental management – Life Cycle assessment – Requirements and guidelines</i>	<i>NEN-EN-ISO 14044</i>

The structure of this document is based on the Corporate Value Chain (Scope 3) Standard. In addition, where necessary, the methodology of the Product Accounting & Reporting Standard is maintained (see the table below).

<i>Corporate Value Chain (Scope 3) Standard</i>	<i>Product Accounting & Reporting Standard</i>	<i>LCA:</i>
<i>H3. Business goals & Inventory design</i>	<i>H3. Business Goals</i>	<i>Chapter 1</i>
<i>H4. Overview of Scope 3 emissions</i>	-	<i>Chapter 2</i>
<i>H5. Setting the Boundary</i>	<i>H7. Boundary Setting</i>	<i>Chapter 3</i>
<i>H6. Collecting Data</i>	<i>H9. Collecting Data & Assessing Data Quality</i>	<i>Chapter 4</i>
<i>H7. Allocating Emissions</i>	<i>H8. Allocation</i>	<i>Chapter 2</i>
<i>H8. Accounting for Supplier Emissions</i>	-	<i>Part of implementation of CO₂ Performance Ladder level 5</i>
<i>H9. Setting a reduction target</i>	-	<i>Chapter 5</i>



7 Declaration drafting Life Cycle Analysis

Dé CO₂ Adviseurs has extensive experience with the preparation of chain analysis and therefore counts as a professionally recognized knowledge institute. Also see the Declaration of Expertise (included in the LCA or separately requestable). It lists the chain analysis that have been drawn up by Dé CO₂ Advisors, including the subject, the client, the date and the Certifying Institute by which the chain analysis has been approved. It also describes which advisors work for Dé CO₂ Adviseurs and what their knowledge and education level is.

This LCA was drawn up by Noël Verberg. In addition, the chain analysis was controlled by Christine Everaars according to the four-eyes principle. Christine Everaars was not involved in drawing up the CO₂ reduction policy of Bombardier Transportation Netherlands B.V. With this assessment, it has been established that the used scope, source data and calculations are correctly displayed in the current report. No deviations were found for completeness, independence and expertise of the analysis.

Signed for agreement

<p>Noël Verberg</p> <p>.... <i>Junior Advisor</i></p>	<p>Christine Everaars</p> <p>..... <i>Adviseur</i></p>
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Dé CO₂ Adviseurs

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Colophon

Author	Noël Verberg
Document	Life cycle analysis: Replacing current data units
Date	03-07-2018
Version	1.2
Responsible Manager	Roger Hall

Signature authorizing manager:

A handwritten signature in blue ink, appearing to read 'RH', is centered below the text. Below the signature is a horizontal dotted line.