

BOMBARDIER

the evolution of mobility

Progress 2018-2019

**Life Cycle Analysis: replacing existing
Vital Processor Units (VPU_N)**

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 progress made on the development of more efficient data computers.

1.1 Recap of the Life Cycle Analysis 2018

In 2018, a life cycle analysis (LCA) of the BT Netherlands Chain provided insight into possibilities to reduce CO2-footprint at Bombardier Transportation, Amsterdam [1]. From an overview of the Product-Market combinations, the category “Private sector – EBI Cab” was chosen to conduct an LCA on because it was the number one emission source in accordance with the CO₂ Performance ladder 3.0 Bombardier Transportation Netherlands B.V

Bombardier Transportation Netherlands B.V. is a big player in services of server-units for datacenters. Since 2018 Bombardier Transportation Netherlands B.V. has been looking for opportunities to use energy servers which use less energy than the existing computers: the replacement of the old servers from IBM (EBIlock VPU) are being replaced with new servers from Kontron (VPU_N). The LCA was about replacing the EBIlock servers. One unit consists of several servers, depending on the wishes of the client.

1.2 Scope

Scope 3 objective set in 2018:

The objective is 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.

Two opportunities were recognized in 2018: Project “Hoekse lijn” and project “Amsterdam – Utrecht”. However, ProRail indicated that at this time, the replacement of the servers for the Amsterdam-Utrecht project shall not be performed. Therefore, this progress report is limited to the Hoekse Lijn project.

In 2018 the design and build of the servers was executed and in 2019 these were installed on the track Hoekse Lijn.

1.3 Clarification about the objective.



In the Life cycle analysis of 2018 [1], the term ‘server’ and ‘unit’ were used to describe the Vital Platform Computer (VPC) and the Vital Processor Unit (VPU-N). However, the terms and ‘server’ and ‘unit’ were not carefully chosen. In this report we will, therefore, speak of VPC and VPU-N.

The objective to replace 8 servers of the possible 20 servers in 2021, should in fact be:

“To replace 8 old VPC of the possible 20 VPC by 2021.”

One new Kontron [2] VPU-N replaces:

Description new	#		Description old	#	
Kontron VPU_N	1	VS	VPC	IBM xSeries336-35u	2
			VPC	IBM System P5	1
			Switch	HP Procurve switch 2626	1
			Switch	HP Procurve 1400-24 G	1

1.4 Report outline

Chapter 2 life cycle analysis

Chapter 3 Emission comparison for Hoekse Lijn

Chapter 4 Progress Chain Initiative

Chapter 5 Conclusion & New opportunities

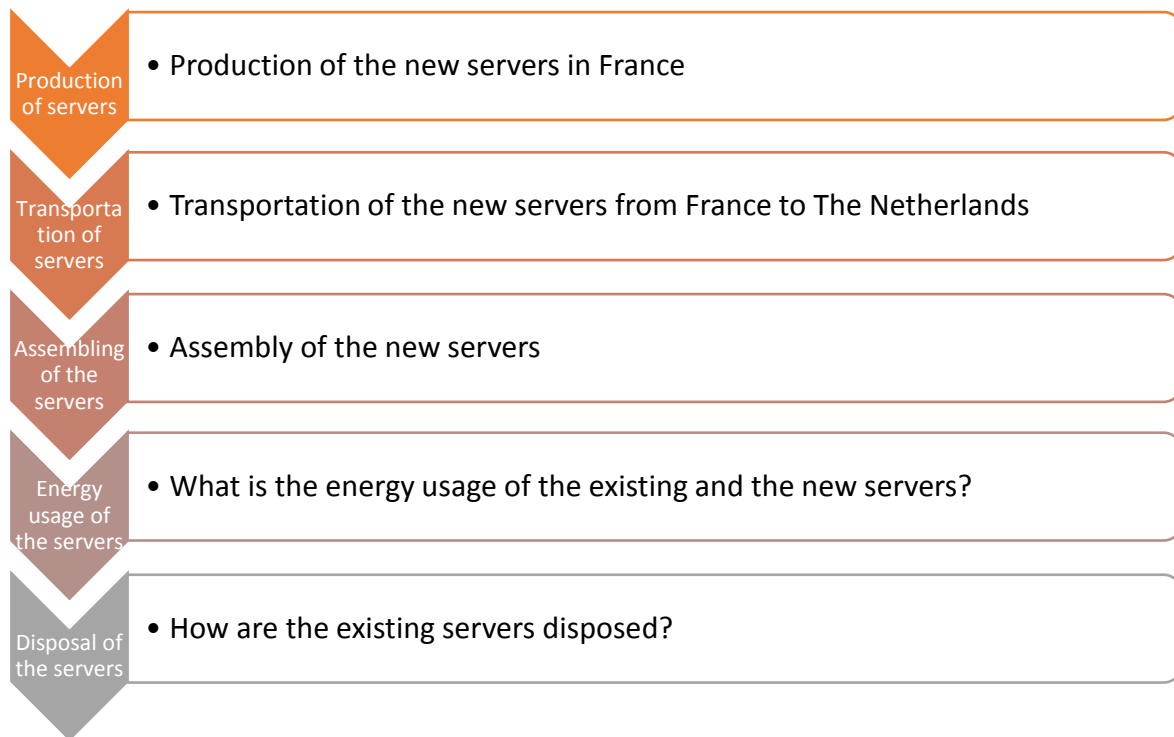
Chapter 6 References

2 Life Cycle Analysis

2.1 Scope LCA

For this LCA Bombardier Transportation Netherlands B.V. has focused on the following issues:

The following steps are in the chain analysis.



The first two steps are considered to be part of the upstream cycle and the last three steps of the downstream cycle.

2.2 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

3 Emission calculation

2018 vs 2019 calculation

The calculation of the LCA of 2018 is changed based on new insights:

1. The average number of 2 VPU's is not correct. The new calculation will incorporate 3 IBM VPC's to be replaced by 3 more efficient KONTRON VPC's.
2. The weight of the Kontron VPU_N is 10 kg [2] and that includes 3 VPC's. The shipping weight is 14,5 kg, but it will not be taken into account because the shipping weight for a IBM VPC is unknown.
3. The weight of one IBM VPC is 14,5 kg (average) [4]. 2018 LCA applied 12 kg. In total 3 VPC's are to be shipped to make one VPU_N system.
4. The travel distance for the IBM VPU_N has not been taken into the account in the 2018 calculation. Most likely, the shipping is performed by ship. However, the travel distance could not be found. Air Travel distance has been taken into account with the calculation.
5. This progress report makes a comparison between the new Kontron VPC's and the old IBM VPC's and not between the switches (mentioned in paragraph 1.3), because:
 - The calculation between 2018 LCA and the 2019 LCA will be performed the same way and are therefore more comparable.
 - The most significant reduction is achieved due to the replacement of the old VPC's.

2019 Calculation and results

3.1.1 Production

There is no information available over the energy consumed for production of the Kontron VPU_N. Therefore, the IBM production Energy consumption is applied to both systems.

Please note that in this calculation, the energy consumption is increased, in comparison to the LCA from 2018, due to the fact that 3 VPC's make one VPU_N, not 2.

Old System	Energy consumption (W)	Production time per VPC (Hours)	Energy consumption (kWh)	Amount	Emission factor kg/CO2/kWh	CO2 Emissions (kg)
VPC IBM	200	1	0,2	3	0,649	0,39
New System	Energy consumption (W)	Production time per VPC (Hours)	Energy consumption (kWh)	Amount	Emission factor kg/CO2/kWh	CO2 Emissions (kg)
VPC Kontron	200	1	0,2	3	0,649	0,39

3.1.2 Transport

In comparison to 2018, 3 VPC's are compared with the new Kontron VPU_N. Each IBM VPC weighs 14,5 kg, while a complete Kontron VPU_N (3 VPC's and switchboards) weighs a mere 10kg.

Old System	Vehicle	Singapore-Amsterdam (km)	Weight per VPC (kg)	Amount	Emission factor kg/CO2/eenheid	CO2 Emissions (kg)
VPU_N	By boat (635TEU)	10512	14,5	3	0,035	457,27
New System	Vehicle	Toulon - Amsterdam (km)	Weight per system (kg)	Amount	Emission factor kg/CO2/eenheid	CO2 Emissions (kg)
VPU_N	By truck	1321	10	1	0,432	13,21

3.1.3 Energy Consumption of the VPU_N

The energy consumption numbers have not changed since the 2018 LCA. The number of VPC's that are replaced by a Kontron have gone up from 2 to 3.

Old system	Energy consumption (KWh)	Emission factor kg/CO2/kWh	Day	Year	25 Years
IBM VPC	2	0,649	31,2	11.370,5	284.262,00
Old system (3 VPC's)	Energy consumption (KWh)	Emission factor kg/CO2/kWh	Day	Year	25 Years
IBM VPU	6	0,649	93,5	34.111,44	852.786,00
NEW system	Energy consumption (KWh)	Emission factor kg/CO2/kWh	Day	Year	25 Years
Kontron VPC	0,1725	0,649	2,7	980,7	24.517,60
Old system (3 VPC's)	Energy consumption (KWh)	Emission factor kg/CO2/kWh	Day	Year	25 Years
Kontron VPU_N	0,5175	0,649	8,1	2.942,11	73.552,79

3.1.4 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 insignificant 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.

3.1.5 Total power consumption Old vs New

The lifecycle energy consumption of a Kontron VPU_N system is estimated to be just 9% of the lifecycle energy consumption of an IBM VPU_N.

System	CO2 Emissions (kg)
IBM VPU_N	853.243,66
Kontron VPU_N	73.566,39

The energy consumption during its 25 years in service overshadows the energy consumed during the production and transport, and most likely the disposal.

4 Progress Chain Initiative

Bombardier has successfully installed 2 new Kontron VPU_N at Hoekse Lijn which will lead to a reduction of 63 tons kg of CO2 per year. This number excludes the energy saved by other related equipment such as air conditioning due to less cooling.

Number of VPC's being replaced	Calculation 2018 LCA			Calculation 2019 LCA		
	CO2 emissions (in tons)			CO2 emissions (in tons)		
	Old	New	Savings per year	Old	New	Savings per year
1	11,37	0,98	10,39	11,52	0,99	10,54
2	22,74	1,96	20,78	23,05	1,97	21,08
3	34,11	2,94	31,17	34,57	2,96	31,61
4	45,48	3,92	41,56	46,09	3,94	42,15
5	56,85	4,9	51,95	57,62	4,93	52,69
6	68,22	5,88	62,34	69,14	5,91	63,23
7	79,59	6,86	72,73	80,66	6,90	73,76
8	90,96	7,85	83,11	92,18	7,88	84,30
9	102,3	8,83	93,5	103,71	8,87	94,84
10	113,7	9,81	103,89	115,23	9,85	105,38
11	125,1	10,79	114,29	126,75	10,84	115,92
12	136,5	11,77	124,68	138,28	11,82	126,45
13	147,8	12,75	135,07	149,80	12,81	136,99
14	159,2	13,73	145,46	161,32	13,79	147,53
15	170,6	14,71	155,85	172,85	14,78	158,07
16	181,9	15,69	166,24	184,37	15,76	168,60
17	193,3	16,67	176,63	195,89	16,75	179,14
18	204,7	17,65	187,02	207,41	17,73	189,68
19	216	18,63	197,41	218,94	18,72	200,22
20	227,4	19,61	207,8	230,46	19,70	210,76

In the table above, the savings per year consist of the yearly energy consumption and the production and transport energy consumption. The last two consumptions are divided spread out over 25 years.

A comparison between initial calculation of 2018 and 2019 shows that the gain of installing the new type of server is slightly higher than was estimated in 2018.

Instead of achieving a yearly reduction of 83 Ton kg CO₂ emission when 8 VPC's are installed, 84 Ton kg CO₂ is realised.

The installation of 2 VPU_N's on Hoekse Lijn sets the total number of VPC's replaced at 6 which will lead to yearly reduction of 63 ton kg per year in CO2 emissions.

5 Conclusion & New opportunities

The installation of 6 new energy efficient VPC's has set Bombardier well its on way to achieve its goal of installing 8 new energy efficiency VPC's by 2021.

However, the objective as it is set now should be redefined. First, the previous LCA calculation was based on the assumption that a new VPU_N would have on average 2 VPC's, but it is in fact always 3. Therefore, the number of 8 servers should be updated to 9 servers installed by 2021.

Second, to focus merely on the number of installed servers to reach an objective can also make it difficult to include other initiatives to achieve reduction in CO2 emissions at Bombardier.

From 2018 there are still some open points left for improvements.

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. Kontron could not provide Bombardier Transportation Netherlands B.V. with better production data.

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 References

Reference	Document code	Title	Revision
[1]	2019/09/1714	Life Cycle Analysis: Replacing old servers	A
[2]	3NSS010404D0007	VCS_N – Getting Started	1.6
[3]	CO2 emissiefactoren	https://www.co2emissiefactoren.nl/	2019-09-10
[4]	105-060	IBM xSeries 336 Speed Bump – Rack-optimized servers with up to 3.6 GHz with Intel Extended Memory 64 Technology	2005-02-15