Environmental Fact Sheet

Phase Adaptive Modules

The aim of this document is to provide relevant and reliable information on the environmental performance of the DIN Module Controller Phase Adaptive. Results reported in this Environmental Information Sheet are based on a Life Cycle Assessment (LCA) carried out by an independent company (Sphera).

This environmental information sheet is based on a Life Cycle Assessment (LCA) study conducted according to DIN ISO 14040/44 and inaccordance with the requirements of the PSR-0005 - Electrical Switchgear and Control Gear Solutions classification, from the PEP ecopassport® Program (PSR-0005-ed3-EN-2023 06 06, supplemented by the PSR-0006-ed2.1-EN-2023 12 08) and especially the specific requirements for "Switch".

All relevant environmental data relating to Climate Change (Carbon Footprint) as well as an overview of other environmental impact categories applying EN 15804+A2 methodology are disclosed in this information sheet.

Manufacturer

Lutron Electronics Co., Inc.
7200 Suter Rd, Coopersburg, PA 18036

Study conducted by

Sphera Solutions GmbH
Hauptstraße 111-113, 70771 Leinfel-den-Echterdingen, Germany

Product description

DIN Module Controller Phase Adaptive- QSNE-4A5-230-D
(as a base scenario)

DIN Module Controller Phase Adaptive- QSN-4A5-D (as a variant)

System description

The product system for this study considers the DIN Module Controller Phase Adaptive product as a baseline (QSNE-4A5-230-D).

The functional unit is defined according to the PSR Standard mentioned above, and the reference unit for this study is one DIN Module Controller Phase Adaptive used over 20 years.

Primary data for the analysis was collected by Lutron. Other relevant data, e.g., upstream processing of polymers, metals, magnets, motor, and others including relevant manufacturing processes according to the Bill of Materials information was taken from Sphera's 2024.2 Managed LCA Content, which is representative of the state-of-the-art processes.

Product reference

The functional unit is one DIN Module Controller Phase Adaptive operating over 20 years which establishes, supports and interrupts the rated current I and rated voltage U, and if applicable the specific specifications, for a wall-mounted or enclosure/cabinet installation, in the Household/Commercial or Industrial application areas.

Environmental Fact Sheet

Phase Adaptive Modules

Material content

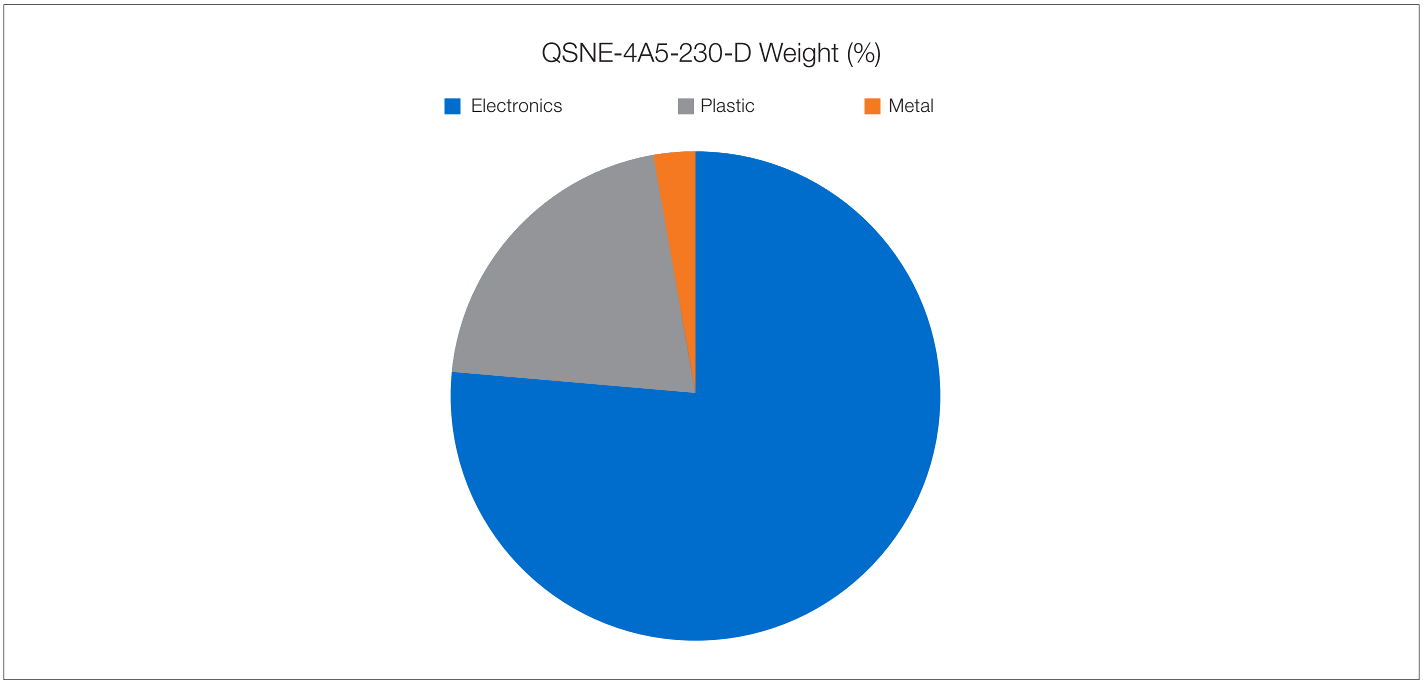

Figure 1: Material Content of QSNE-4A5-230-D, in weight

Material	% of total weight
Electronics	76%
Metal	3%
Plastic	21%

Environmental Fact Sheet

Phase Adaptive Modules

Scope of the LCA

A Cradle-to-Grave LCA study was carried out according to DIN ISO 14040/44 using LCA for Experts software. The system boundary includes upstream raw material production in China and their transportation to the manufacturing site in China. The Use phase was considered in UK, and End-of-Life (EoL) as treatment as base scenarios.

Environmental impacts of the system were calculated following EN15804+A2 methodology with a focus on Climate Change (kg CO2 eq.), while also addressing other midpoint impact categories.

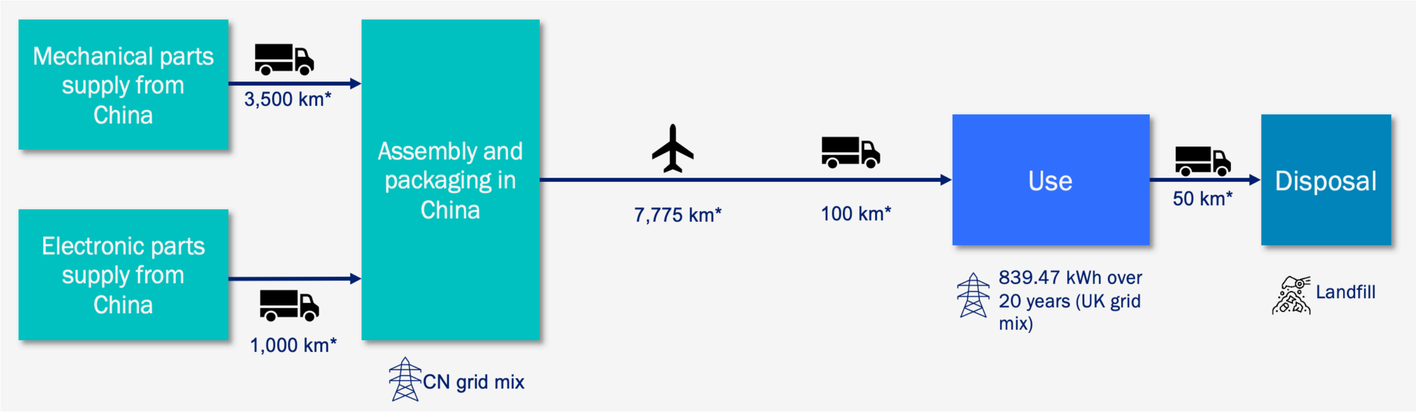

Figure 2: Schematic representation of the QSNE-4A5-230-D's life cycle
(*Default transportation scenario for continental, intercontinental and domestic transportation)

Parts manufacturing is performed in China. Final assembly is performed in China. Installation, usage and EoL are in UK. Transports have been considered as per default scenario provided in the PCR (3,500 km and 1,000 km trucks for continental transport, and 50 km for domestic transport). Default EoL is considered to be landfill.

DIN Module Controller Phase Adaptive - QSN-4A5-D is presented as a scenario of the baseline product. This differ in required assembly electricity and water (dependent on product weight), use-phase location, assembly location, use-phase energy consumption.

Calculation Rules

Calculation Rules are defined in the PSR and considers the following:

- The reference flow associated with the Life Cycle Assessment analysis consists of: the Product and its primary Packaging during the reference service life of 20 years.
- The electricity consumption in the use phase was calculated assuming 138 W for 5 min, 10 times a day.
- The energy consumption of the different parts constituting the functional unit are determined according to the rules of the in force PSR by considering figures communicated by the manufacturer to its customers (catalogues, datasheets, etc.).
- Waste from the Manufacturing Stage is defined in the PSR and considers that "10% manufacturing scrap was considered. Therefore, the input quantities were multiplied by a factor of 1.11 to get the same mass as output."
- Upstream packaging is defined in the PSR as 5% of product weight was considered as upstream packaging with the following proportions (wood: 50%, cardboard: 40% and plastic: 10%).
- The environmental impact results generated by the life cycle of the reference product with respect to the functional unit are equivalent to the environmental impacts with respect to the declared unit.

Environmental Fact Sheet

Phase Adaptive Modules

Climate change results for the base scenario

The Climate Change Potential of one DIN Module Controller Phase Adaptive is 290.18 kg CO2 eq. Use and manufacturing stages contribute to 88.73% and 9.80% of this value respectively, 98.5% together. In particular, EoL (assuming landfilling as default EoL destination) only contributes to 1.48% of the impact over the whole product life cycle and is not presented in more detail here.

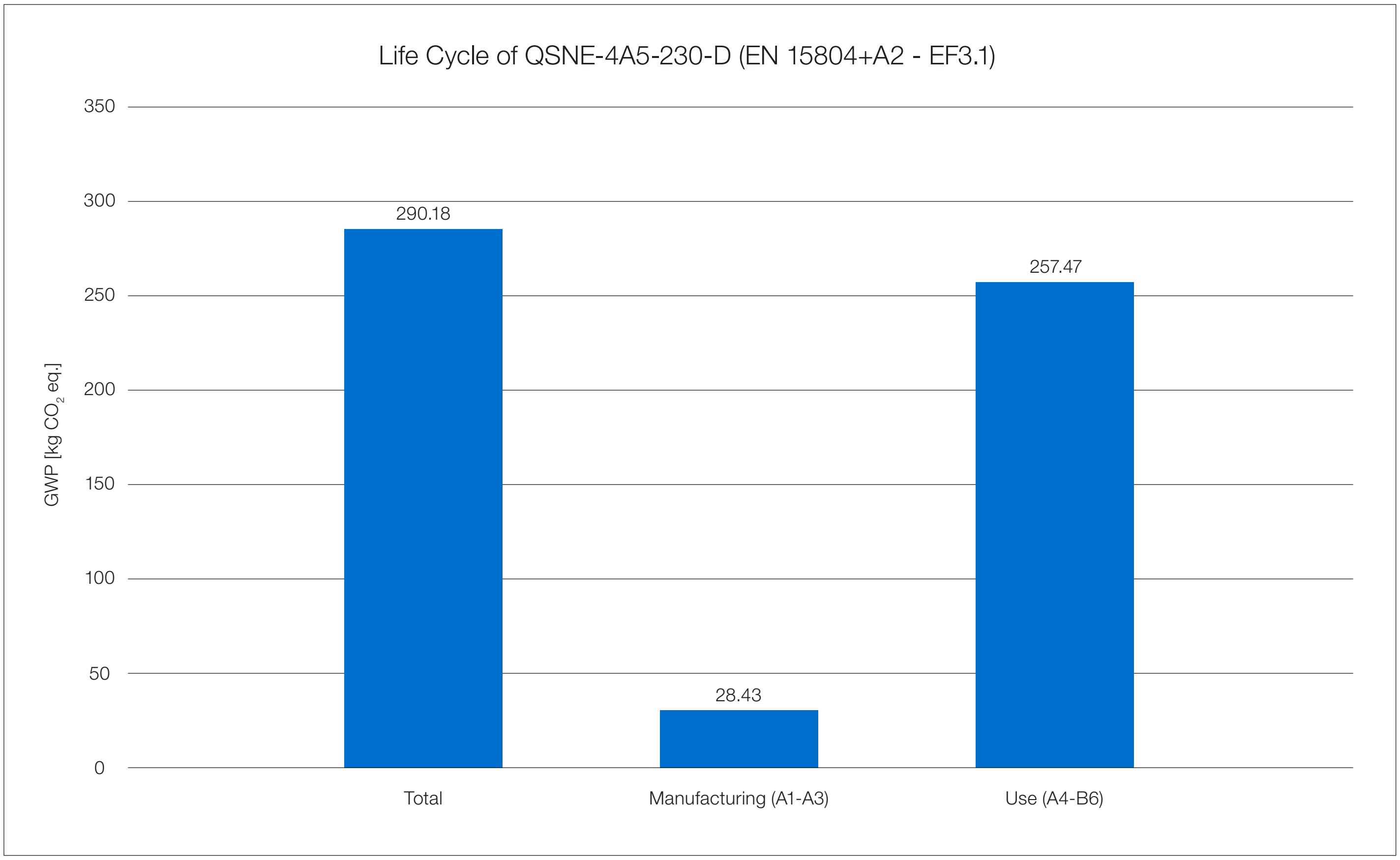

Figure 3: Climate Change Potential of one unit of DIN Module Controller Phase Adaptive

Environmental Fact Sheet

Phase Adaptive Modules

Climate change results for the base scenario

The manufacturing stage contributes to 9.80% of the total life cycle impacts in terms of climate change. The SMT-MB (SMT-MB mainboard and connectors) contributes to 57.70% of this value, followed by the SMT-CB (SMT-CB controlboard and connector) with 18.69%.

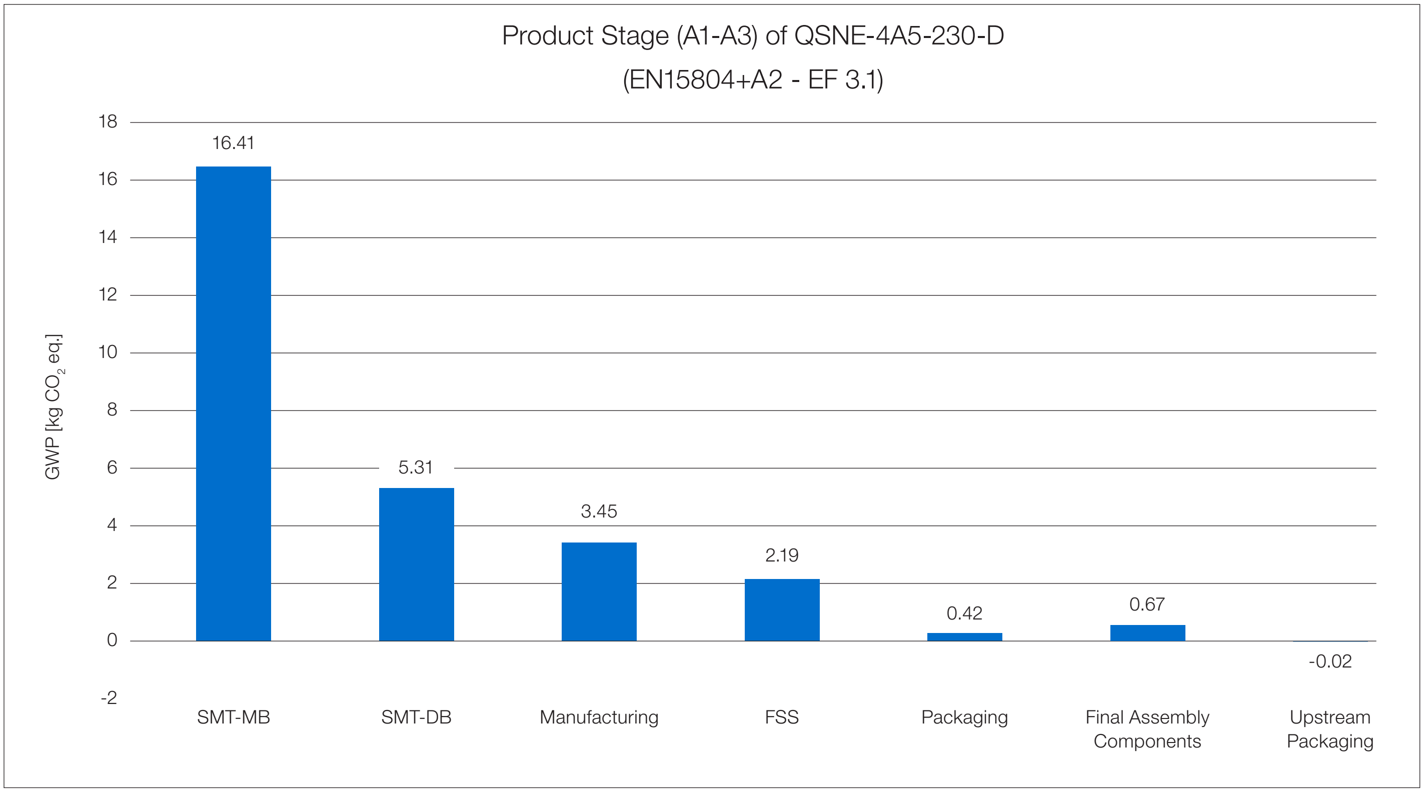

Figure 4: Climate Change Potential in the Manufacturing Stage of one unit of DIN Module Controller Phase Adaptive

Environmental Fact Sheet

Phase Adaptive Modules

Climate change results for the base scenario

The installation and use stages contribute to 2% and 98% of this value respectively. Phases B1 to B5 as well as B7 are not applicable for the use stage.

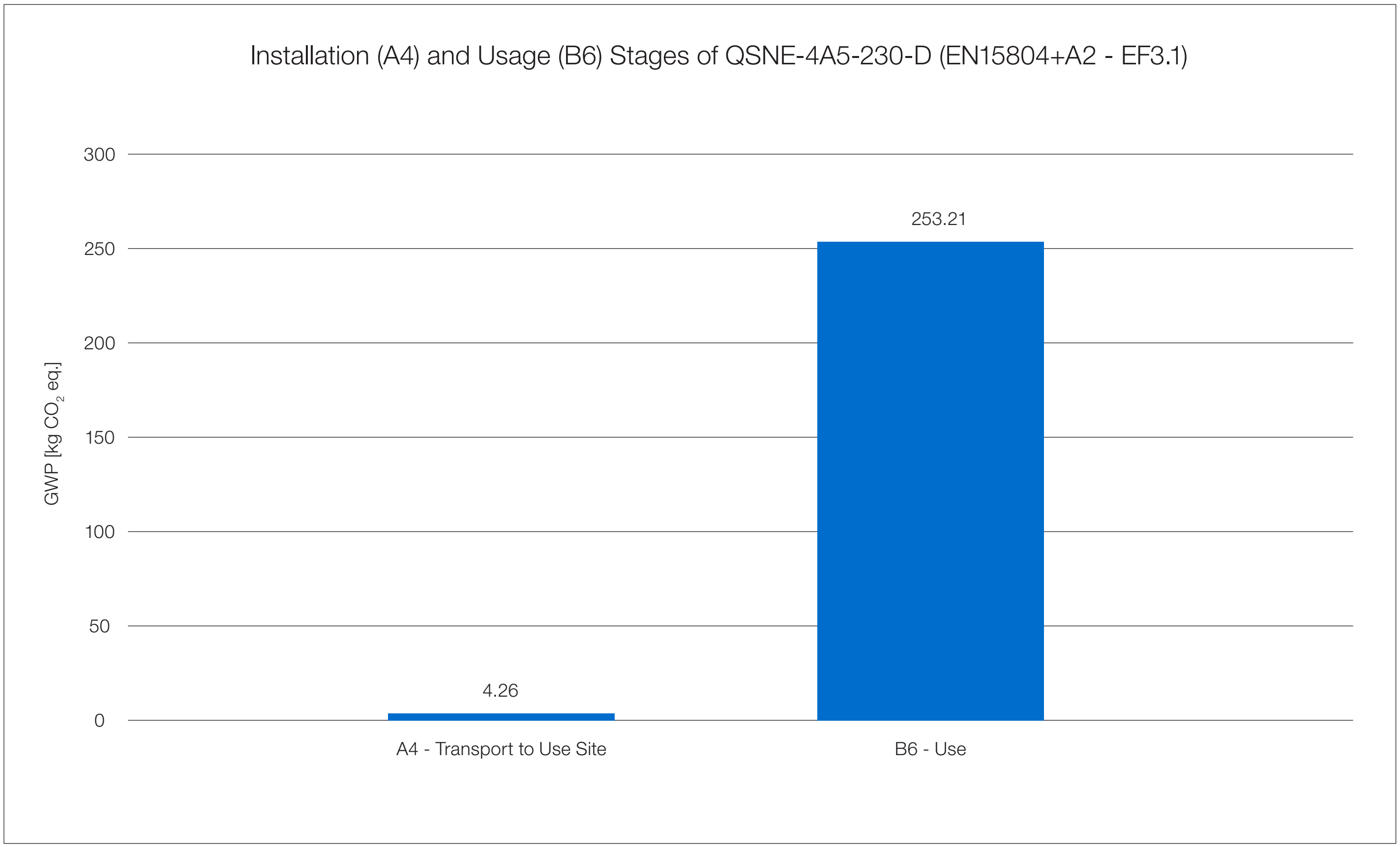

Figure 5: Climate Change Potential in the Installation and Use Stages of one unit of DIN Module Controller Phase Adaptive

Environmental Fact Sheet

Phase Adaptive Modules

Climate Change results comparing the base scenario with different DIN Module Controller Phase Adaptive variants

DIN Module Controller Phase Adaptive variants differ with required assembly electricity and water (dependent on product weight), use-phase location, assembly location, use-phase energy consumption. The GWP of DIN Phase Adaptive Family is between 290.18 and 358.01 kg CO2 eq.

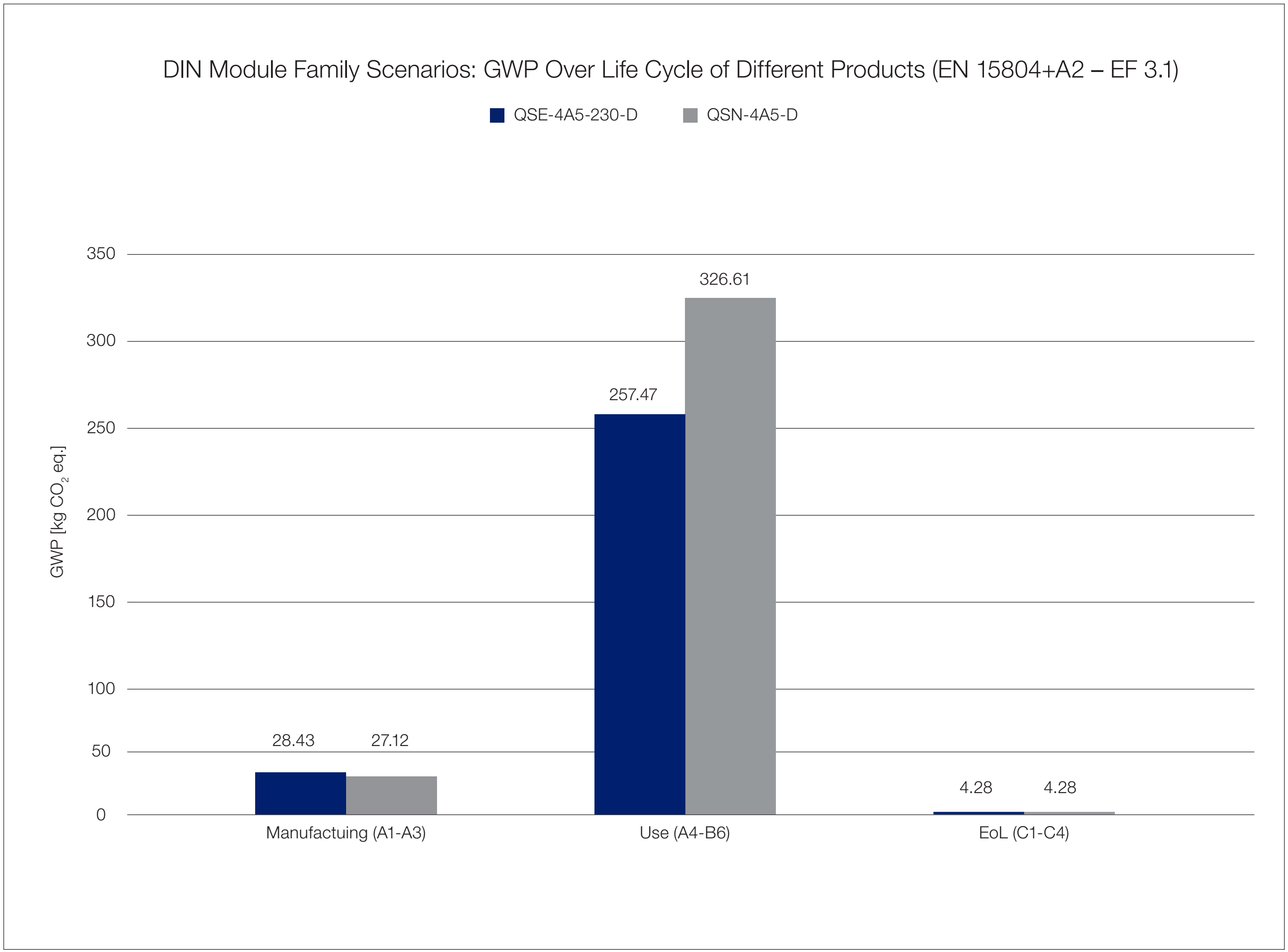

Figure 5: Climate Change potential in the Life Cycle of different DIN Module Controller Phase Adaptive variants

Environmental Fact Sheet

Phase Adaptive Modules

Additional environmental impact indicators

Impact category	A1-Raw Material Supply	A2-Transport (Upstream)	A3 - Manufacturing	A4 - Transport to use site	B6 - Use	C1-C4 - EoL
01 EN15804+A2 (EF 3.1) Climate Change - total [kg CO2 eq.]	2.48E+01	1.91E-01	3.45E+00	4.26E+00	2.53E+02	4.28E+00
02 EN15804+A2 (EF 3.1) Ozone depletion [kg CFC-11 eq.]	1.59E-10	3.20E-14	1.67E-11	2.62E-13	5.69E-09	3.13E-13
03 EN15804+A2 (EF 3.1) Acidification [Mole of H+ eq.]	3.74E-01	3.14E-04	1.19E-02	1.58E-02	4.85E-01	1.59E-02
04 EN15804+A2 (EF 3.1) Eutrophication, freshwater [kg P eq.]	1.19E-04	9.28E-07	9.53E-06	8.48E-07	1.04E-03	8.86E-07
05 EN15804+A2 (EF 3.1) Eutrophication, marine [kg N eq.]	2.44E-02	1.21E-04	2.62E-03	7.07E-03	1.21E-01	7.10E-03
06 EN15804+A2 (EF 3.1) Eutrophication, terrestrial [Mole of N eq.]	2.66E-01	1.40E-03	2.82E-02	7.75E-02	1.27E+00	7.78E-02
07 EN15804+A2 (EF 3.1) Photochemical ozone formation, human health [kg NMVOC eq.]	8.68E-02	3.20E-04	7.70E-03	2.01E-02	3.20E-01	2.02E-02
08 EN15804+A2 (EF 3.1) Resource use, mineral and metals [kg Sb eq.]	4.28E-03	1.89E-08	1.61E-07	1.04E-07	4.69E-05	1.06E-07
09 EN15804+A2 (EF 3.1) Resource use, fossils [MJ]	3.48E+02	2.86E+00	3.60E+01	5.60E+01	5.26E+03	5.63E+01
10 EN15804+A2 (EF 3.1) Water use [m³ world equiv.]	9.49E+00	3.36E-03	1.08E+00	6.79E-03	6.93E+01	7.94E-03

Table 1: Life Cycle Impact of one piece of DIN Module Controller Phase Adaptive in EN 15804+A2 categories

The trend indicated by the carbon footprint (indicator climate change, total, under focus in this document) is relfected in most of the other indicators. In this case, particularly, due to the high relative contribution of energy consumption in the use stage. It is the hotspot for most indicators except Resource use, minerals and metals.

Impact categories that relate to electricity consumption and fossil fuels behave similar to Climate Change, such as Resource Use fossils and Water use. The Eutrophication categories (which are slightly higher for A1) refer to the Manufacturing Stage's raw material extraction, specifically related to Phosphorus and Nitrogen emissions. Acidification Potential (AP) and POCP are also sensitive to raw material extraction and production processes, particularly copper and precious metals in electronics for AP due to sulfuric ores, and the energy consumption in their production associated with nitrogen oxide emissions. Resource Use, Mineral and Metals are by definition related to the extraction and production of raw materials and is here greatly dominated by the production of electronic components in A1. Ozone Depletion Potential is included for reasons of completeness, but the foreground system does not relate to relevant emissions and the background data have very few and minor non-representative residues left in the LCI, which make a meaningful interpretation impossible.

Environmental Fact Sheet

Phase Adaptive Modules

Additional environmental impact indicators

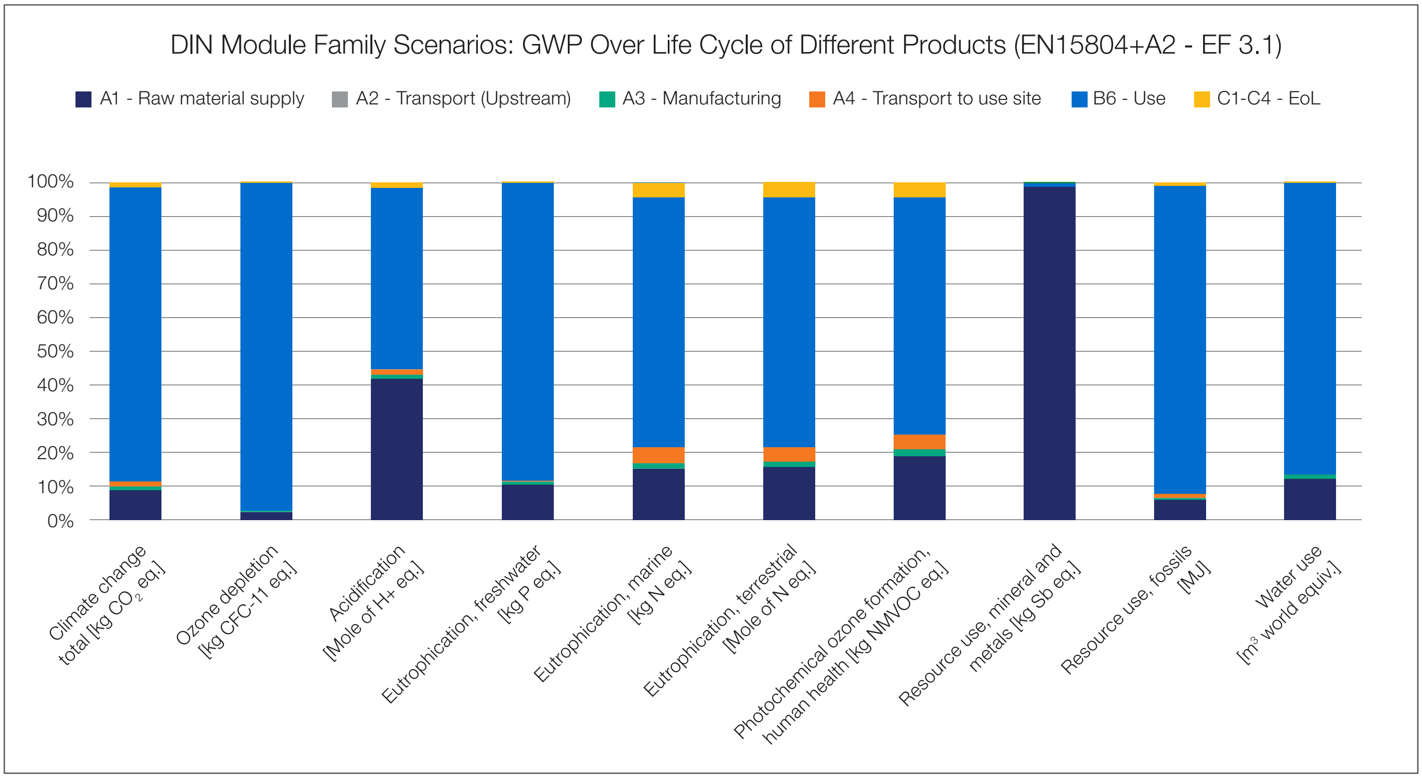

Figure 6: Life Cycle Impact of one piece of DIN Moduler Controller Phase Adaptive in EN 15804+A2 categories

Environmental Fact Sheet

Phase Adaptive Modules

Summary and conclusion

With the aim to assess the environmental impact of the DIN Module Controller Phase Adaptive produced by Lutron, Climate Change Potential was used as a reference indicator in this study due to its stability and global importance.

Climate Change was used as a reference indicator to assess the environmental impact of the DIN Module Controller Phase Adaptive produced by Lutron. The results on all impact categories show that climate change can be used as a good proxy to estimate the environmental impacts of this product and identifying its impacts. Exception to this rule is the impact category “resource use, minerals and metals”, which is specifically influenced by metal contents in electronics and hence behave differently from the other impact categories.

Within the Cradle-to-Grave system boundary of the device, the LCA study shows electricity consumption during the Use Stage as the main hotspot for Global Warming Potential, followed by the manufacturing of electronic components. The observation of the hotspot is seen as a trend in most other environmental categories as well.

The scenario analysis shows that the Climate Change results of different product variant of the DIN Module Controller Phase Adaptive (QSN-4A5-D) are higher than 23.38% of the total impacts.