VOLVO

How LCA helps to understand the true environmental impact of electric buses

Mobility Insights by Volvo Buses

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The rapid transition to electromobility has sparked a broader discussion about the total environment impact of electric vehicles. To quantify the impact, there is a standardized method; Life Cycle Assessment (LCA).

How does Volvo Buses work with LCA? How can LCA help public transport authorities, operators and other stakeholders when opting for the most sustainable solution? Volvo Buses' expert Maria Wedenby explains.

MARIA WEDENBY has been responsible for Public Affairs at Volvo Buses since January 1, 2022. She has extensive experience in the bus industry and in-depth knowledge in electromobility and sustainable transport solutions. In her former role as City Mobility Director at Volvo Buses, she worked closely with cities, authorities and operators to ensure the optimal system solutions. As Head of Public Affairs, Maria Wedenby represents Volvo Buses in international committees within industry organisations, such as UITP and ACEA.

5 questions and answers about LCA

1. What new environmental requirements are placed on suppliers of electric buses?
2. How far has the bus industry come in terms of LCA?
3. How does Volvo Buses work with LCA?
4. What is the environmental impact of an electric bus from a life cycle perspective?
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1

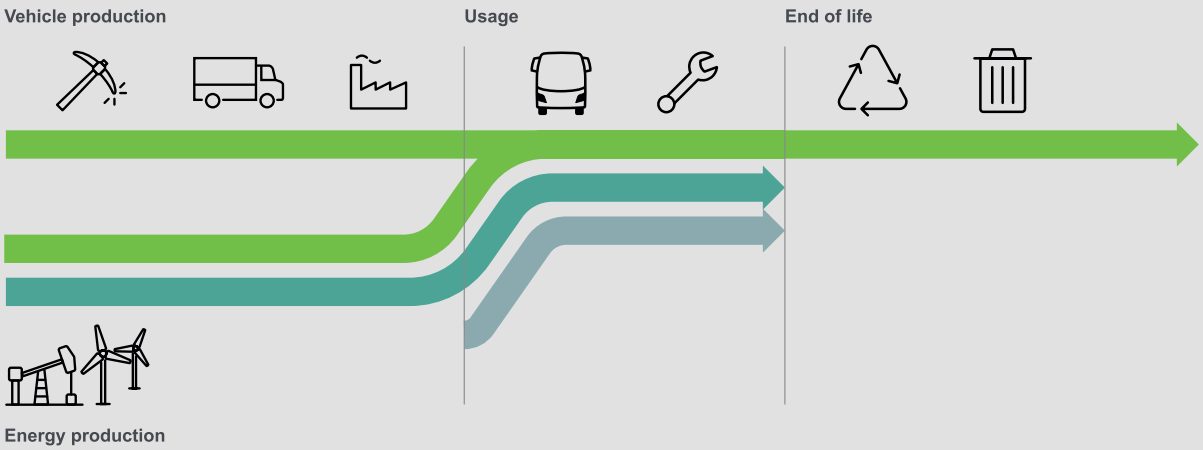
What new environmental requirements are placed on suppliers of electric buses?

The climate issue is more acute than ever. For governments, cities, operators and other stakeholders in public transport, it's very important to know what type of technology is most sustainable to be able to make the right decisions.

Historically, the main focus has been on emissions, i.e. the vehicles' environmental impact during the use phase. Today, we meet a growing interest, and even demand, for a full Life Cycle Assessment (LCA) of our products. All stakeholders want to know the bus's environmental impact throughout the entire life cycle, from raw materials, manufacturing, operation and maintenance, and how the product is taken care of at the end of its service life. Therefore, recovery and recycling of materials, as well as remanufacturing of components, are included in a full LCA. Furthermore, the second life of traction batteries is also an issue on the agenda.

Sources of global emissions throughout the lifecycle

The main purpose of LCA is to identify and quantify the environmental impact of a product, service or a system in a cradle-to-grave perspective. The life cycle includes production, usage and end-of-life.



LCA — **Life Cycle Analysis**
Total environmental impact, cradle to grave

WTW — **Well-To-Wheel**
Impact from energy production and emissions in operation.

TTW — **Tank-To-Wheel**
Impact from emissions in operation.

The main reason for those requests is the rapid transition to electric vehicles in public transport. Unlike fossil-fueled buses, electric buses have no tailpipe emissions. Still, the electricity they use causes emissions when it is produced, and these emissions must be taken into account. That's what we call well-to-wheel (WTW). And subsequently, the WTW figures must be included in a full LCA calculation. It is apparent that the carbon footprint of electricity production has a major impact – in the use phase and overall.

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How far has the bus industry come in terms of LCA?

In the transport industry, city bus operations in public transport have been an important driver in the transition to electromobility. The bus industry is therefore in discussions with PTAs and PTOs about the scope and how to set up the LCA of electric buses in a harmonised way. The intention with LCA is to provide verified and comparable information within a product category.

However, according to the ISO norms, you can only make a 1-to-1 comparison between products if processes and prerequisites are identical, but this is seldom the case. Nevertheless, the information from these LCA analyses provides a good indication of a product's environmental performance.

The urgency in fighting global warming, the increasing awareness of air quality-related health problems, and new EU regulations, call for a more unified application of LCA studies in public transport. Within UITP, there is ongoing work on how to make it easier for stakeholders around the world to understand and interpret this type of environmental calculation. In addition, the EU Commission is considering to propose common methods, within the ISO standards, on LCA and CO_2 calculations from a WTW perspective.

> “City bus operations in public transport have been an important driver in the transition to electromobility.”

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How does Volvo Buses work with LCA?

LCA is one of several methods we use to work towards our environmental goals. As part of the Volvo Group, Volvo Buses is fully committed to supporting the Paris Agreement to limit global warming by 2050, and we have already set some of the most ambitious climate targets in the industry to be reached by 2030. The targets are validated by the Science Based Targets initiative (SBTi) and the Volvo Group will report accordingly on the progress.

Our target is to reach a net-zero value chain emissions by 2040 at the latest and the ambition is to sell 100% fossil-free products that same year. The Volvo Group is developing a large range of products with zero emissions, which will be available, step by step, in all segments by 2030.

Volvo Buses' strategy to reduce the environmental impact of our products is to minimise harmful effects in all phases of their life cycle. LCA and other environmental calculations have long been an essential part of that work. LCA also helps us to guide and advise PTAs, operators, and other stakeholders concerning migration to more sustainable transport solutions. Volvo Buses is at the forefront and leading many discussions globally in this area.

In 2018, we actively took part in developing the UITP Tender Structure Document including Annex IV – Environmental Calculations. For example, it includes comparison of all bus types from WTW and TTW perspective. Since then, the model has been used globally in many discussions with authorities and operators, at seminars and UITP training sessions.

Since 2020, Volvo Buses has been submitting full LCA Environmental Declarations for Volvo 7900 Electric and Volvo 7900 Electric Articulated, and the Environmental Declaration for the new Volvo BZL Electric chassis is due in 2022. These LCA declarations are conducted in compliance with ISO 14040 and 14044 standards.

Data collection is a very complex process and includes everything from material content, energy consumption, water consumption and waste, to preventive maintenance, fuel consumption and the vehicle's life length.

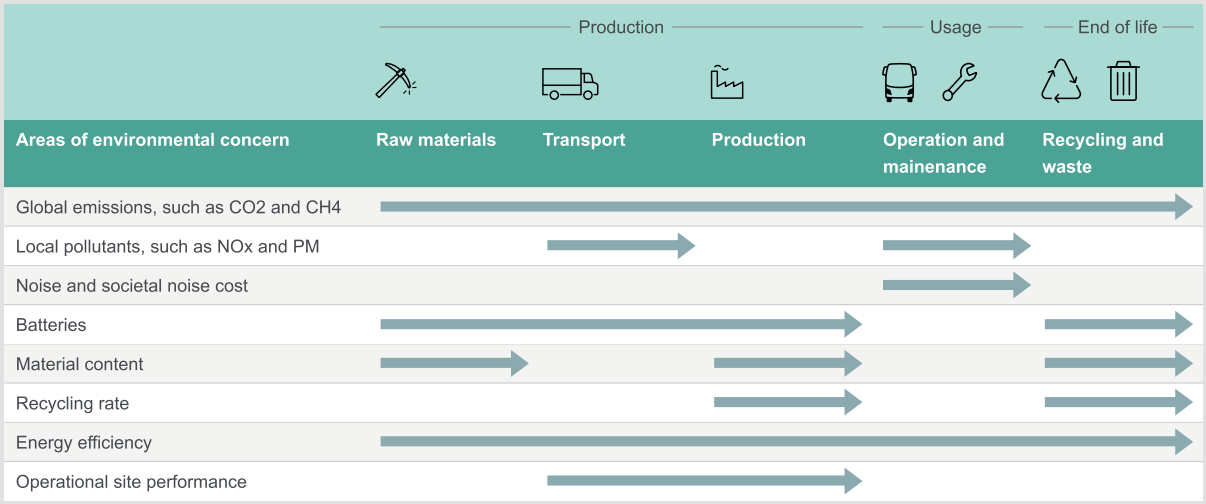
The process of collecting data from the whole supply chain is constantly improving. In parallel with the development of LCA softwares with databases of generic data, Volvo Buses has a systematic and close collaboration with our suppliers, in order to increase the amount of verified data.

When all necessary data for a product is collected, the LCA is performed by an independent contractor.

> "LCA analysis and other environmental calculations have long been an essential part of that work."

Environmental impact through the life cycle

Environmental performance includes more than CO2 emissions and energy efficiency. Material composition, recycling and production methods have an impact on an LCA, as well as several other types of emissions and pollutants.



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What is the environmental impact of an electric bus from a life cycle perspective?

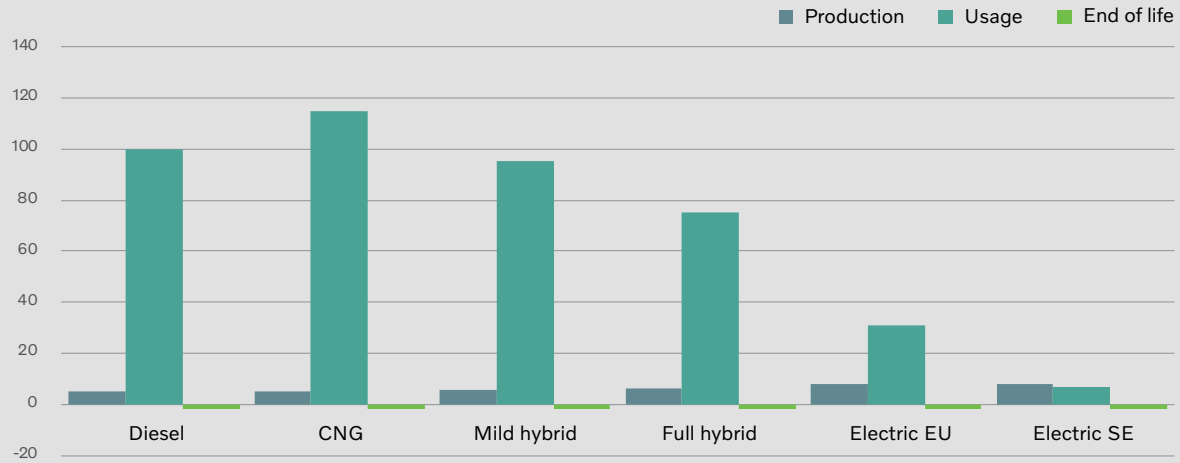
When it comes to conventional buses, such as diesel and gas, the use phase stands for the absolute majority of the environmental effects in an LCA calculation. For electric buses, the impact in this phase is closely related to where and how the electricity used for propulsion is produced.

The carbon footprint during operation can vary immensely, depending on how the electricity is produced. Typically, the emitted CO_2-equivalents from power production spans from ≈12 g/kWh from modern wind power to ≈1,200 g/kWh from using brown coal. So, it's obvious that the electricity mix used for charging is the single largest factor when it comes to environmental impact from electric buses.

Efforts aim at cleaner electricity production will work in favour of electric buses. Still, this is an important factor that must be considered when performing and analyzing environmental calculations.

Climate impact of buses

Typical global warming potential in CO2 equivalents of electric and conventional buses in an LCA perspective.



The chart is indicative, with average diesel bus as reference at index 100. Impact from the electricity mix applies to the use phase only, where EU-mix is set to 275 g/kWh while a Swedish figure is set to 65 g/kWh of CO2 equivalent. For end-of-life, recycling has been credited, which results in a negative figure.

Sources: Use phase relative impact is according to UITP Tender Structure, Annex IV. Manufacturing and end-of-life relations are weighed average estimates from Volvo Group.

> “It’s obvious that the electricity mix used for charging is the single largest factor when it comes to environmental impact.”

Currently, the production phase of electric buses has a higher environmental impact compared with conventional buses. The main reason for this is the manufacturing of batteries that requires additional resources and energy.

As battery development is fast-moving, the environmental impact needs to be continuously evaluated. The use of scarce raw materials, working conditions in mines and potential to recycle cell materials are parameters where more research is needed.

Also, the application of used vehicle batteries in infrastructural energy networks has a great potential and is an area to be further developed. From a life cycle perspective, the second life usage of batteries means that the ‘in-use’ phase is significantly extended, reducing the overall environmental footprint.

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What role does LCA play in the shift towards a circular economy?

The world's resources are limited, and we must carefully consider all the materials and technologies we use in our products and processes. LCA helps us identify improvements throughout the entire life cycle and it is an important tool in our quest for circularity. With accurate data, we can influence and improve our products' sustainability profiles in the early design phase. It also helps us proactively evaluate alternatives in the design and supply processes to minimize and eliminate scarce materials and substances of concern.

Recycling is paramount. We continuously seek to increase the recycling at the end of the vehicle's service life, as well as the use of recycled material in manufacturing. If we look at the recyclability and recoverability index for a Volvo 7900 Electric bus these figures are 87.7% and 98.2%, respectively, according to the ISO22628 standard. In fact, a higher figure than that required in the car industry, currently at 85 and 95%.

From linear to circular economy

Linear economy

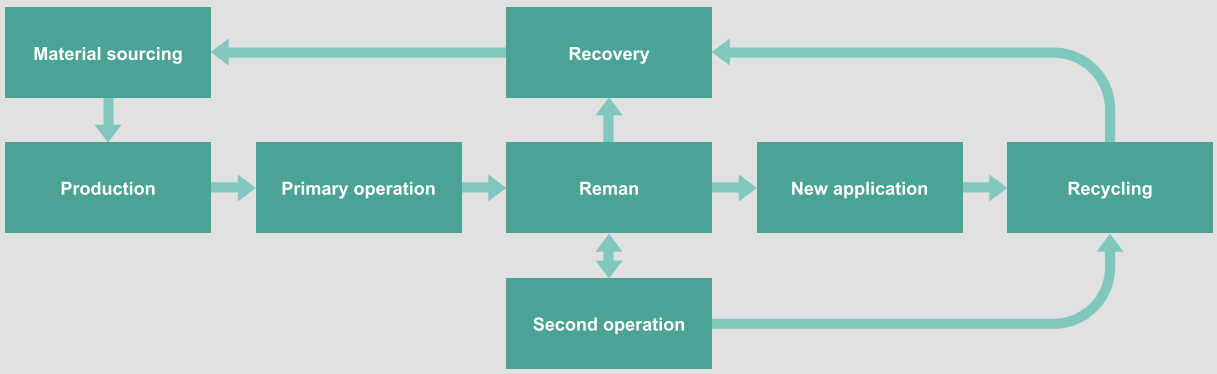
Circular economy

Again, one of the most crucial issues in the shift towards electromobility besides electricity production is the production, usage and recycling of batteries. The EU Commission recently presented a proposal of an EU Battery Directive on how to report the environmental impact of batteries and recycling was an essential part of the scope.

This is already high on our agenda. Within the Volvo Group, a lot of research and development work is ongoing in this area. This includes investigating the possibility to remanufacture batteries. And we are already co-operating with recycling companies and other actors, installing used bus batteries as energy storage in various applications.

With an increased focus on the circular economy and higher demands on transparency of data in the transport industry, LCA will play an even more important role going forward. Therefore, Volvo Buses is very active in this area of competence. We have regular discussions with the European Commission, international organisations, PTAs, PTOs and other stakeholders. Spreading and increasing the knowledge about these issues are important steps in the transition to more sustainable public transport.

Reuse and recycling of batteries



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