A close-up, low-angle shot of the front of a white Siemens Avenio train. The train is sleek and modern, with a large windshield and a digital display above it showing the word 'Avenio'. The train is set against a dark, blue sky. The Siemens logo is visible on the front of the train.

SIEMENS

Ingenuity for life

Avenio

Product Environmental
Declaration according to
ISO 14021 Type II

[siemens.com/mobility](https://www.siemens.com/mobility)

The product

Avenio, the new family of low-floor trams: unique vehicles made for today's cities. The innovative Avenio single-articulated trams can be adapted to the individual requirements of public mass transit – comfortable and efficient, safe and reliable. They also meet the highest standards in terms of green mobility, thanks to reduced energy costs and an exceptionally long service life.

The Siemens Environmental Mission Statement – responsibility in action

For Siemens, protecting the environment is not only sound business practice and part of our duty as a good corporate citizen, but is also a key success factor for our company. We fulfill these commitments with advanced manufacturing processes, innovative products, and the highest environmental management standards. **Our goal:** Conserve natural resources in all areas of the company and, in so doing, protect the environment.

This approach is based on Siemens' EHS principles relating to environmental protection, healthcare management, and safety. Consistent and innovative environmental management that exceeds the legal requirements is an integral part of our business processes and our contribution to sustainable company development.

2 modules 18 m	Seats	Standing places	Total
2.30 m	24	79	103
2.40 m	36	73	109
2.65 m	36	86	122
3 modules 27 m	Seats	Standing places	Total
2.30 m	42	118	160
2.40 m	50	122	172
2.65 m	52	140	192
4 modules 36 m	Seats	Standing places	Total
2.30 m	52	170	222
2.40 m	72	164	236
2.65 m	72	192	264
5 modules 45 m	Seats	Standing places	Total
2.30 m	68	211	279
2.40 m	96	200	296
2.65 m	96	235	331
6 modules 54 m	Seats	Standing places	Total
2.30 m	80	260	340
2.40 m	112	250	362
2.65 m	112	292	404
7 modules 63 m	Seats	Standing places	Total
2.30 m	104	292	396
2.40 m	144	276	420
2.65 m	144	326	470
8 modules 72 m	Seats	Standing places	Total
2.30 m	116	341	457
2.40 m	160	326	486



Basis for calculating standing places: 4 passengers/m2 in a bi-directional train

Environmental key figures

Depiction of the key environmental figures makes it possible to compare products in relation to their environmental compatibility. The calculated key figures apply to the basic configuration of the Avenio platform and to the intended operating conditions.

Test object

The environmental declaration was prepared on the basis of the Avenio platform in its basic configuration. Refer to the table below for the technical data. A product environmental declaration according to ISO 14025 Type III, including an eco balance sheet according to ISO 14040, can be generated based on customer-specific requirements.

Material composition

We comply with requirements according to the "UNIFE Railway Industry Substance List" throughout the entire supply chain. This ensures that no banned materials or substances are used that could harm humans or the environment. In their basic configuration, trams in the Avenio family have a total mass of approximately 47 metric tons and consist of 84% metal materials such as steel and aluminum (see Figure 1).

Technical data of the Avenio platform basic configuration	
Vehicle configuration	4-section low-floor articulated multiple unit for unidirectional operation
Wheel arrangement	Bo'2'Bo'Bo'
Line voltage	750 V DC
Track gauge	1,435 mm
Vehicle length over buffers	36,850 mm
Vehicle width	2,300 mm
Low-floor area	100 %
Entrance height	300 mm
Capacity (4 passengers/m ²)	216, including 69 seats
Maximum speed	80 km/h

Figure 1: Material composition of the Avenio tram.

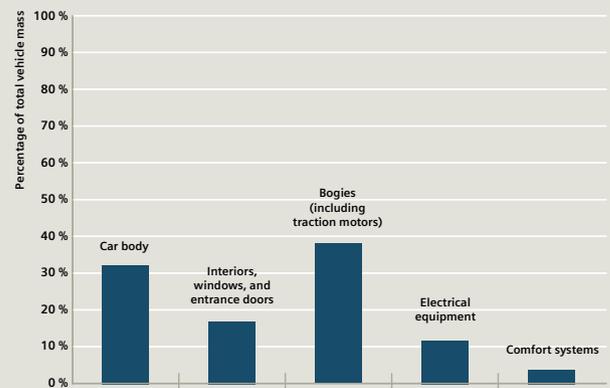
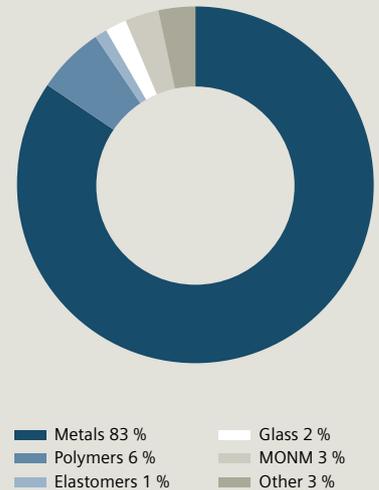


Figure 2: Mass assignment to the main product groups

Greenhouse warming potential

The greenhouse warming potential describes the global warming caused by greenhouse gases, such as carbon dioxide (CO₂) and methane (CH₄). Under the described conditions for the lifecycle stages, the greenhouse warming potential of the Avenio trams (4-section basic configuration) is 8.74 grams of CO₂ equivalent per kilometer and passenger over the entire lifecycle. The largest portion by far of these emissions (8.60 grams of CO₂ equivalent per kilometer and passenger) is generated during operation. The energy mix used to operate the Avenio trams is crucial for emissions volume: If a majority of this power is generated from renewables, the Avenio's emission potential can be reduced even further.

End of life

Due to the use of natural and recyclable materials, the Avenio is 95.5% recyclable, where 92.5% of the materials are recycled and 3% is recovered by incineration in caloric power plants (see Figure 4). Vehicle disposal yields a benefit of 75 metric tons of CO₂ equivalent.

Fire safety

The Avenio platform was designed according to the fire safety requirements under EN 45545. The material certificates were generated according to DIN 5510-2/EN 45545-2. The trams can be equipped with fire alarms and temperature sensors, allowing fire to be detected at an early stage.

Emissions comparison

Thanks to the Avenio's high efficiency, greenhouse gas emissions during the operating phase are much lower than in private transportation (source: Ecoinvent Version 01.02.2011, 100% capacity utilization). Compared to a car with an internal combustion engine, the Avenio reduces greenhouse gas emissions by as much as 80% per passenger (see Figure 5).

Noise and vibration development

The outdoor noise level (LpA_{eq,Tp}) generated by a passing train traveling at a speed of 60 km/h is maximum 78 dB(A) at a distance of 7.5 meters from the center of the track. While the indoor noise level (LpA_{eq,T}) within the passenger compartment is between 68 and 71 dB(A) – at a speed of 60 km/h according to ISO 3095 (outdoor noise) and ISO 3381 (indoor noise) or VDV154/2011.

The outdoor and indoor noise emissions and the ground borne vibrations generated during operation (minimal unsprung masses) were minimized for the comfort of passengers and residents living near the railway tracks.

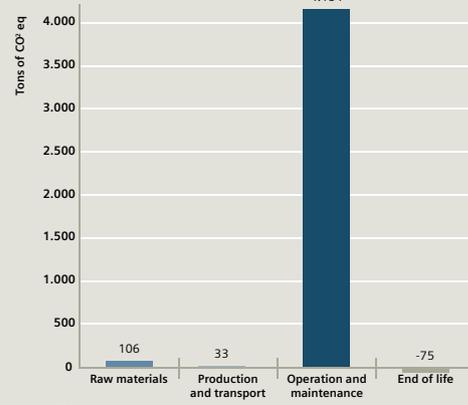


Figure 3: Greenhouse warming potential of the Avenio family during the different lifecycle stages.

Figure 4: End-of-life behavior of Avenio light rail vehicles.

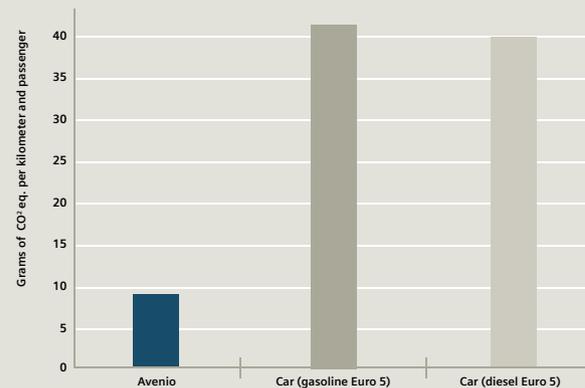
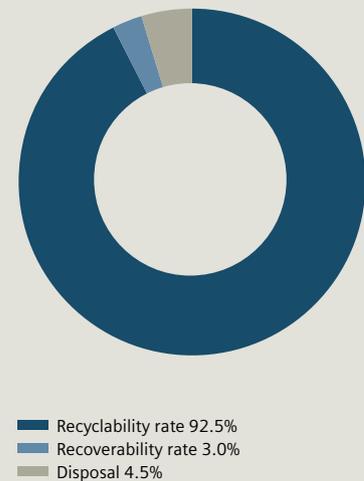


Figure 5: Comparison of greenhouse gas emissions between the Avenio family and modern cars.

Lifecycle stages

From development to disposal: The Avenio platform benefits from Siemens' more than 135 years of experience in tram engineering and almost 25 years in low-floor technology. The effects on the environment have literally made breathing easier: The trains are quiet, wear-resistant, and low-emission, and after a period of use of 30 years or more are over 95% recyclable.



Raw materials

This stage covers the materials used to manufacture the Avenio platform. All processes and effects on the environment were taken into account, from extracting raw materials to manufacturing semi-finished products.



Production and transport

This stage covers all materials, energies, and fuels used in the manufacturing process. The lifecycle data was taken from the EHS report (fiscal year 2013/14) of the Siemens production facility in Vienna. This data was assigned to the Avenio platform according to defined allocation methods.

Disposal of the production waste materials was also taken into account. Delivery to the end customer was estimated on the basis of a distance of 500 kilometers. The vehicles were transported by road.



Operation and maintenance

The energy consumption shown was calculated on the basis of realistic operating conditions. Fully loaded and with an energy recovery rate of up to 45%, the energy consumption starts at 12.6 Wh per kilometer and passenger. Operation over a 30-year period of use was based on a total annual mileage of 70,000 kilometers.

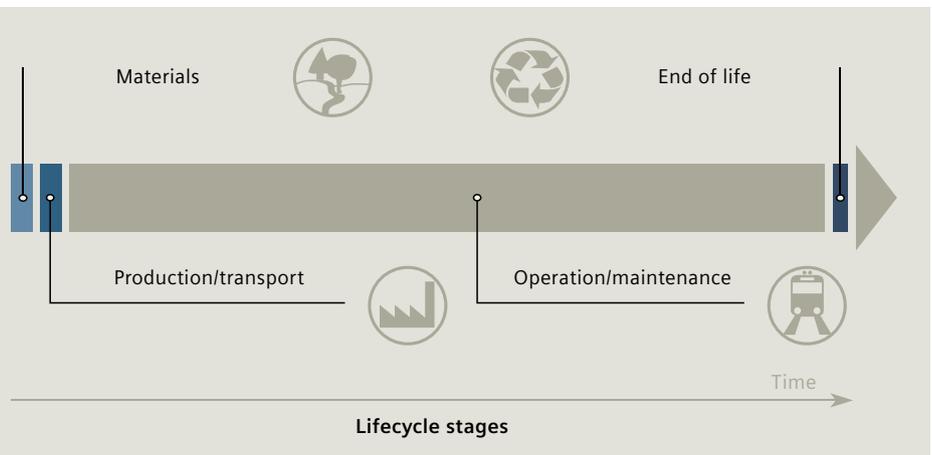
Energy consumption values can be calculated individually based on the train configuration and the route traveled, including vehicle options (such as an energy storage unit).

The trains are operated with the average European energy mix. The materials required for maintenance and the disposal of waste materials were taken into account on the basis of the preventive maintenance plan.



Disposal

The calculation for the final lifecycle stage was based on a theoretical recycling process involving pretreatment, dismantling, and shredding according to the "UNIFE Recyclability and Recoverability Calculation Method for Rolling Stock." This made it possible to show the recyclability and recoverability of the Avenio platform, taking into account its current dismantling and recycling characteristics.



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