Downner
Relationships creating success

中车长春轨道客车股份有限公司
CRRC CHANGCHUN RAILWAY VEHICLES CO., LTD.

Sydney Growth Trains

Environmental Product Declaration in accordance with ISO 14025

EPD registration number: S-P-001161
Approval date: 2018-09-07
Valid until: 2021-09-07
Geographical scope: Australia

AUSTRALASIA EPD

Contents

Foreword

At Downer, environment and sustainability is embedded in our business and is a core element of delivering on our Purpose and Promise.

We exist to create and sustain the modern environment by building trusted relationships with our customers. We do this by conducting our activities in a manner that is environmentally responsible and sustainable so our business is fit for the future.

For Downer, offering the most reliable fleet on the rail network is the foundation of our rail transportation success. We are proud of our ongoing, exceptional fleet performance and committed to bolstering the performance of our mobility solutions.

We are committed to improving asset maintenance and encouraging condition-based maintenance which is executed through our dedicated engineers and innovation resources and partnerships with universities to develop new solutions for the rail industry.

I am pleased to present the first Australian-verified Environmental Product Declaration for our Suburban Sydney Growth Trains and look forward to seeing the fleet enter passenger service.

Michael Miller
Executive General Manager –
Rollingstock Services

About Downer

At Downer, our customers are at the heart of everything we do.

We exist to create and sustain the modern environment and our promise is to work closely with our customers to help them succeed, using world-leading insights and solutions.

Our business is founded on four pillars:

Our Pillars

Safety	Delivery	Relationships	Thought leadership
Zero Harm is embedded in Downer's culture and is fundamental to the company's future success	We build trust by delivering on our promises with excellence while focusing on safety, value for money and efficiency	We collaborate to build and sustain enduring relationships based on trust and integrity	We remain at the forefront of our industry by employing the best people and having the courage to challenge the status quo

Downer has over 100 years' rail experience and has expertise covering all sectors from rolling stock to infrastructure and in every project phase, from manufacturing to through-life-support and operations.

Downer's track record spans project management services, engineering design, systems engineering, supply chain engagement, systems integration, manufacturing, logistics, testing, commissioning, asset management, fleet maintenance, rail infrastructure design and construction, through-life-support and operations.

As Australia's leading provider of passenger rolling stock asset management services, we deliver reliable and safe services to the fast-growing and dynamic public transport sector and partner with our customers to deliver solutions across all transport domains. These include: heavy rail, electric and diesel trains, light rail, bus, and multi-modal transport solutions.

In Downer, whole-of-life asset considerations in New South Wales, Australia are met in accordance with (but not limited to):

- Authorised Engineering Organisations (AEO) requirements
- Rail Safety National Law requirements.

Leveraging our global supply chain, Downer has formed strategic joint ventures and relationships with leading technology and knowledge providers including CRRC Changchun Railway Vehicles Co, Ltd.

Both Downer and our Significant Contractor CRRC Changchun have ISO 14001:2015 Environmental Management System certification that drive performance in delivering environmental and sustainable outcomes.

Sydney Growth Train

Reliable Mobility.

The Sydney Growth Train (SGT) delivered by Downer, is the centrepiece of the New South Wales Government's *More Trains, More Services* program. The Downer SGT fleet is based on the proven Waratah platform which continue to show exceptional performance in reliability and availability, and is the current generation train operating on the Sydney rail network.

The SGT presents a high standard for heavy rail transportation, with reliability in design and through life support at the forefront of our rail transportation solutions.

Downer will:

- Supply and deliver 24 new eight-car, Waratah-style modern suburban trains
- Equipment, maintenance and operation of a Maintenance Facility for the trains
- Maintenance and providing Through Life Support (TLS) for the fleet and other related assets.

CRRC Changchun have manufactured and supplied the SGTs, while Downer delivered testing, commissioning of the fleet into service and the TLS of the trains.

Manufacturing Phase

The manufacture of the SGT trainsets was predominately completed out of CRRC Manufacturing Facility, located at Changchun.

Testing and Commissioning Phase

Limited final assembly, testing and commissioning was completed at Downer's Cardiff Service Delivery Centre and Auburn Maintenance Centre both located in New South Wales.

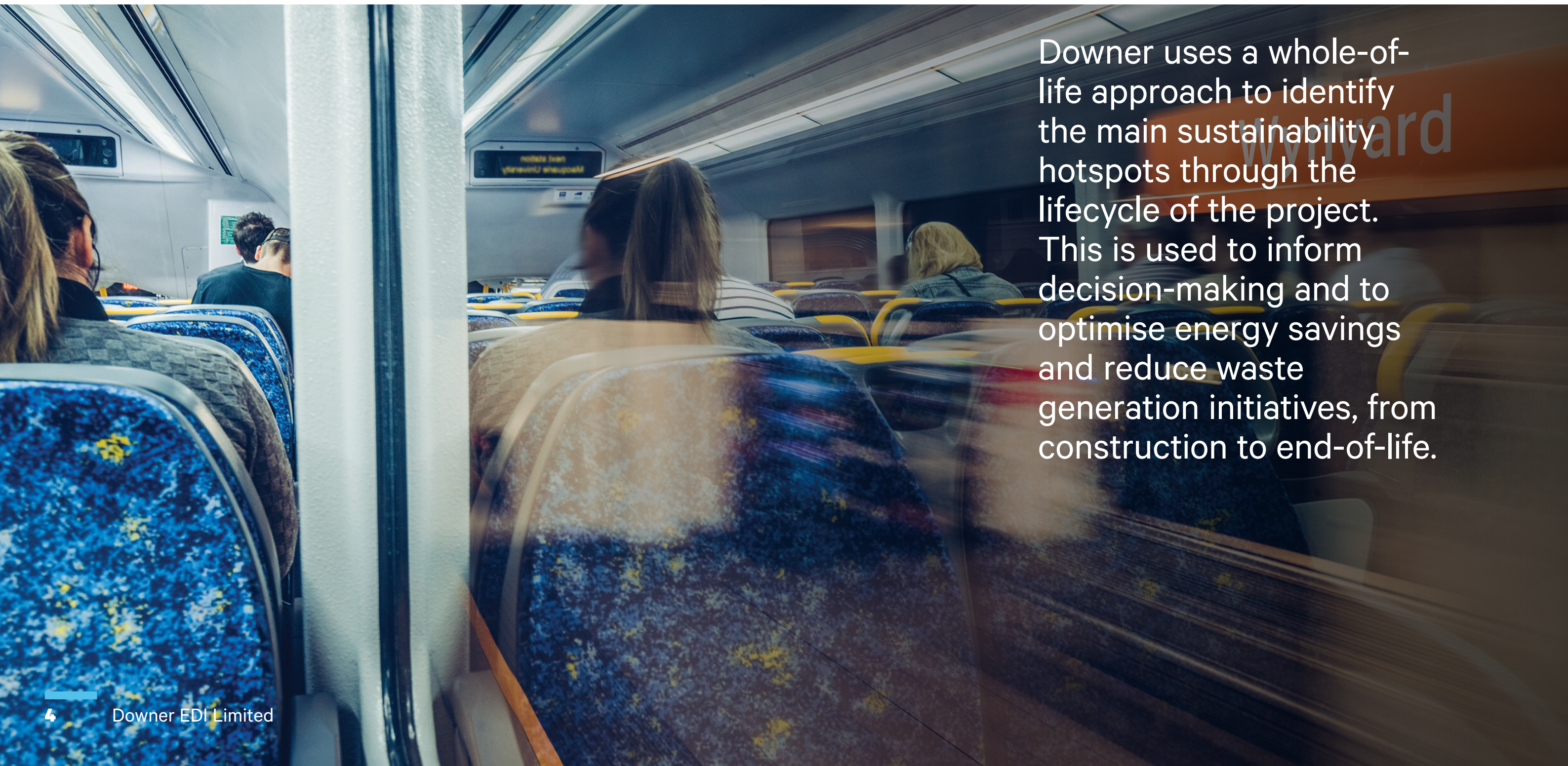
Through Life Support Phase

The TLS Phase of the SGT trainset activities will occur at Downer's Auburn Maintenance Centre and will conduct activities such as maintenance, spare part management, subsystem and component servicing and upgrading.

Downer develops and delivers world-class trains with exceptional fleet performance, environmental and sustainability outcomes through a range of innovations and proven methods that minimise energy use, generation of pollutants and waste, and support effective use of technologies that contribute to overall reliability.

The SGT will provide a reliable and comfortable commuter service when the new trains begin service. Key features of the new trains, based on the highly successful Waratah train design, include:

- Improved air-conditioning with advanced temperature control
- High definition customer information screens to provide journey and safety information
- Internal and external CCTV and customer help points.



Downer uses a whole-of-life approach to identify the main sustainability hotspots through the lifecycle of the project. This is used to inform decision-making and to optimise energy savings and reduce waste generation initiatives, from construction to end-of-life.

Proven Performance

The Waratah train is the best performing train operating on Sydney's network, with the Waratah Fleet average availability of 100% and rolling 3-month MDBI consistently higher than the target of 50,000km, achieving between 70,000 and 100,000 km. With modifications to the SGT, Downer will further enhance reliability performance.

SGT will leverage from Downer's credible and highly successful maintenance and availability regime, which includes the Fleet Control Centre and mobile technicians. A team of maintenance support officers works alongside Sydney Trains' operations staff to provide full time help desk support for the SGT operating on the network. They will analyse SGT performance data and identify and corrective maintenance before the trainset returns to the Auburn Maintenance Centre. Maintenance support workers are assisted by a team of mobile technicians who attend to any maintenance incidence across the Sydney Trains network.

Proven Solutions

The SGT will use one of the Waratah fleet's most successful attributes – its intelligent and highly efficient Heating, Ventilation, Air-Conditioning (HVAC) system. From launch, the Waratah's air-conditioned cars created a step-change in improving the customer experience and after the introduction of the SGTs, the Sydney train network will have a fully air-conditioned suburban fleet.

In keeping with our commitment to creating and sustaining the modern environment and delivering reliable mobility solutions, Downer has developed Australia's first verified Environmental Product Declaration (EPD) for our Suburban SGT fleet servicing the Sydney train network.

Downer's success and availability record on the Waratah and now SGT comes partly from their excellent relationships with parts suppliers around the globe

SGT operation

To contribute to a reduction in the carbon footprint of the operational phase of the SGT fleet, we have incorporated materials and components that minimise energy use and improve sustainable outcomes. This will reduce the environmental footprint over the asset lifecycle, without risk to service reliability or operational performance. These components include:

Lighting systems

Waratah (2012) was the first train on the Sydney network to use dimmable LEDs. The SGT fleet will incorporate second generation LED lighting that is 43% more energy efficient than the first-generation LED lighting used on the Waratah train. This will reduce the environmental footprint of the future fleet, including greenhouse gas emissions.

Accessibility

Dedicated disabled person access is included within the entry level floor for the car providing 16 spaces per trainset all with access to emergency help points including braille plates. The SGT also features customer information system providing automatic announcements, hearing aid loops and electronic display screens. Other accessibility features include additional handrails, 234 windows per trains with vandal resistant fittings to aid a comfortable environment and wide vestibules to promote faster boarding and alighting.

Stabling mode

The stabling mode will be switched on when the trainset is not in use. This mode reduces the energy use to its minimum. For the first 20 minutes of stabling mode, adequate internal lighting enables a passenger, driver or guard to exit the train. Only external step lights remain illuminated to allow crew to walk alongside the trainset in dark conditions. Energy saving is increased after 60 minutes: the electronic systems shut down apart from Electronic Train Information System (eTIS), which will switch to a low-power sleep mode.

Wide vestibules to promote faster boarding and alighting

Stabling and NightSafe modes to save energy with the train is not in use.

Customer information system providing automatic announcements, hearing aid loops and electronic display screens within all floors of the train car.

Reduction to a single-airbag bogie still provides a smooth and comfortable ride whilst using less associated materials over the life of the SGT.

Improved internal train environment with brighter energy saving LED lights and display screens.

Smart air conditioning that automatically adjusts for the ambient temperature and number of passengers on board

This is an illustration of 4 cars of an 8 car SGT trainset

NightSafe mode

In NightSafe mode, car lighting and HVAC are turned off. Only cars with a Crew Cab will keep HVAC and cab lighting. Body side external doors will be closed and locked, as will any inter-car access doors that lead into the car.

Battery Charging Technology

Our Battery Management System offers best practice battery charging controls which prolong battery life and ensure fewer battery replacements over the life of the train.

Regenerative Braking System

Our Regenerative Braking System harnesses friction energy from braking that is usually lost to heat that is utilised to feed back to the overhead wire or recharge the batteries on the trainset.

Electronic Train Information System (eTIS)

A train operating system supplied by EKE, which informs our train architecture by connecting all information systems of the trainset leading to efficiencies in development and maintenance materials.

Asset Information System (AIS)

We will improve the customer experience by creating a fully air-conditioned suburban fleet that is supported by our innovative and industry-leading Asset Information System (AIS). This provides near real-time data on the performance of systems including the air-conditioning, and ensures the system is operating efficiently. We will maintain an optimal, temperature-controlled environment, with real-time response to any passenger concerns or system alerts. Downer has developed innovative operational intelligence tools contained in its AIS, which provide users with powerful data to optimise the operations, management and maintenance of the fleet.

These tools help us to:

- Prolong the life of the fleet
- Reduce costs
- Improve sustainability outcomes
- Improve the customer experience through live monitoring of the system, (for example, the HVAC which provides a reliable and fully climate-controlled train).

Additional Initiatives

To further reduce the fleet's carbon footprint during operation, the CCTV system will conserve energy with low light CCTV cameras using limited energy and low energy LED panels where cameras are viewed.

A comfortable passenger environment with 234 windows per train and vandal-resistant fittings such as durable woollen moquette fabric seating.

Energy recovery during braking

Enhanced Accessibility: additional handrails, hearing aid loops, priority seating with 16 wheelchair spaces per trainset

MC

TDC

Passenger internal emergency door releases and 32 emergency help points with direct communication access to the guard throughout the train for extra security and timely assistance

Prolonged life and fewer battery replacements over the life of the SGT through smart battery charging controls

Intercar doors improve passenger throughflow and movement.

SGT Lifecycle Insight - ISO 14025

This EPD provides a transparent insight into the environmental performance and lifecycle of the SGT.

The trainset has been defined as 'passenger rolling stock' with a functional unit of 'transport of one passenger for one kilometre'. Inputs, outputs and environmental impacts have been normalised and reported per passenger-kilometre (pkm).

This EPD is based on an 8-car configuration of the SGT, with an expected service life of 30 years. This service life has been used to apportion construction, maintenance and end-of-life impacts.

Content Declaration

The material content of the trainset has been determined from the trainset bill of materials. Components which are complex assemblies, e.g. HVAC units, have had their material content estimated by Downer's engineering team.

Any unaccounted components, where the material composition could not be determined, have been assumed to be aluminium for the impact assessment as a conservative assumption.

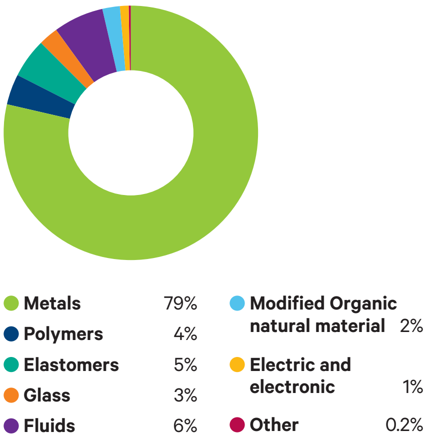
A breakdown of the train material composition using the categories from PCR 2009:05 is given below in Table 1.

Table 1: Material composition of the 8-car SGT trainset

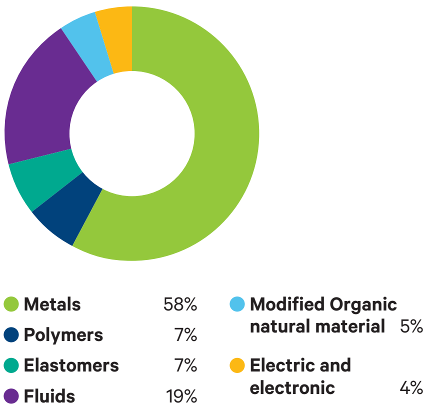
Material	Construction (kg)	Construction (%)	Maintenance (kg)	Maintenance (%)
Metals	**320,000**	78.7	**102,000**	58.0
Polymers	**15,800**	3.87	**11,800**	6.68
Elastomers	**20,200**	4.96	**11,500**	6.53
Glass	**11,100**	2.73	**-**	-
Fluids	**25,600**	6.29	**34,300**	19.5
Modified organic natural material*	**8,670**	2.13	**8,510**	4.83
Electric and electronic	**4,370**	1.07	**7,930**	4.51
Others	**973**	0.239	**-**	-
Total	**407,000**	100	**176,000**	100

* Modified organic natural materials refers to natural materials e.g. cotton, wood and cardboard, etc.

Material composition: Construction



Material composition: Maintenance



Technical information

General characteristics

Total EMU length
163.1 m

Cab car length
20,700mm

Intermediate car length
20,300mm

Bogie wheelbase
2,300mm

Car width
3.05 m

Maximum passengers (8 car set)*
2,148 per set

1st floor height
1.92 m

2nd floor height
1.92m

New wheel diameter
940mm

Doors per side
2 per car

Total mass (8 car set)
407,000kg

Car height from track
4.385 m

Number of seats
894 per trainset

Tip up seats
48 per set

Wheelchair spaces per set
16 per set

TDC – Number of seats
101 per car

TC – Number of seats
110 per car

MC – Number of seats
118 per car

Performance

Power supply voltage
1,500Vdc

Maximum speed
130km/h

Auxiliary converter power
153kW

Total installed traction power
4,000kW

Start-up acceleration
0.8 m/s^2

Mean service deceleration
1.0 m/s^2

Mean emergency brake deceleration rate
1.1 m/s^2

Noise emissions†

Stationary sound pressure level
65 dB

Acceleration sound pressure level
80 dB

Constant speed sound pressure level
83 dB

* Defined as the maximum design payload in accordance with EN15663:2017, representing all seats filled with 6 passengers/m^2 in standing areas
† These measurements have been calculated from tests conducted in accordance with ISO3095:2013

End of Life Asset Recovery

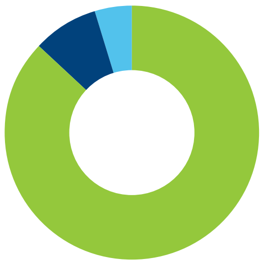
The overall recovery of the SGT has been considered with the aggregate recycling and recoverability rate of 95%.

Table 2: SGT end of life asset recovery rates

End of life recovery	
Recyclability rate	87.1%
Recoverability rate	95.4%

The recyclability and recoverability rates have been calculated according to the recyclability and recoverability calculation method for railway rolling stock (UNIFE, 2013), based on ISO 22628. Recyclability rate has been calculated as "the percentage of mass of the vehicle that can be reused or recycled." Recoverability rate additionally includes the percentage of mass that could potentially be used for energy recovery purposes.

End of Life Asset Recovery



Recyclability	87.1%
Recoverability	8.3%
Disposal	4.6%

Data sources

Primary data have been collected for the construction, planned maintenance and end-of-life treatment of the trainset from Downer and the appropriate suppliers. Secondary datasets covering material and energy production have been sourced from the GaBi database (thinkstep, 2018).

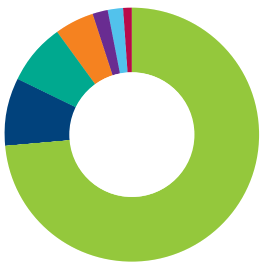
Electricity sources

The grid mix used to model the use phase is based on the 2015 New South Wales grid mix (thinkstep, 2018), original source: Electricity Gas Australia (EGA, 2017).

Table 3: NSW electricity grid mix composition

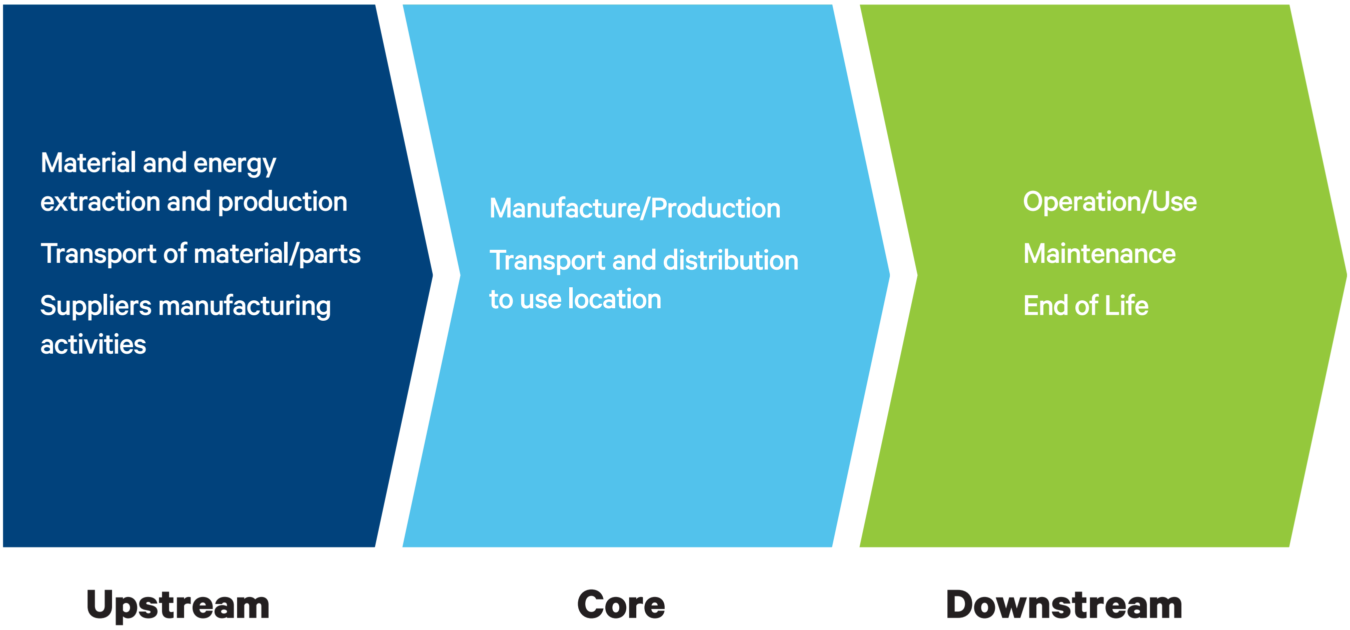
Electricity source	Contribution (%)
Hard Coal	74.3
Import from QLD	8.74
Imported from VIC	7.89
Natural gas	4.95
Hydro	2.09
Wind	1.94
Other	<1
Total	**100**

NSW Electricity grid mix composition



Hard Coal	74.3%
Import from QLD	8.74%
Import from Vic	7.89%
Natural gas	4.95%
Hydro	2.09%
Wind	1.94%
Other	<1%

System boundary



Upstream Module: Material production and transport

The upstream module includes the extraction and production of raw and basic materials and the production of auxiliary materials for rail vehicle assembly/manufacturing. The eight-car trainset has been analysed and broken down into its fundamental materials based on the bill of materials. Modelling the production of these basic and raw materials was carried out by using secondary data taken from the GaBi database (thinkstep, 2018).

Transport by truck and ship for 50% of the components was determined based on the location of the supplier and distance to the manufacturer. A mass-weighted average transport distance was assumed for the remaining 50% of components.

Core Module: Assembly and transport to user

The core module includes the assembly of the trainset and delivery from the assembly facility to the location of use. The assembly facility is located in Changchun, China. Construction was managed by CRRC Corporation Limited. Transport was by rail and ship from the manufacturing facility to the location of use in Sydney, Australia.

Downstream Module: Use phase and end-of-life

Use phase

The downstream module consists of the use phase and the end-of-life (EoL) phase. The service life and annual maintenance schedule were used to construct a model of the use phase of the trainsets. Two scenarios were investigated for energy use and passenger loading (see Table 4 for further detail):

- **Nominal-capacity scenario** – This scenario reflects the SGT design load for peak-time operation of 1200 passengers. This loading is commonly achieved and exceeded during peak times - Based on Waratah operation data for HVAC and interpolated between Waratah operation and SGT physical test data for all other energy consumption.
- **Fully-loaded scenario** – The train operates fully loaded, comprising all seats occupied and standing areas carrying 6 passengers/m^2 (the maximum design payload in accordance with EN15663:2017). This represents the best possible environmental performance of the fleet - Based on Waratah operation data for HVAC and SGT physical test data for all other energy consumption.

Table 4: Scenario parameters

	Nominal capacity loading scenario	Fully-loaded scenario
Service life (years)	30	30
Distance travelled over service life (km)	5,940,000	5,940,000
Average passenger load (passengers)	1,200	2,150
Load factor (%)	134	240
Average electricity consumption (kWh/km)	25.3	30.0
Electricity consumption per passenger-kilometre (kWh/pkm)	0.0211	0.0140

End-of-Life

The end-of-life phase includes the impacts associated with the landfill of non-recycled and non-reused components. Impacts associated with recycling and reuse are not included, as they are allocated to the user of these resources in subsequent product systems, as required by PCR 2009:05.

Impact assessment indicators – In detail

The EPD declares the Life Cycle Impact Assessment (LCIA) indicators shown in Table 5. The indicators are calculated based on Leiden University's Institute of Environmental Sciences (CML) characterisation factors (as updated January 2016).

Table 5: Indicators for life cycle impact assessment

Impact Category	Unit	Description
Global Warming Potential (**GWP**)	kg CO_2 equivalent	A measure of greenhouse gas emissions, such as CO_2 and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may in turn have adverse impacts on ecosystem health, human health and material welfare. Global Warming Potential is calculated with a time horizon of 100 years.
Eutrophication Potential (**EP**)	kg PO_4^{3-} equivalent	Eutrophication covers all potential impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P). Nutrient enrichment may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. In aquatic ecosystems increased biomass production may lead to depressed oxygen levels, because of the additional consumption of oxygen in biomass decomposition.
Acidification Potential (**AP**)	kg SO_2 equivalent	A measure of emissions that cause acidifying effects to the environment. The acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H^+) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline and the deterioration of building materials.
Photochemical Ozone Creation Potential (**POCP**)	kg C_2H_4 equivalent	A measure of emissions of precursors that contribute to ground level smog formation (mainly ozone O_3), produced by the reaction of Volatile Organic Compounds (VOC) and carbon monoxide in the presence of nitrogen oxides under the influence of Ultraviolet (UV) light. Ground level ozone may be injurious to human health and ecosystems and may also damage crops.
Ozone Depletion Potential (**ODP**)	kg CFC-11 equivalent	A measure of air emissions that contribute to the depletion of the stratospheric ozone layer. Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants.

Results of Assessment

Environmental impact indicators

Nominal Capacity Scenario

The following indicators describe potential environmental impacts for each product per functional unit.

Table 6: Environmental impacts for nominal capacity loading per passenger km

	Upstream	Core	Downstream		Total
	Materials	Manufacturing	Use	Disposal	Total
GWP (kg CO_2 eq.)	2.52E-04	7.07E-05	0.0208	1.27E-06	**0.0211**
EP (kg PO_4^{3-} eq.)	1.01E-07	4.33E-08	9.02E-06	9.34E-10	**9.17E-06**
AP (kg SO_2 eq.)	1.45E-06	4.89E-07	1.12E-04	4.57E-09	**1.14E-04**
POCP (kg C_2H_4 eq.)	9.07E-08	3.70E-08	5.59E-06	-1.19E-09*	**5.72E-06**
ODP (kg R11 eq.)	3.36E-12	1.27E-17	2.85E-11	1.41E-19	**3.19E-11**

* Negative due to nitrogen monoxide emissions from trucks, which have a negative characterisation factor according to the CML methodology

GWP = Global warming potential,
ODP = Ozone depletion potential;
AP = Acidification potential;
EP = Eutrophication potential;
POCP = Photochemical ozone creation potential

Fully-loaded scenario

Table 7: Environmental impacts for full loading per passenger km

	Upstream	Core	Downstream		Total
	Materials	Manufacturing	Use	Disposal	Total
GWP (kg CO_2 eq.)	1.41E-04	3.95E-05	0.0137	7.09E-07	**0.0139**
EP (kg PO_4^{3-} eq.)	5.65E-08	2.42E-08	5.96E-06	5.22E-10	**6.04E-06**
AP (kg SO_2 eq.)	8.11E-07	2.73E-07	7.38E-05	2.56E-09	**7.49E-05**
POCP (kg C_2H_4 eq.)	5.07E-08	2.07E-08	3.69E-06	-6.67E-10*	**3.76E-06**
ODP (kg R11 eq.)	1.88E-12	7.07E-18	1.59E-11	7.88E-20	**1.78E-11**

* Negative due to nitrogen monoxide emissions from trucks, which have a negative characterisation factor according to the CML methodology

GWP = Global warming potential,
ODP = Ozone depletion potential;
AP = Acidification potential;
EP = Eutrophication potential;
POCP = Photochemical ozone creation potential

Carbon footprint

Fully loaded scenario

The GHG emissions throughout the lifecycle of the SGT are 13.9 g of CO_2 equivalents when applied to one passenger travelling one kilometre fully-loaded scenario. Under the same scenario, approximately 98% of the potential GWP impacts occur as a result of emissions from the generation of electricity, used within the operational phase of the SGT lifecycle.

Resource and waste indicators

The following indicators describe the use of renewable and non-renewable material and energy resources, as well as the production of waste.

Table 8: Resource use for nominal capacity loading per passenger km

Indicator	Upstream	Core	Downstream		Total
	Materials	Manufacturing	Use	Disposal	Total
Renewable resources					
Materials (kg):					
Carbon dioxide (sequestered in bio-based materials)	2.74E-06	4.68E-09	2.18E-05	-3.26E-08	**2.45E-05**
Energy (MJ*):					
Wind	4.09E-05	1.90E-05	0.00483	1.14E-07	**0.00489**
Hydro	3.28E-04	6.20E-05	0.00253	7.66E-08	**0.00292**
Solar	2.29E-04	1.99E-05	9.89E-04	3.90E-07	**0.00124**
Other	5.12E-05	9.45E-09	2.60E-06	1.55E-09	**5.38E-05**
Non-renewable resources					
Materials (kg):					
Limestone	1.39E-05	1.16E-06	1.42E-04	1.98E-08	**1.57E-04**
Natural aggregate	2.25E-06	6.47E-07	1.15E-04	5.20E-07	**1.18E-04**
Iron	4.87E-05	1.09E-07	1.95E-05	1.05E-08	**6.84E-05**
Bauxite	2.76E-05	2.66E-09	9.84E-06	9.06E-11	**3.75E-05**
Silicon	2.35E-05	1.48E-11	4.77E-07	5.50E-13	**2.40E-05**
Magnesium	2.13E-05	1.38E-11	4.32E-07	5.40E-13	**2.17E-05**
Copper	2.84E-06	1.46E-09	4.35E-06	7.27E-12	**7.19E-06**
Chromium	6.73E-06	2.86E-10	1.49E-07	1.06E-12	**6.88E-06**
Sodium chloride	4.02E-06	2.46E-09	2.76E-06	3.33E-09	**6.78E-06**
Other	1.62E-05	9.70E-08	1.37E-05	8.60E-07	**1.75E-05**
Energy (kg):					
Hard coal (26.3 MJ/kg)	5.35E-05	2.17E-05	0.00680	2.30E-08	**0.00688**
Lignite (11.9 MJ/kg)	6.90E-06	4.91E-08	0.00186	3.95E-08	**0.00187**
Natural gas (44.4 MJ/kg)	1.81E-05	1.31E-06	3.77E-04	1.07E-07	**3.97E-04**
Crude oil (42.2 MJ/kg)	2.15E-05	2.65E-06	1.36E-04	2.78E-07	**1.61E-04**
Other** (2,370 MJ/kg)	1.29E-07	4.84E-10	1.82E-08	7.93E-11	**1.48E-07**
Water (kg)					
Total water consumption	2.78E-03	5.42E-04	0.0736	9.57E-08	**0.0769**
Direct use in the core module	-	2.81E-07	-	-	**2.81E-07**
Waste (kg):					
Total	2.80E-05	2.37E-07	7.37E-05	1.06E-05	**1.13E-04**
Hazardous	1.68E-11	5.72E-13	3.45E-11	4.13E-14	**5.19E-11**
Non-hazardous	2.80E-05	2.37E-07	7.37E-05	1.06E-05	**1.13E-04**

* Net calorific value (NCV)
** Includes electricity generated from peat and uranium

Table 9: Resource use for full loading per passenger km

Indicator	Upstream	Core	Downstream		Total
	Materials	Manufacturing	Use	Disposal	Total
Renewable resources					
Materials (kg):					
Carbon dioxide (sequestered in bio-based materials)	1.53E-06	2.62E-09	1.43E-05	-1.82E-08	**1.58E-05**
Energy (MJ*):					
Wind	2.29E-05	1.06E-05	0.00319	6.34E-08	**0.00322**
Hydro	1.83E-04	3.46E-05	0.00166	4.28E-08	**0.00188**
Solar	1.28E-04	1.11E-05	6.41E-04	2.18E-07	**7.80E-04**
Other	2.86E-05	5.28E-09	1.51E-06	8.67E-10	**3.01E-05**
Non-renewable resources					
Materials (kg):					
Limestone	7.77E-06	6.46E-07	9.36E-05	1.11E-08	**1.02E-04**
Natural aggregate	1.26E-06	3.62E-07	7.59E-05	2.91E-07	**7.78E-05**
Iron	2.72E-05	6.06E-08	1.21E-05	5.86E-09	**3.93E-05**
Bauxite	1.54E-05	1.49E-09	5.52E-06	5.06E-11	**2.10E-05**
Silicon	1.31E-05	8.29E-12	2.68E-07	3.07E-13	**1.34E-05**
Magnesium	1.19E-05	7.73E-12	2.43E-07	3.02E-13	**1.21E-05**
Copper	1.59E-06	8.15E-10	2.44E-06	4.06E-12	**4.03E-06**
Chromium	3.76E-06	1.60E-10	8.51E-08	5.94E-13	**3.85E-06**
Sodium chloride	2.25E-06	1.37E-09	1.57E-06	1.86E-09	**3.81E-06**
Other	9.05E-06	5.42E-08	8.58E-06	4.80E-07	**1.05E-05**
Energy (kg):					
Hard coal (26.3 MJ/kg)	2.99E-05	1.21E-05	0.00450	1.28E-08	**0.00454**
Lignite (11.9 MJ/kg)	3.86E-06	2.74E-08	0.00123	2.21E-08	**0.00123**
Natural gas (44.4 MJ/kg)	1.01E-05	7.30E-07	2.48E-04	6.00E-08	**2.59E-04**
Crude oil (42.2 MJ/kg)	1.20E-05	1.48E-06	8.90E-05	1.55E-07	**1.03E-04**
Other** (2,370 MJ/kg)	7.21E-08	2.70E-10	1.12E-08	4.43E-11	**8.36E-08**
Water (kg)					
Total water consumption	1.56E-03	3.03E-04	0.0483	5.34E-08	**0.0502**
Direct use in the core module	-	1.57E-07	-	-	**1.57E-07**
Waste (kg):					
Total	1.56E-05	1.33E-07	4.75E-05	5.91E-06	**6.92E-05**
Hazardous	9.38E-12	3.19E-13	2.24E-11	2.31E-14	**3.21E-11**
Non-hazardous	1.56E-05	1.33E-07	4.75E-05	5.91E-06	**6.92E-05**

* Net calorific value (NCV)
** Includes electricity generated from peat and uranium

Appendix

EPD registration information:

Environmental product declarations within the same product category from different programmes may not be comparable.

EPD information:

EPD registration number:
S-P-001161

Approval date:
2018-09-07

Valid until:
2021-09-07

Revision date:
2018-10-11

Product group classification:
UN CPC 43913: Rail locomotives powered from an external source of electricity

ANZSIC C2393: Railway Rolling Stock Manufacturing and Repair Services

Reference year for data:
1 July 2016 to 30 June 2017

Geographical scope:
Australia

Contact information

EPD owner:

Downer
Relationships creating success

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EPD produced by:

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thinkstep Pty Ltd
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EPD programme operator:

AUSTRALASIA EPD

The Australasian EPD Programme Limited
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PCR according to ISO 14025:2006

PCR:
PCR 2009:05 Rolling stock, Version 2.12, 2018-01-15

PCR review was conducted by:
The Technical Committee of the International EPD® System. Chair: Massimo Marino. Contact via info@environdec.com.

Independent verification of the declaration and data, according to ISO 14025:

- ☐ EPD process certification (Internal)
- ☑ EPD verification (External)

Third party verifier:

START2SEE
LIFE CYCLE ASSESSMENTS

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Accredited or approved by:
The Australasian EPD® Programme

The EPD Owner has the sole ownership, liability, and responsibility for the EPD.

For more information visit: www.environdec.com

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List of Acronyms

AEPDP	Australian EPD Programme
AP	Acidification Potential
CML	Institute of Environmental Sciences at Leiden University
CRRC	CRRC Corporation Limited
EoL	End-of-Life
EMU	Electric Multiple Unit
EP	Eutrophication Potential
GaBi	Ganzheitliche Bilanzierung (German for holistic balancing)
GWP	Global Warming Potential
ISO	International Organisation of Standardisation
LED	Light-emitting diode
MDBI	Mean Distance Between Incident
ODP	Ozone Depletion Potential
pkm	Passenger Kilometre
POCP	Photochemical Ozone Creation Potential
SGT	Sydney Growth Train
TDC	Trailer Driver Car
TC	Trailer Car (non-driving)
MC	Motor Car

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