

# Tindo

## The World's First Solar Electric Bus



The Adelaide City Council's electric solar bus is the first in the world to be recharged using 100% solar energy, and will be used everyday by the people of Adelaide through the Adelaide City Council's free Adelaide Connector Bus service.

Tindo – the Kurna Aboriginal name for sun - is the culmination of the Council's eight-year project to deliver a pure electric community bus.

International research suggests people strongly prefer electric buses to those powered by other means, such as diesel engines.

Electric buses can operate in busy City streets and residential neighbourhoods in a clean and quiet manner, which makes them very popular with both passengers and the public.

### Batteries

Recent advances in battery technology have helped the successful development of pure electric buses with a suitable range between recharges.

The Tindo solar electric bus uses 11 Zebra battery modules, giving it unprecedented energy storage capacity and operational range.

The Swiss-made Zebra batteries use sodium/nickel chloride technology, with their benefits including:

- Designed for long life and reliability
- Not affected by external temperatures
- Can be stored indefinitely fully charged
- Lightweight
- High energy and power density

The Zebra batteries used in Tindo are virtually maintenance free, and are therefore expected to result in significant cost savings.

The unique battery management interface ensures that the batteries system can't be damaged by inappropriate operation or charging protocols.

Unlike other batteries available for electric buses, these controlled temperature batteries operate without loss of performance or life expectancy in virtually any conditions.

In addition to conventional controls and instrumentation, a driver display panel is provided, from which the bus operator and maintenance staff can check the status of Tindo's drive and charge.

### Carbon Neutral

Tindo is recharged using a unique solar photovoltaic (PV) system at the Adelaide Central Bus Station.

The solar PV system on the Bus Station's roof is currently Adelaide's largest grid-connected system, generating almost 70,000 kilowatt hours of zero carbon emissions electricity each year to offset the total energy required to recharge Tindo's batteries.

Much of the funding for this \$550,000 solar PV system was generously provided by the Australian Government through the Adelaide Solar City program, with the Adelaide City Council also committing significant funding.

There are very few pure battery electric buses around the world. Most are characterised by being significantly smaller in size, and having shorter operational range.

Tindo is the only pure electric bus recharged by 100% solar PV electricity.

It's important to note that Tindo would not be carbon neutral if it were recharged from the carbon-intensive South Australian electricity grid.

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### Vehicle Management System

The vehicle management system (VMS) is critical to achieving Tindo's full potential.

It's the main controller for all the electric vehicle-related items on the bus, and ensures that the driver's operational requests are processed and the equipment performs to meet those requests.

The VMS monitors all equipment on the bus and makes sure that it's all working within the desired and correct parameters. Should any item not be working properly, the vehicle management system adjusts other equipment to compensate.

The VMS is responsible for controlling Tindo's main drive system and the auxiliary battery charging and management, and it logs all fault and warning conditions relating to the drive system.

A display panel on the driver's console provides information from the vehicle management system on the operations of the bus.

### Accelerating

Electrical energy from the batteries is fed to the motor inverter. The motor inverter converts this electrical energy into a format correct for the electrical motor. The electric motor uses the energy from the inverter to produce a rotational motion. The rotational motion from the motor is connected to the drive chain, which makes the bus move.

### Braking

When the vehicle slows down, the batteries are no longer driving the vehicle. The motor electronically converts into a generator. The forward motion of the bus then turns the motor/generator to generate electricity which is stored back into the batteries. This is referred to as regenerative braking.

### Highlights

Performance:

- 200 km between recharges under typical urban conditions
- "Fast charge" provides 1 km of extra range per 1 minute of charge
- Acceleration and hill climb equivalent to a diesel bus
- Battery and drive systems deliver full performance under almost all conditions

Reliability:

- Robust, proven components
- Drive system components rated to last 130,000 hours or better
- Quality chassis design and assembly
- Abuse-tolerant batteries
- Integrated on-board charge system
- Precision battery "state-of-charge" metre (fuel gauge) for driver

Safety:

- Battery modules electrically isolated
- Interlocks on all high-voltage cabinets
- Hermetically-sealed batteries – no gasses produced
- No exposed electrical terminals
- Minimum battery maintenance

Maintenance:

- Onboard diagnostics via the vehicle management system (VMS)
- Propulsion system virtually maintenance free
- No frame corrosion because no battery gasses are created

Life-Cycle Costs:

- Long-life batteries
- Low maintenance components
- Forklifts, battery trucks, load banks not required
- Minimised training for mechanics
- Fuel costs 50% lower than for a diesel bus
- Use of on-board electronics for charging functions

### Technical Specifications

Dimensions:

- Length – 10.42m
- Width – 2.48m
- Height – 3.06m
- Weight – 11,480kg (Curb)

Capacity:

- Seated – 25
- Wheelchair – 2
- Total – 27

Performance:

- Motor power nominal – 36 kW
- Motor power peak – 160 kW
- Charge power – 36 kW
- Speed – 76 km/h
- Gradability – 12.5%

Battery System:

- Type 11 modules Zebra Z36-371-ML3C-64
- Rated energy 261.8 kWh
- Accessible energy 235.6 kWh
- Roof-mounted solar PV Uni-Solar PVL-68 W (peak)

Fast Booster Charger (located on Franklin St, outside Adelaide Central Bus Station):

- Power – 70 kW
- Input – 400V 3-phase AC 100a
- Output – 386V DC 200a 70 kW
- 1 minute of charge = 1 kilometre

[www.adelaidecitycouncil.com/tindo](http://www.adelaidecitycouncil.com/tindo)