Simulation Study

To better tend to customer's needs, Toshiba offers a more customer-oriented engineering which includes a simulation study using Toshiba's advanced traction power simulation software engines. With this, Toshiba can offer a more suitable solution.

Ratings and Specifications

Item	Rating / Function	
Rated Line Voltage	DC 750V (DC 600V and DC 825V are also available)	DC 1500V
Rated Power	500kW - 2000kW	1000kW - 4000kW
Applicable Load Pattern	Class I - IX (IEC 62924) 0.75(p.u.) continuous	Class I, IV, VI - IX (IEC 62924) 0.5(p.u.) 60s + 0.25(p.u.) 240s (cycle time: 300s)
Rated Capacity	146kW - 777kW	
Rated Battery Voltage	DC 600V (530V ~ 713V)	
Operation Mode	1. V-SOC Mode -Charge and Discharge corresponding with feeding voltage and SOC. Voltage stabilization of transient fluctuation is also available. 2. Emergency Power Supply Mode -Discharge energy without power from grid.	
Control Function	1. V-SOC Control 2. Monitoring 3. Sequence Control 4. Schedule Control 5. Data Logging (Option) 6. Remote Maintenance (Option) 	
Applicable Standard	IEC / JEC	

Find out more about Toshiba transportation solutions on http://toshiba-railway.com

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TOSHIBA

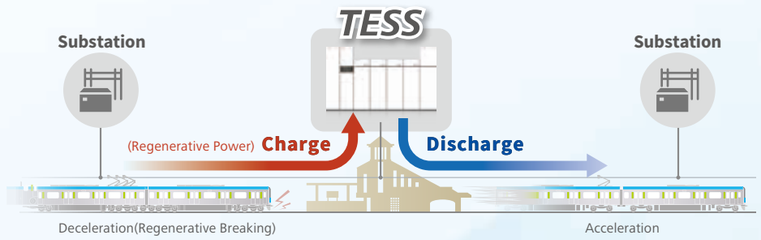
Traction Energy Storage System with SCiB™ For DC Railway Power Supply Systems

Traction Energy Storage System with SCiB™

When a train set is braking, it generates energy which can be used by the adjacent accelerating trains.
But in most cases, this regenerative energy is not efficiently utilized by the next train and is wasted as heat through onboard or wayside resistors.
Such cases does not only incur energy wastage but also likely to cause abrupt shift from regenerative braking to mechanical braking.
This sudden change may further cause passenger ride discomfort and degradation of the brake shoe due to abrasion.

Toshiba's Traction Energy Storage System (TESS) efficiently stores surplus regenerative energy in the SCiB™ and discharges it to another accelerating train. TESS is installed with Toshiba's patented advance control system which allows flexible control of charge-discharge cycles in accordance to the battery's State-of-Charge (SOC).
This allows significant increase in battery lifetime.

Toshiba developed Traction Energy Storage System (TESS) with SCiB™, a new energy saving solution with Toshiba's own battery technology of high quality.



Key Benefits

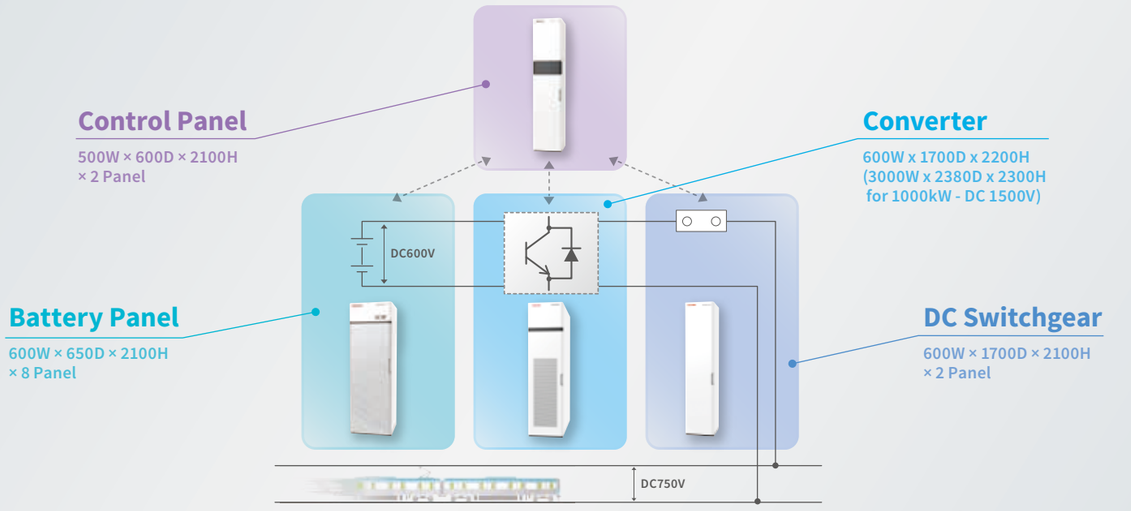
Better Regenerative Braking Operation
Surplus regenerative energy can be efficiently charged and discharged to/from the SCiB™ Battery thus preventing regenerative brake failures.

Energy Saving
SCiB™'s remarkable charge- discharge efficiency characteristics can reduce energy wastage and ultimately, promote power demand peak cut.

Line Voltage Stabilization
Installation of TESS can improve traction power quality through voltage stabilization.

Emergency Power Supply
Stored energy can be utilized to accelerate the trains and safely bring passengers to the nearest station during power failure. This function is most applicable when installed in tunnel and bridge sections.

System Outline



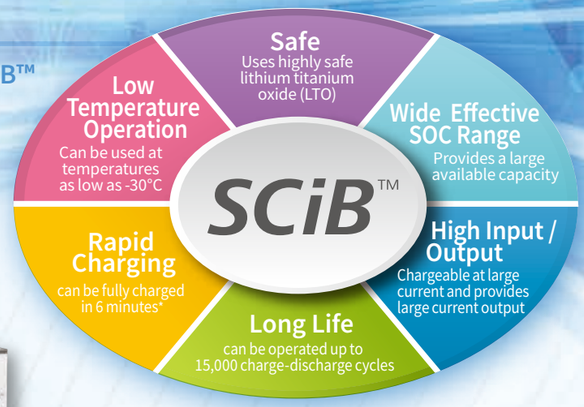
*Dimensions of 500kW TESS for DC 750V Railway System

High performance SCiB™

TESS utilizes Toshiba's own high performance SCiB™

This battery has various outstanding characteristics.
By using unique oxide materials, SCiB™ holds high resistance against thermal runaway caused by internal short circuiting brought about by physical stresses.

Crush Test for SCiB™ Cell Battery



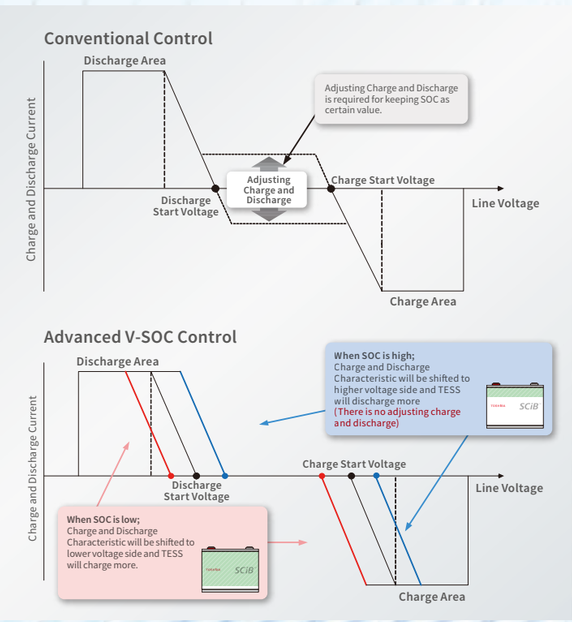
*Results of cell level tests under certain conditions. Not a guaranteed performance.

Advanced V-SOC Battery Control

Toshiba also developed a completely new and advanced Charge-Discharge algorithm for the efficient control of TESS.

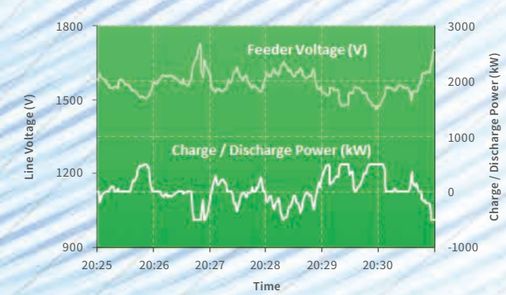
For conventional energy storage systems, battery is charged and discharged to keep specified SOC (State of Charge). Thus, battery is charged and discharged regardless of the feeding voltage. There will be instances when the battery will be unnecessarily charged/discharged even at rated line voltage (area between the Charge Start Voltage and Discharge Start Voltage). Thus causing feeding voltage imbalance and shortened battery lifetime.

As for Toshiba's advance V-SOC control method, charge and discharge characteristics automatically shifts depending on SOC. When SOC is high, charge-discharge characteristic will shift to the higher voltage side, hence the battery shall be easily discharged. On the other hand, when SOC is low, charge-discharge characteristic will shift to the lower voltage side thus, battery shall perform more charging. The lifetime of a battery strongly depends on the charge-discharge times and current. By using this control algorithm, unnecessary charge and discharge can be greatly reduced.



Toshiba's system does not define any certain SOC which means that charge and discharge will be performed dynamically within a wide range of SOC.

※SOC : State-of-Charge
※V-SOC : Voltage-State-of-Charge



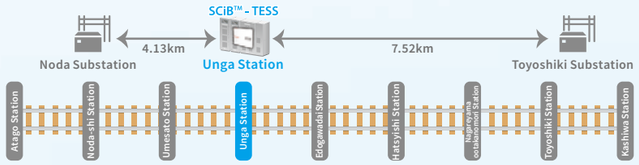
Charge/Discharge corresponding with Feeder Voltage

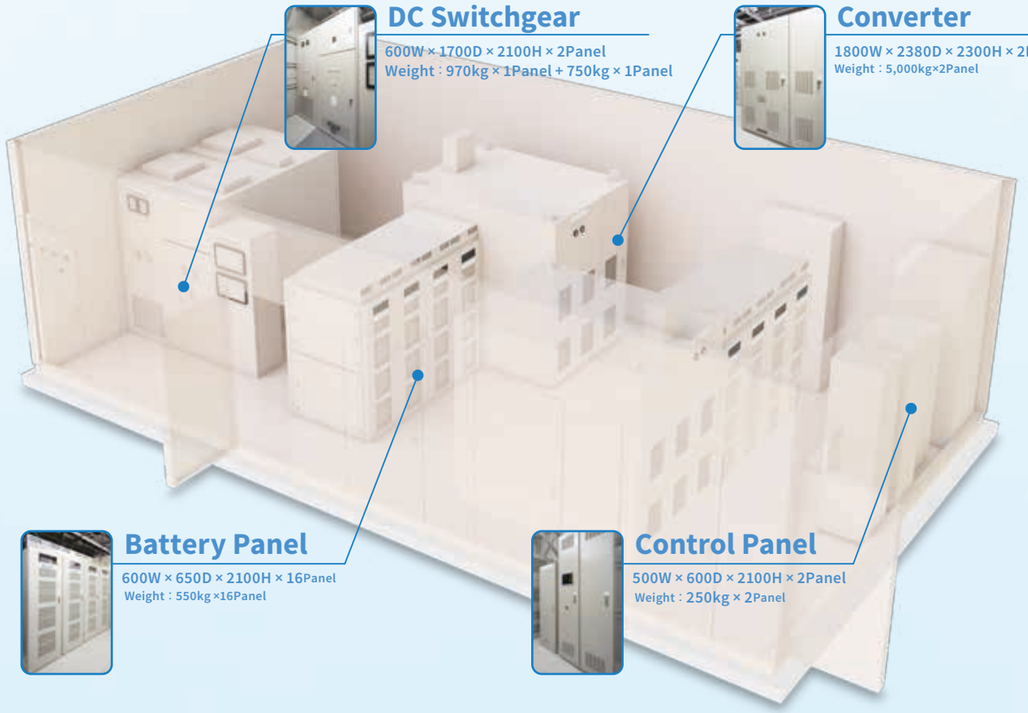
Performance Record

TESS for Line Voltage Stabilization

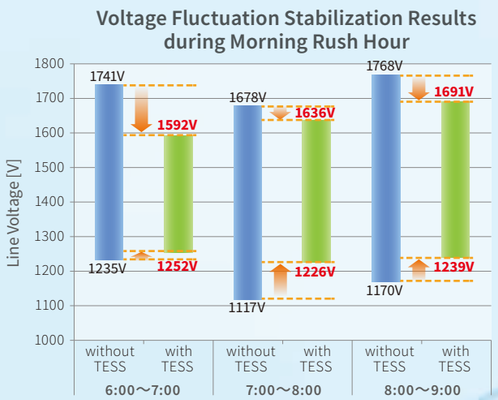
Tobu Railway – Unga Battery Post

During the adaptation of new type of cars, significant loss in line voltage was expected to occur between Noda Substation and Toyoshiki Substation (11.65km distance). To stabilize line voltage in this section and avoid building new substation, 1000kW TESS was installed as a battery post.





TESS was able to stabilize line voltage fluctuation without having to build a new substation.
Furthermore, power peak cut was also achieved through the effective use of regenerative energy.



TESS for Energy Saving

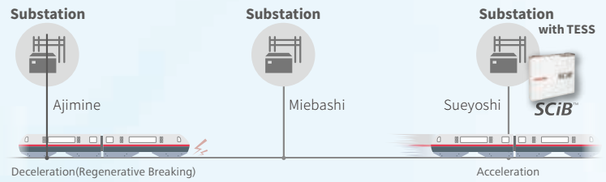
Okinawa Urban Monorail - Sueyoshi Substation Field Test Result

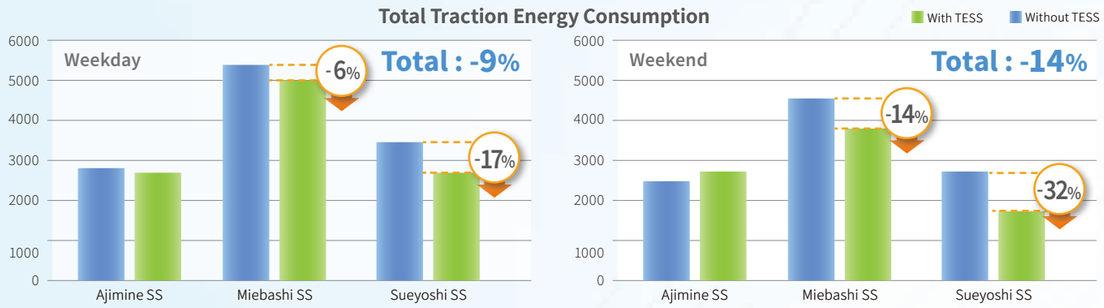
500kW TESS was installed in Sueyoshi Substation of Okinawa City Monorail. With TESS operation, 10% power peak cut was achieved in Sueyoshi SS power consumption alone. Significant power peak cut was also achieved in total power consumption in all substations.

With TESS, daily traction energy consumption was reduced to 575kWh/day (-17%) during weekday and 883kWh/day (-32%) during weekend while reducing the adjacent substation energy consumption as well.

Power Peak Cut

Location	Peak Value (Without TESS)	Peak Value (With TESS)	Peak Cut Effect
Sueyoshi SS	310 kWh/0.5h	280 kWh/0.5h	10%
All SS (Total)	830 kWh/0.5h	800 kWh/0.5h	3.6%





TESS for Emergency Power Supply

Tokyo Metro – Ayase Substation Field Test Results

500kW TESS was installed in Ayase Substation of Tokyo Metro for energy saving and emergency power supply. TESS was able to independently power a 10-Car Train including all its auxiliary equipment (air conditioners, etc.) through a 2.4 kilometer distance from Ayase Station to Kita-Senju Station. This distance has a section with steep gradient of up to +33‰. Even at this stringent condition, TESS was able to safely power the train in a power failure condition.

Field Test Conditions	
TESS Capacity	194kWh
TESS Output	500kW
Train Speed	15km/h
Auxiliary Power	In Use