In today’s electric rail transit systems, regenerative braking systems are becoming the norm. The power generated from braking vehicles is fed back into the power supply and distribution network for use by other vehicles drawing power at the same time.

If other vehicles are not available to use this regenerated power, the voltage on the distribution network rises to the point where the braking vehicles must terminate regeneration to the network. In these cases, the braking train will dissipate the kinetic energy as heat either through on-board resistors or through wayside resistors. In either case, the energy is lost.

The Solution – EnerGstor Wayside Energy Storage

The new BOMBARDIER® EnerGstor® wayside energy storage system is based on supercapacitor technology, which captures and stores the otherwise unusable regenerated braking energy and recycles it back into the system. EnerGstor technology provides both economic and environmental benefits.

The potential economic benefits include reducing the capital cost of a new transit system (or extension of an existing system) and reducing the ongoing energy costs of transit system operation. Potential environmental benefits include reduced losses (increased efficiency) of the electric power distribution system, reduced carbon emissions (depending on the source of electrical energy) and reduced waste heat generation.
EnerGstor technology has the potential to accomplish the following:

1. **Recover braking energy:** Ensuring that the power system is always receptive to braking energy from regenerating trains, and storing the braking energy for later use;

2. **Level power flow:** The EnerGstor system can reduce the peak demand by averaging loads over a period of time;

3. **Mitigate voltage sag:** EnerGstor technology improves system voltage at required locations without the need for additional traction power substations;

4. **Reduce the number of traction power substations:** For fleet expansion on existing transit systems, EnerGstor technology can reinforce the critical supply areas without requiring installation of new traction power substations. For new transit systems or extensions, the EnerGstor solution can reduce the number and/or rating of new traction power substations required;

5. **Reduce waste heat:** Dissipating braking energy generates a large amount of heat. This heat warms tunnels and stations and must be managed through ventilation. By ensuring the network is receptive the EnerGstor system minimises the waste heat produced;

6. **Eliminate or reduce the need for vehicle or wayside resistors:** By increasing the instances of re-using regenerated energy, EnerGstor technology substantially reduces the need for resistors on board vehicles or on the wayside.

**How does the EnerGstor solution work?**
The EnerGstor system stores energy released from nearby braking trains, then energy is released from the EnerGstor system when nearby train(s) are drawing power. The energy released can reduce the network energy consumption/demand by up to 20 per cent.

**What technology is behind the EnerGstor solution?**
The EnerGstor system is based on supercapacitor technology, which is well known for its high performance, high duty cycle and low maintenance. Supercapacitors are uniquely able to combine the energy storage properties of batteries with the power discharge characteristics of capacitors. They are able to hold a very high charge which can be released in a controlled manner. By taking advantage of state-of-the-art technologies, the energy transfer becomes more reliable and efficient.

**EnerGstor System Concept**
The EnerGstor solution is based on modular design which allows system to be properly sized for any application.

Each EnerGstor solution unit consists of one or more power cells. Each power cell consists of a power converter controlling its own set of energy storage modules. The power cells are monitored by a common supervisory controller. The supervisory controller also provides optional wireless communication capability between the EnerGstor solution unit and the outside world. EnerGstor technology can be monitored and controlled locally or remotely through the internet or other network. The graphic below demonstrates the EnerGstor system concept.
EnerGstor Main Features

The EnerGstor unit is intended to be mounted on the wayside adjacent to the tracks.

Main features of EnerGstor technology include:
- Small, low-profile enclosure
- No civil works necessary for typical installation
- No modifications to existing transit infrastructure required
- Autonomous unit
  - No house power connection required
  - No SCADA connection required
  - Only connections are to the traction power +ve, -ve and ground
- Lowest hardware and installation cost possible

Design for compatibility

The EnerGstor system is designed to be compatible with any transit technology regardless of type or manufacturer. To provide the energy savings feature, trains must be equipped with regeneration capability. For voltage regulation, regeneration is not a requirement.

Scalability and modularity

The EnerGstor system design is scalable, with an energy capacity ranging from 0.25 to 5.0 kWh or more. The energy capacity of EnerGstor system is configurable to specific project needs by simply adding or removing power cells from the EnerGstor system configuration.

Remote monitoring and control

EnerGstor technology can be monitored and controlled remotely via internet link. Detailed data and event logs are available remotely in real time or on demand for unit performance analysis and maintenance.

Possible failures are recorded locally with the option to send via email to the designated maintenance personnel. This improves system reliability. Due to the large storage capacity of the Supervisor control unit, historical data can be kept for up to six months.

Reliability and redundancy

The distributed architecture improves reliability while reducing the need for equipment redundancy. If a failure occurs on one or more power cells, the remaining power cells will continue to operate normally, minimising the overall impact of the failure(s).

Autonomous power

As an option, EnerGstor technology does not require house or control power from an external source. The traction power itself can be used to power all EnerGstor system equipment. No external connections to a power supply are required.

Independence of operation

The normal operation of the EnerGstor system unit is transparent to the operations of the transit system and has only beneficial effects on the performance of trains or power equipment.

EnerGstor technology is designed to operate independently, regardless of the transit system operating schedule. On-going operator interface or interaction with the EnerGstor system unit is not required.

Supercapacitor module

Supervisor main screen
Duty cycle
Transit systems operating at headways of 120s or less, typically have adequate system receptivity, due to presence of nearby trains. The frequency of the required charge and discharge cycles will vary from one transit system to the other. The configuration of the unit can be adjusted to match the specific project requirements.

Maintenance requirements
Over the design life of an EnerGstor system unit, no ongoing maintenance is required with the exception of simple inspection and cleaning preventive maintenance activities.

How much energy can EnerGstor technology save?
The energy savings achieved by EnerGstor technology will depend on the application. For example, if the EnerGstor solution is installed for energy saving purposes, it can save as much as the entire regenerated energy of the transit system. The regeneration energy varies from one system to the other, ranging to as much as 30 per cent of the total energy consumption. System receptivity must be taken into account when estimating or measuring the energy savings of EnerGstor technology. If an EnerGstor system is installed to provide voltage regulation, energy consumption and maximum demand will be reduced mainly during peak transit operation.

Technical data

<table>
<thead>
<tr>
<th>EnerGstor Wayside Energy Storage (for 1kWh unit)</th>
</tr>
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<tbody>
<tr>
<td>Voltage</td>
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<tr>
<td>Max Energy (kWh)</td>
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<tr>
<td>Max output power (kW)</td>
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<tr>
<td>Cooling</td>
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<tr>
<td>Dimension (mm)</td>
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<tr>
<td>Operating Ambient Temperature</td>
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ECO4 – Energy, Efficiency, Economy and Ecology
EnerGstor forms part of Bombardier’s ECO4* environmentally friendly technologies. Addressing the growing challenges among operators to reduce Energy consumption, improve Efficiency, protect the Ecology while making sense Economically, ECO4 is the concrete validation of Bombardier’s declaration The Climate is Right for Trains*.