Braking energy recovery on the metro network – RET (Rotterdam)

CONCEPT

Most recent rail vehicles have the ability to brake electrically using regenerative braking techniques. In that case, the electric motor can work as a generator recovering the vehicle's kinetic energy and converting it into electricity. However, the energy recovered will only be used by another vehicle accelerating nearby, thus reducing greatly the potential energy savings. Given RET owns its high-voltage electrical network, RET invested in two inverters (reversible substations) to improve the braking energy recovery level on its metro network. This makes it possible for other vehicles and station buildings (lighting, escalators, …) to use the recovered energy.

SUPPLIER

Inverters (reversible substations):
IMTECH Traffic & Infra B.V. (Netherlands)

Technical Data	
Technology	IGBT
Voltage range	400-1000 VDC
Maximum power	1 MW
Feedback current	58 A AC
Efficiency rate	98%
Weight	3.6 tons
Noise	<65 dB(A)

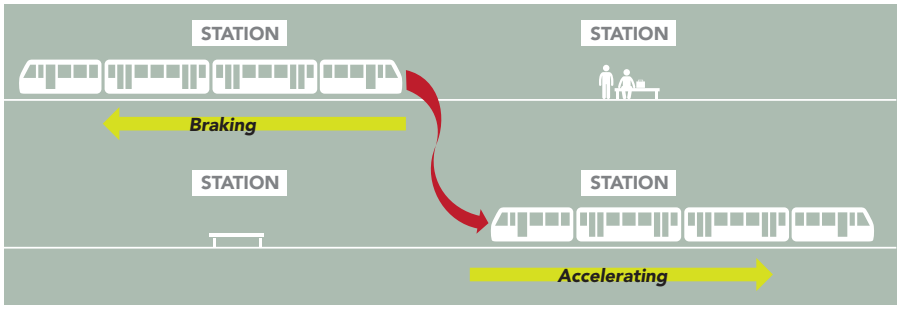
OBJECTIVES

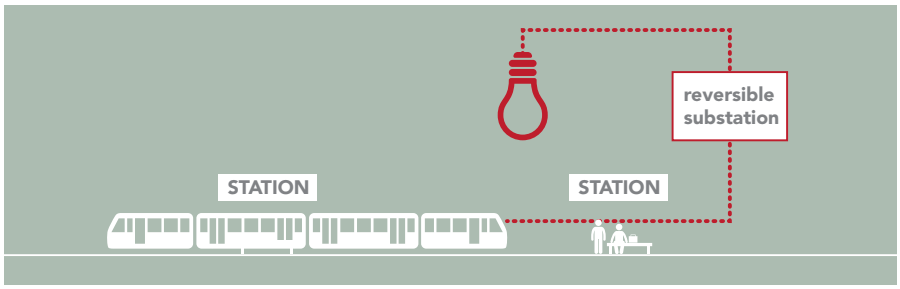
- Reduce the energy consumption and the related CO_2 emissions of the metro traction;
- Evaluate the systems in terms of efficiency and delivered savings;
- Communicate about the advantages of installing braking energy recovery systems to raise the awareness of the passengers.

INVESTMENT DESCRIPTION

Metro vehicles are propelled by electric motors supplied by substations placed along the tracks. The electricity is transferred via a third rail. All the metro trains used on the Rotterdam network have the ability to brake electrically using regenerative braking techniques. A small portion of the recovered kinetic energy can be reused to power vehicles auxiliaries whereas the remaining energy is sent back to the electrical network. If a vehicle is accelerating nearby, the accelerating vehicle takes advantage of this energy transfer. If that is not the case, the network voltage increases due to the energy surplus and this extra energy has to be dissipated in braking resistors.

RET identified braking energy recovery as a great opportunity to reduce the energy used by its metro system. RET has previous experience with braking energy recovery technologies. A supercapacitors-based storage system has been implemented along the tram network, but the results were below





Results	
Investment costs (€)	€478,000
Estimated energy savings (kWh)	600.000 kWh
Estimated CO_2 savings (TCO_2)	9.4 TCO_2
Operational costs (€/year)	€3,000
Benefits (€/year)	€54,780
Payback time (years)	5

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expectations. The installation was also very noisy and had to be encapsulated in a container. RET also has some doubts about flywheels. In the past RET has experienced a number of failures with an on-board flywheel system on a tram: the flywheel worked loose and destroyed the installation. RET made an assessment of this situation, taking into account the history of other energy recovery systems, investment and operational costs, space requirements and the risks of each technology. A reversible substation was seen as the best option for the metro network in the Rotterdam area. As a result, RET decided to invest in two inverters, where no storage is needed and energy can be used directly on the 10kV RET network.

To determine the best location for these inverters on the network, a network simulation was done with different timetables. This led to the recommendation to place them in two existing substations: one in Schiedam and one in Spijkenisse.

A European tender was launched and one company was selected. The success of these two substations will determine whether RET will place new orders.

COST AND FUNDING

The investment costs for the deployment of two inverters is €478,000 including the procurement and internal costs for RET.

RESULTS

The building works for the two inverters were finished in Nov 2013. The new installations needed to be adapted to the existing RET electrical equipment. During the first test at location Schiedam, RET encountered malfunctioning with the existing installations. Due to a long delivery time of the replacement parts and the time to investigate the problems this installation will be operational in June 2014. To prevent the malfunctioning at location Spijkenisse, RET and IMTECH have worked out an improvement. This installation is in operation since May 2014.

LESSONS LEARNED

RET recommends to check whether the new system can be adapted to the existing installations before implementing the inverter. Extensive simulations can certainly help. Supplier experience is very important in this context, especially when testing prototypes.

CONTACT

RET
Virgil Grot - Regie & Ontwikkeling
RET Client contact center
+31 (0) 900 500 60 10
kcc@ret.nl