

## REVERSIBLE SUBSTATION IN DC TRACTION

Priya Sharma<sup>1\*</sup>,

<sup>\*1</sup>MTech 4th sem GHRCE

**\*Corresponding Author: -**

---

### **Abstract: -**

*In order to improve the green foot prints and also reduce the operational costs, it is currently standard practice to fit the Rolling stock of Metros railway units with regenerative dynamic braking systems. Thus, energy generated by a braking train can be reused by other accelerating trains. The excess energy is inverted back to the system for use in auxiliary power requirement like lighting lifts, escalator ect in stations. To capture the regenerative energy the popular technology in use are Energy Storage Systems (Batteries, Super capacitors and Fly wheel) and Inverters. For the urban metro rail using DC traction recently a new technology has been used which is known as the “Reversible Electric Sub Stations”. This improves the line receptivity of the DC systems by transferring the excess energy to the AC side. This new technology will make it possible to send that part of the braking energy that is usually burnt in resistors, back into the grid. That is by making the electric substation “reversible”, meaning that they can also operate in the reverse, feeding energy from the braking trains back to the grid. The main benefit is 99% of the regenerated energy is used and the braking resistors in the Rolling stock can be removed, which will in turn reduce the train mass and heat generated.*

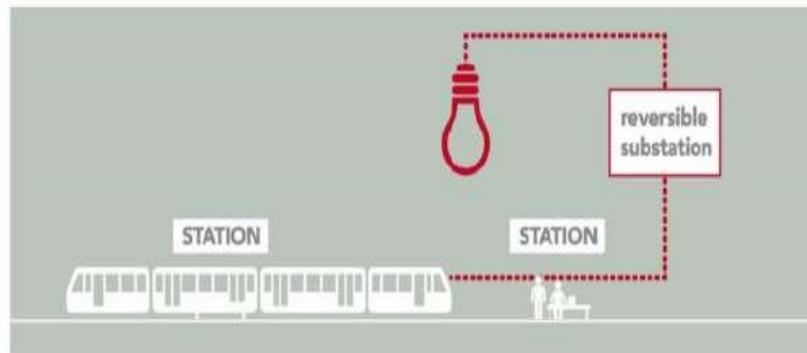
**Key words:** Regeneration, Braking, Metro rail, green energy



Distributed under Creative Commons CC BY-NC 4.0 OPEN ACCESS

## INTRODUCTION

Going by the dictionary definition a substation means “transform voltage from high to low, or the reverse, or perform any of several other important functions “Substations provide current only in one direction and not able to absorb energy generated by other sources. So going by that definition a “Reversible Substation “means that system which allows it to operate in both the direction. The quality of energy that the network is able to absorb depends on the number of accelerating and braking trains in the line. This is known as the receptivity of the line. The aim of Reversible Substation is to maximise the receptivity of the network. This paper discusses the available technologies for reversible substations.



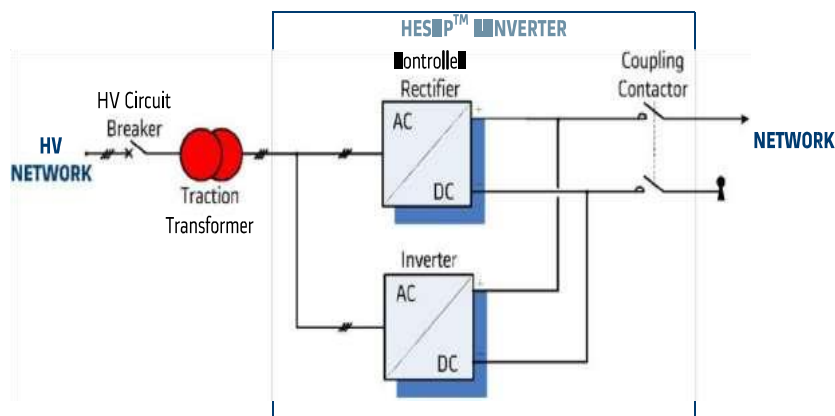
## Reversible Substation

As the technology is new there only very few vendors offering Reversible substations the three technologies in practice today are

- Using converters (only new installations)
- Using Chopper/Inverters
- Using thyristor controlled inverters

## Using Converters

This technology has been used by Alstom in creating a new product HESOP (Harmonic and Energy Saving Optimiser). It consists of a thyristor rectifier bridge associated with an IGBT converter and the associated dynamic voltage controller. The rectifier bridge operates in the traction mode only. While in traction mode, the inverter operates as an active filter. In braking mode it regenerates the energy back to the ac side. Both rectifier and inverter are controlled dynamically with a single controller that switches from one mode to the other without any dead time. The basic architecture is as given in Fig .1.



**Fig.1**

This optimises the power required for traction and recovers 99% of energy during braking mode. So this reduces the energy drawn from the grid and in turn reduces the operational cost. If the reversible substations are used then the number of traction sub stations also can be reduced there by reducing the infrastructural investment. The requirement of the on board resistors are not required since there 99% energy recovered during braking this leads to less train heat dissipation and in turn less tunnel and in station ventilation. The trains weight is reduced which contributes to further traction energy savings. The layout is as given in Fig 2.

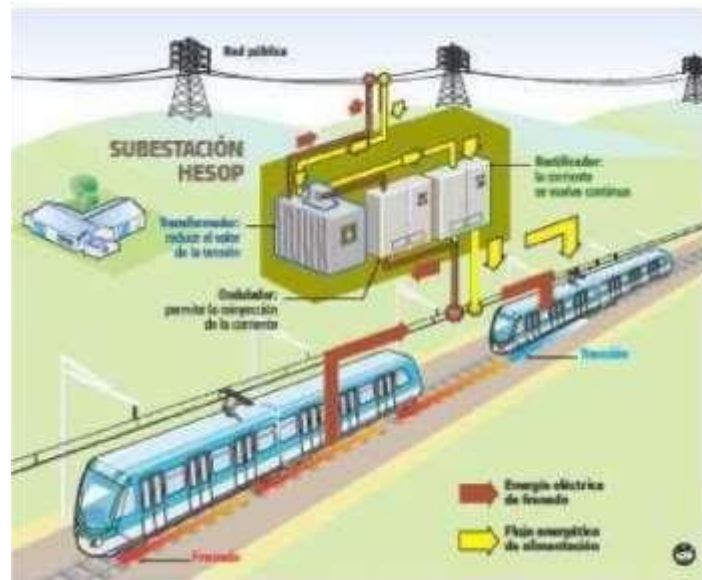


Fig 2

### Using Chopper/Inverters

The system consists of power electronics equipment installed in the substation and connected to the main equipment that already exists in the substation, such as transformer and rectifier. The system continuously monitors voltage until it detects a rise in voltage where the inverter gets activated and the surplus energy generated by braking is taken back to the grid or used by the auxiliary systems in the station. The general configuration of the system is as given in Fig. 3. This is being used by INGEBER to design their system.

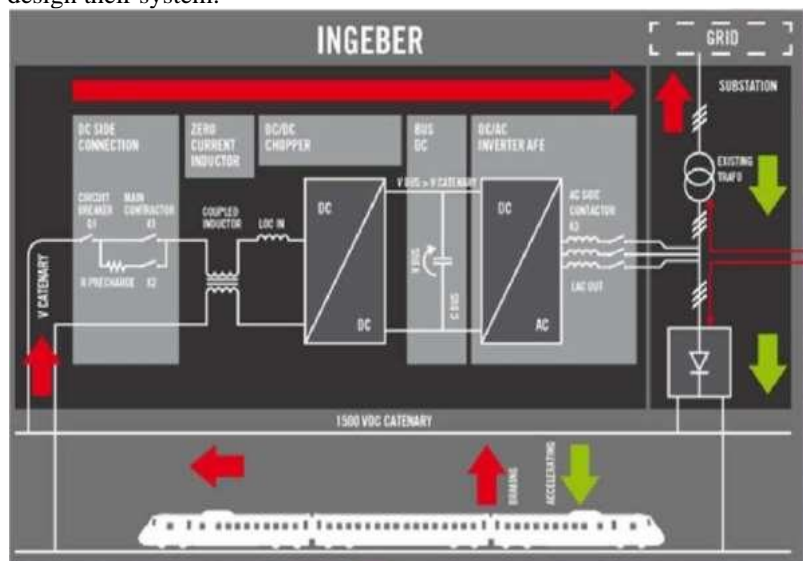


Fig 3

### Thyristor controlled Inverters

A thyristor controlled Reversible Sub stations allows recovering the braking energy and feeding back to the grid or for use in auxiliary systems in the stations. The principle has been used by SIEMENS to design their systems. If an antiparallel inverter is added to the diode rectifier, the power flow of the substation can be reversed, i.e. energy can be fed back into the supply grid or used by the auxiliary systems in sttions.. The inverter is only activated when recovered energy is available. The inverter set points have to be controlled in such a way that a certain share of the regenerated energy is available to be used by other trains for acceleration. The general layout is given in Fig. 4

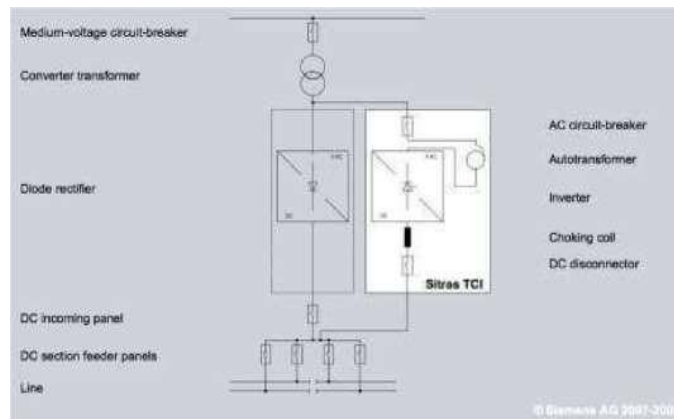


Fig 4

The Advantageous of having a Reversible substation are

- **Less energy consumed:** re-used through the station equipment (auxiliaries, escalators, lighting, ventilation, etc.) or re-injected into the electricity network
- **Lower fixed-cost contract** thanks to reduced power installed
- **Less penalties for customers** due to low harmonics & high-power factor (high energy quality)
- **Removal of brake resistors:** reduced train's weight & HVAC consumption
- Recovered energy quality is better than classic substations
- Recovered energy fits with power grid network absorption capacity
- 100 % of recovered energy is counted
- **Availability:** substations remain in operation even in case of unexpected peak load
- **Line voltage stabilization:** even in case of fluctuation on AC side
- **Possible network evolutions:** line voltage modification, increase of traffic
- **Facilitated maintenance:** less use of mechanical brakes, remote monitoring functions

## Conclusion

Braking energy recovery is certainly one of the most promising technologies for improving the energy efficiency of rail transport systems. This paper was aimed at giving the new technology that is available for reversible substations. We have different technologies competing in the same market with no clear leader. As the technology is new the advantageous and disadvantageous and also the existing system is to be considered while taking a decision.

## References:

- [1].Efficient recovery of braking energy through a reversible dc substation-Author,Comic D,Alstom transport engr.
- [2].WP2B Energy Recovery –An overview of braking energy recovery technologies in the public transport field. The “Ticket to Kyoto” project-www.tickettokyoto.eu.