GE VERNOVA

STATIC FREQUENCY CONVERTER FOR RAIL ELECTRIFICATION

Power Conversion & Storage solution to help otimize power connections and stabilize catenary power distribution.

Rail operators are switching line voltage from 3 kV to 25 kV to increase traffic capacity and reduce substations count/count of substations. A Static Frequency Converters (SFC) is an enabler of this transition, particularly where the network grid capacity is limited. Helping to link lower voltage connection to the grid, saving costs and deployment time.

To balance high renewable energy penetration in grid energy mix, for greenfield projects (newly created lines), SFC substations can help ensure excellent power quality from the grid, balance power between substations to avoid localized peaks, facilitate power exchange between trains, and increase distance between substations, reducing costs to connect to the transmission network.

SFCs allow to decouple frequency and phase between the catenary and the grid connections, enabling the removal of neutral sections along the catenary.

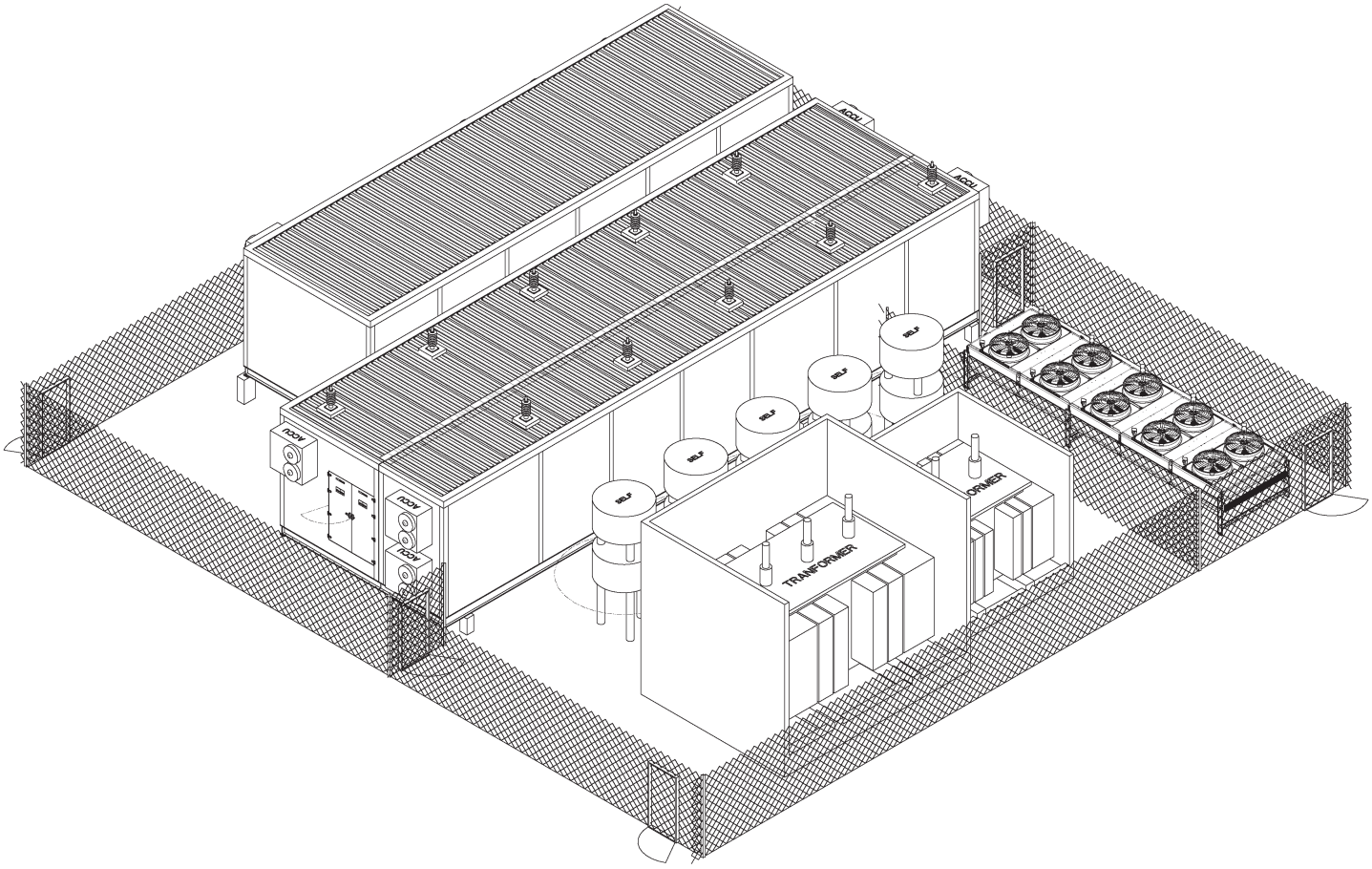
As cutting carbon emissions becomes a more pressing issue, populations are looking for a way to reduce their travel impact. Electric railways are recognized as the optimal solution due to their superior energy efficiency, reduced and lower operating costs.

This trend is supported by public investments as rail operators need to increase power capacity, pushing them to upgrade old 3 kV DC distribution networks to 25 kV AC.

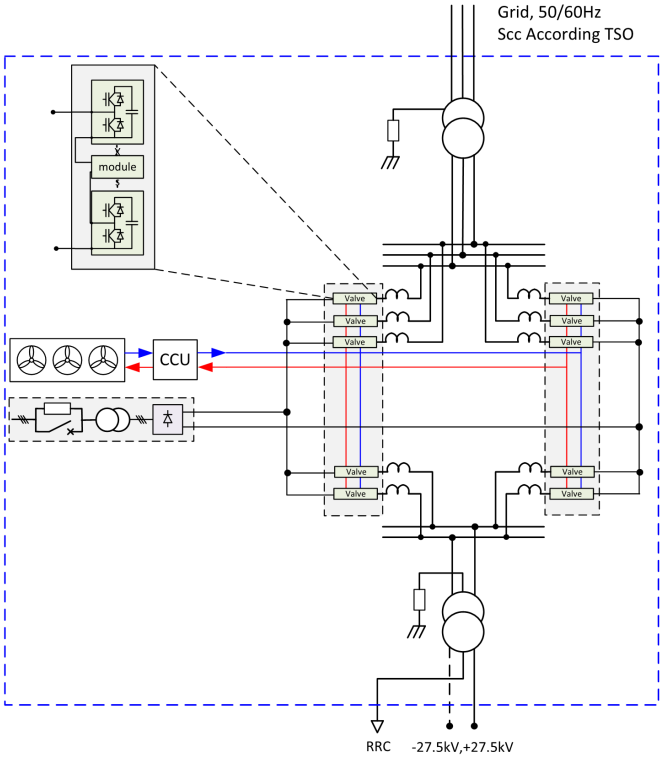
In certain countries, the single-phase railway network historically operates at a frequency distinct from that of the public grid, rendering direct connections between the two networks unfeasible without frequency conversion. In contemporary applications, Static Frequency Converters (SFCs) are employed when the power capacity of the grid network serving the rail line is constrained or the cost and time to bring a high voltage line is prohibitive. Additionally, some new railway projects are integrating SFCs for enhanced system optimization.

TECHNOLOGY

Grid Frequency	50-60 Hz
Tension Grid	20 kV - 400 kV (Can be adjusted if needed)
Apparent nominal power	30 MVA
Insulation	33/95/200 kV
Converter Type	MMC
Converter typology	Indirect
MMC Levels	10
MMC Redundancy	N+1 hot redundancy N+2 available in option
Cooling type	Air & glycol/water mixture
Catenary Frequency	50-60 Hz (Solution 16.7 Hz exists)
Typical Catenary tension	5 or 2*25 kV (Can be adjusted if needed)
Operating voltage	18 kV - 27.5 kV (Loaded) 17.5 kV - 29 kV (Transient)
Typical land plot dimensions	19,500×19,500 mm

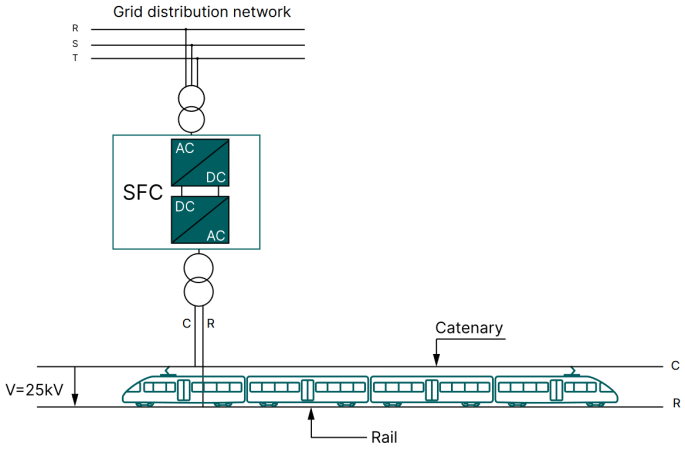


E-House Typical



BENEFITS & FEATURES

- Avoid unbalanced grid loads and resulting penalties to grid operators
- Provide reactive power control on grid and traction networks
- Increase of efficiency e.g. by reduced power consumption in railway system
- Reduce complexity for rail operator by eliminating the neutral section in overhead catenary lines
- Flexibility to connect rail grid to power grids of different providers and to grids of reduced voltage or short-circuit capacity
- Facilitate management of brake energy by sending back braking energy from catenary to the grid
- Increase distance between substations



SFC implementation

A SFC provides multiple features, including independent reactive power control for both grids and the capability to supply the railway from a weak three-phase grid with low short circuit power, ensuring perfect voltage balancing between phases.

The synchronization of SFCs is possible with the Phasor Management Unit (PMU), such as the GE Vernova Multilin N60, which assists in balancing power across substations. The system is secured by protection and control relays like the GE Vernova Multilin Agile. Additionally, it supervises and manages the entire traction power supply to optimize availability. Faults along the line are located using Travel Wave Form Localization (TWFL) technology; fit for faster recovery of line supply.

About GE Vernova's Power Conversion & Storage business

GE Vernova's Power Conversion & Storage business combines advanced energy conversion and storage systems to meet the electrification needs of utilities and industries. With a focus on power stability, energy storage, and industrial electrification solutions, Power Conversion & Storage empowers customers by addressing their most complex electrification challenges and accelerating their transition to a sustainable, decarbonized future.

For more information, please visit
gevernova.com/power-conversion

Glossary

SFC	Static frequency converter
IEGT	Injection enhanced gate transistor
MMC	Modular multilevel converter
STATCOM	STATic synchronous COMpensator
PMU	Phasor management unit
TWFL	Travel wave form localization

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