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Static Frequency Converter

International Conference on

GREEN INITIATIVES & RAILWAY ELECTRIFICATION

Hotel Le Meridien, New Delhi

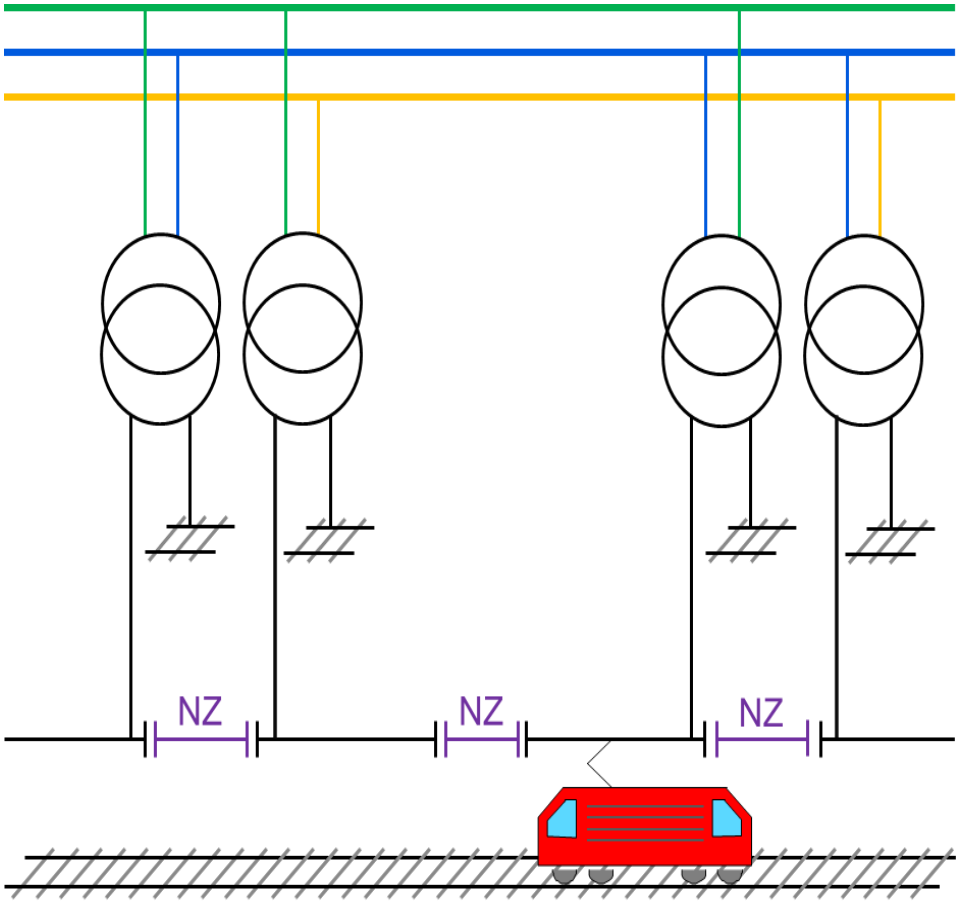
Arunav Kumar Jha, ABB FACTS

Agenda

- Conventional Feeding system
- Static Frequency Converter
  - SFC Feeding concept
  - Advantages over conventional feeding concept
  - Parallel Feeding and advantages
  - SFC Benefits Summary
- ABB references for 50 Hz and 16.7 Hz
- Project Wulkuraka 50 Hz reference
  - Schematics
  - Footprint
  - Site Observations

Conventional Feeding System

Typical Railway Power Supply Connection 25 KV, 50Hz



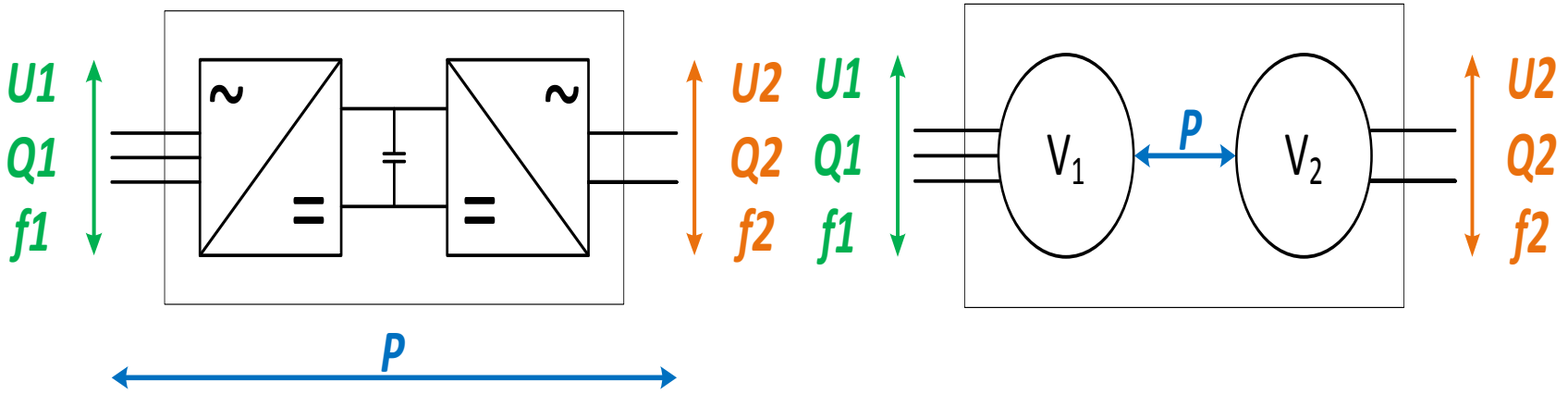
Simple solution but with drawbacks

- Neutral sections due to connection to different electrical phases
- Non optimal catenary voltage
- High catenary short circuit current
- Power flow cannot be controlled and regenerative energy cannot be captured in the system
- Higher peak demands, lower overall traction system efficiency
- Unbalance effect on public grid
- High harmonics injected into supply grid from traction vehicles
- High voltage fluctuations in feeding grids caused by fluctuations of railway loads
- Need for reactive power compensation equipment for fulfilling Grid code requirements

Static Frequency Converter (SFC)

SFC Feeding Concept

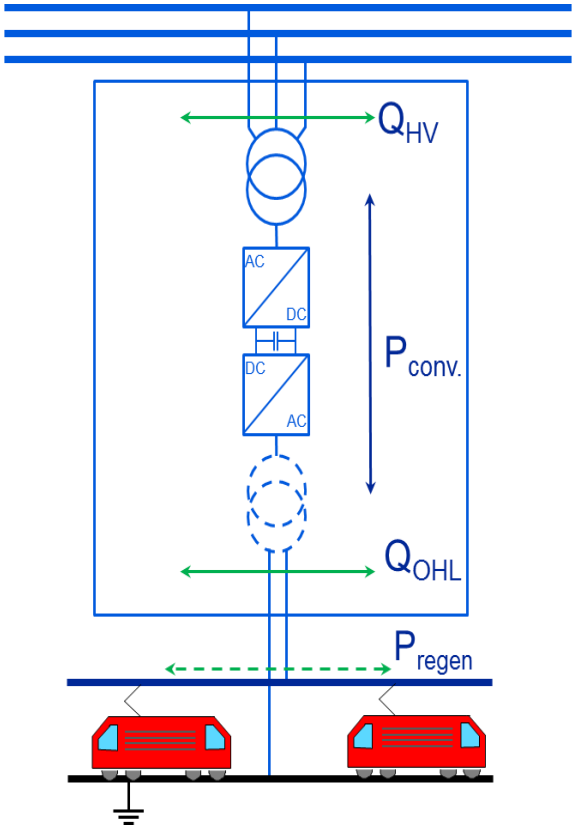
Introduction to frequency converter



- Static Frequency Converter Decouples Electrically the two grids
- Active Power cannot be stored, but can be controlled
- Frequency , Voltage & Reactive Power can be controlled on both converter sides

SFC feeding system & Conventional Feeding System

SFC Feeding System Connection 50Hz

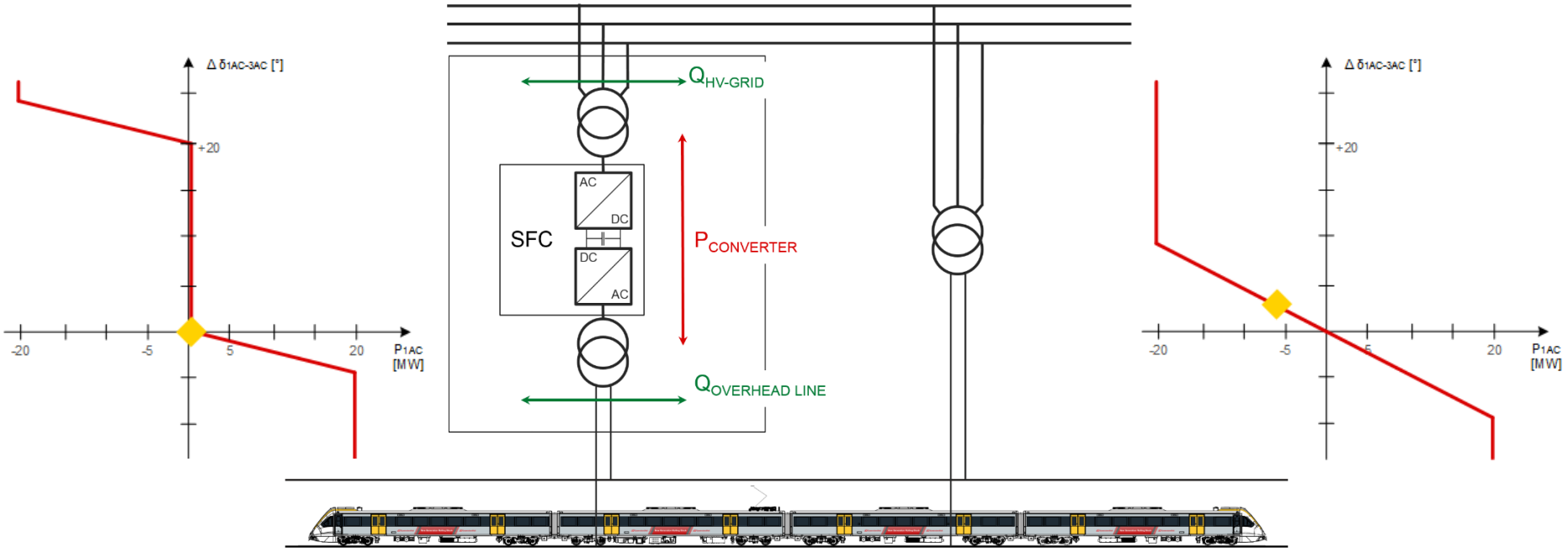


Key benefits

- No Neutral zone, continuous power feeding to train
- Parallel & synchronized feeding, increased availability
- Catenary voltage improvements, increased torque capability
- Improved corridor performance, higher overall system efficiency
- Optimized use of regenerative breaking
- Reduction of peak demand
- Excellent short circuit behavior, low fault current contribution
- Fully balanced load, at desired power factor, low harmonic contribution

Static Frequency Converter (SFC)

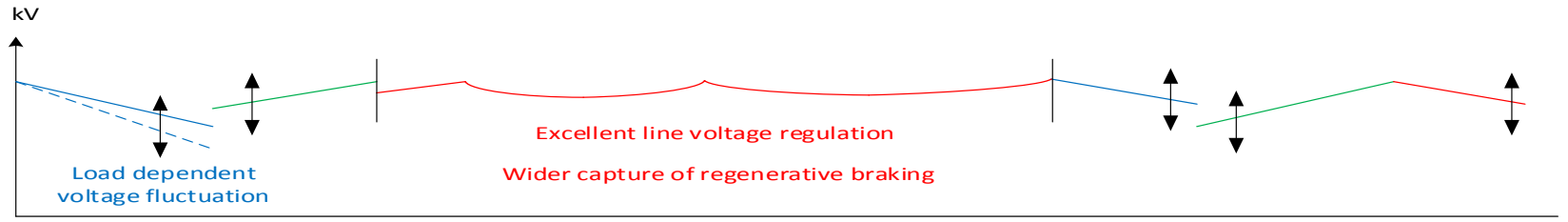
SFC Feeding Concept :Parallel Feeding 1/2

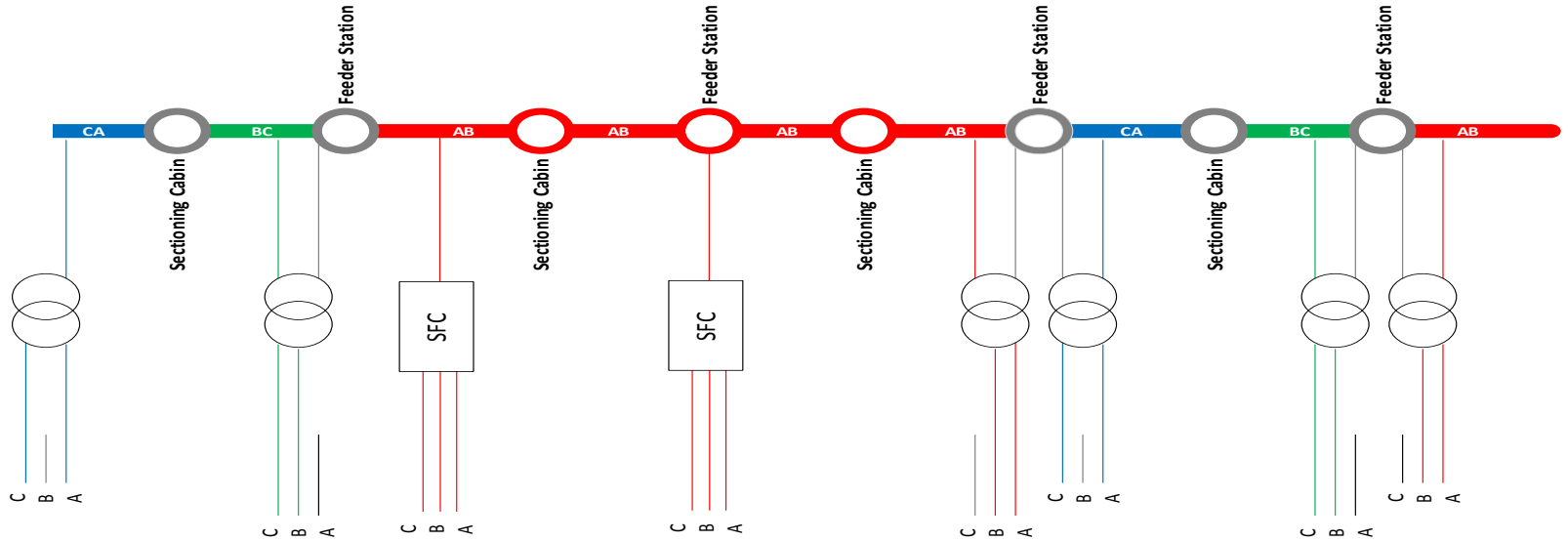


Optimized Use of Regenerative Breaking Energy

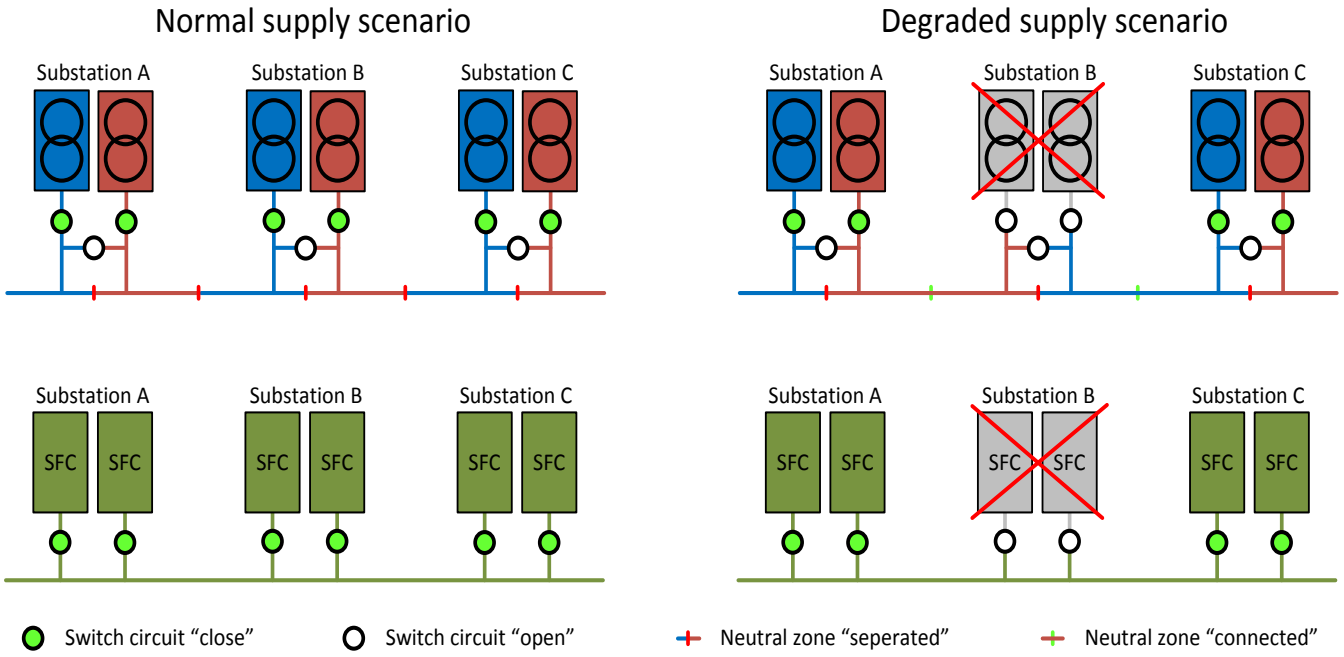
Static Frequency Converter (SFC)

SFC Feeding Concept Parallel Feeding 2/2





Railway system simulation



- With SFC No neutral zone
- Smooth take over from other connected SFCs in case of any sub station down
- Smooth and synchronized re-connection as soon as Faulty substation back in operation

Benefits of converter based railway power supply system

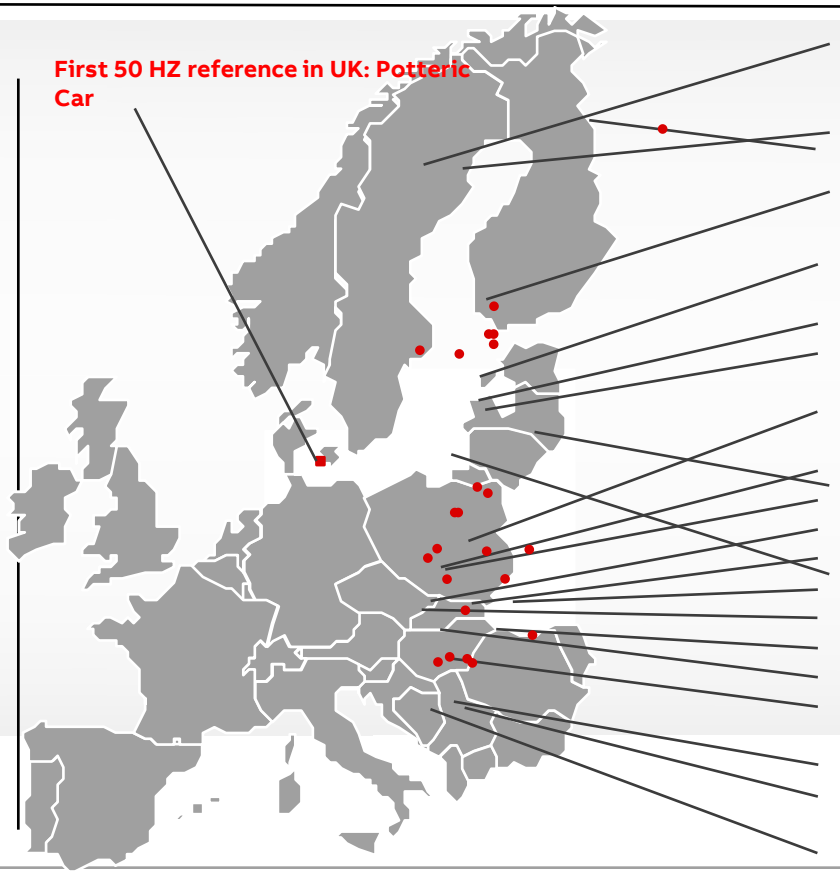
- Longer feeding distance reachable
- Reduced active power consumption
- Improved fault behavior
- Reduced catenary short circuit current
- Excellent fault ride through behavior (both sides)
- Continuous stable operation during grid single phase fault
- Catenary voltage support during 3ph grid failure
- Improved power capabilities with active catenary voltage control
- Advanced test functionality for rolling stocks and catenary lines
- No harmonics effect from OHL toward 50 Hz grid
- Improved system efficiency achievable

ABB's Expereince with SFC Technology Delivery

Reference list of ABB SFCs

Title

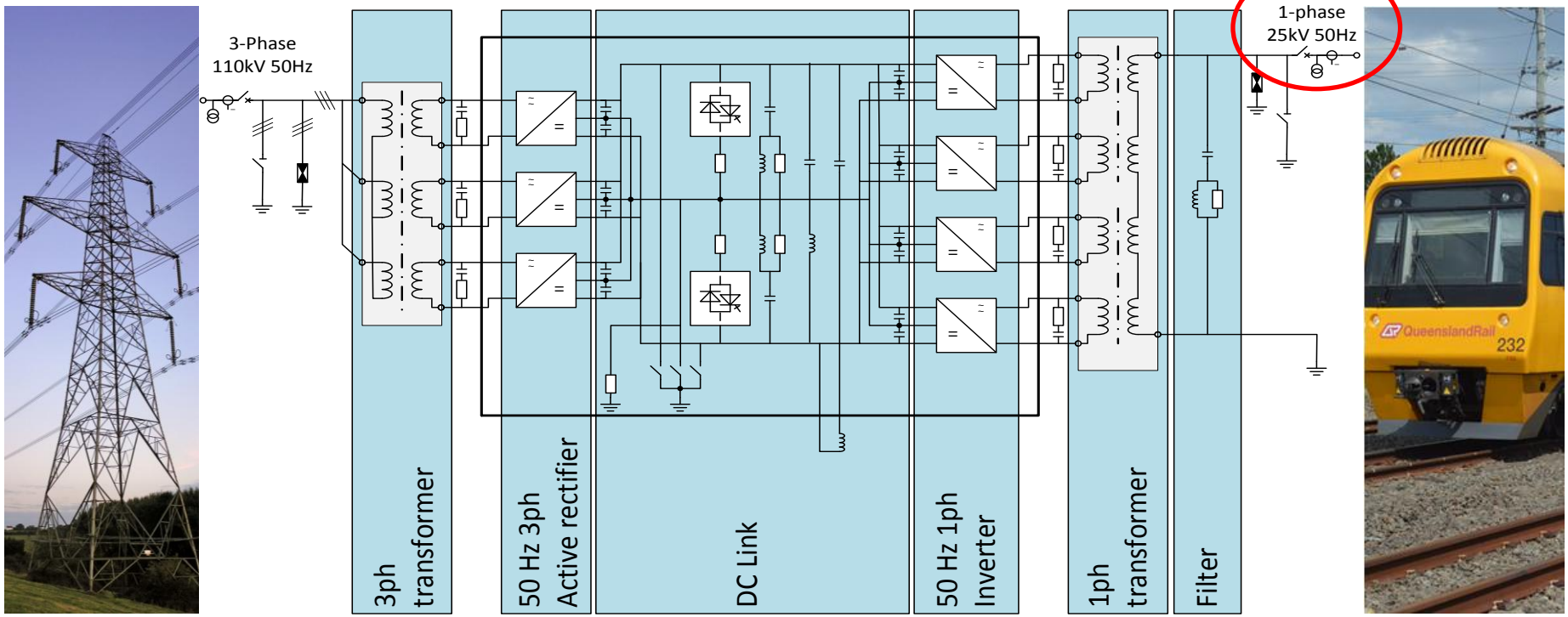
- Largest installed base / more than 40units in service, more than 1.2 GW SFC installed power
- More than 20 years of experience in applications for rail power supply
- Proven control and protection algorithms for 50 Hz and 16 Hz
- Satisfies high reliability and availability demands
- For 50 Hz:
- Wulkuraka, Queensland Rail, AU 1x 16MVA, commissioned in 2016
- Potteric Car, Network Rail, UK awarded in May 2017, 1x42 MVA



PCS6000 16Hz References	
Kalix	2x19MVA
Stavanger	2x17MVA
Rudshögda	1x15MVA
Alnabru	2x15MVA
Holmlia	1x15MVA
Larvik	1x15MVA
Neumünster	2x35MVA
Lübeck	2x19MVA
Bremen III	1x40MVA
Bremen II	1x80MVA
Datteln	4x120MVA
Wolkramshausen	2x19MVA
Doberlug	2x19MVA
Düsseldorf	1x19MVA
Hof	2x15MVA
Limburg	8x19MVA
Neckarwestheim	2x75MVA
Timelkam	2x37MVA
Landquart	1x20MVA
Bever	1x20MVA
Obermatt	1x10MVA
Wimmis	4x21MVA

Reference project Wulkuraka

Converter single line diagram



Reference project Wulkuraka, Queensland Rail

Customer needs

Brisbane – Rosewood line
Increased energy demand on the track
new rolling stock maintenance depot nearby
25 kV 50 Hz substation without unbalance effects

ABB Response

Turnkey solution incl. 20 MVA Static frequency converter incl. control, transformers, switchgears, cooling, filters, installation and commissioning
110 kV 50 Hz 3ph ↔ 25 kV, 50 Hz 1-Ph

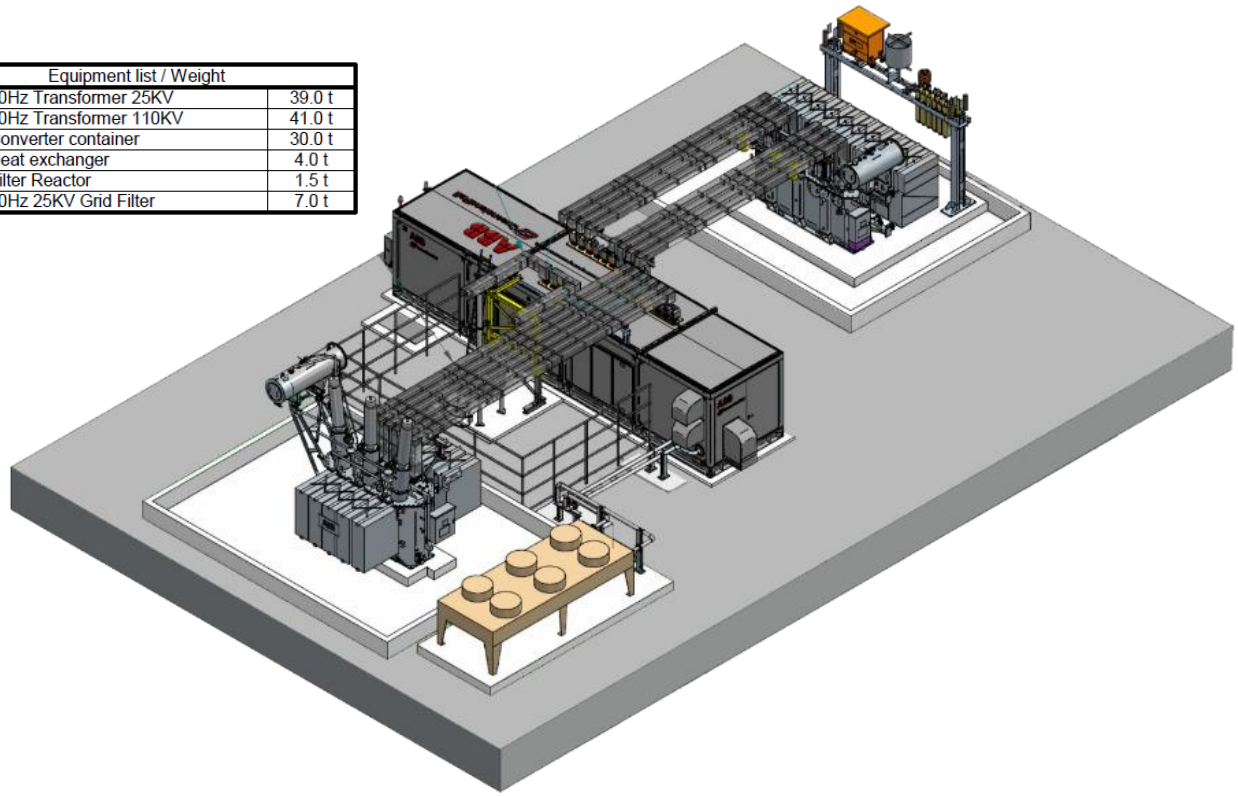
Customer's benefits

Stronger railway corridor performance

Reference project Wulkuraka, Queensland Rail

Layout 30m x 20m

Equipment list / Weight		
1	50Hz Transformer 25KV	39.0 t
2	50Hz Transformer 110KV	41.0 t
3	Converter container	30.0 t
4	Heat exchanger	4.0 t
5	Filter Reactor	1.5 t
6	50Hz 25KV Grid Filter	7.0 t



Reference project Wulkuraka

ABB's experience with SFC Technology

50:50 Hz Wulkuraka Queensland Rail

Peak demand reduction

Measured by customer @ Wulkuraka in 2016

Scope is to corridor performance

Reduced energy billings

Use will enhance further on when new fleet is in operation producing more regenerative energy