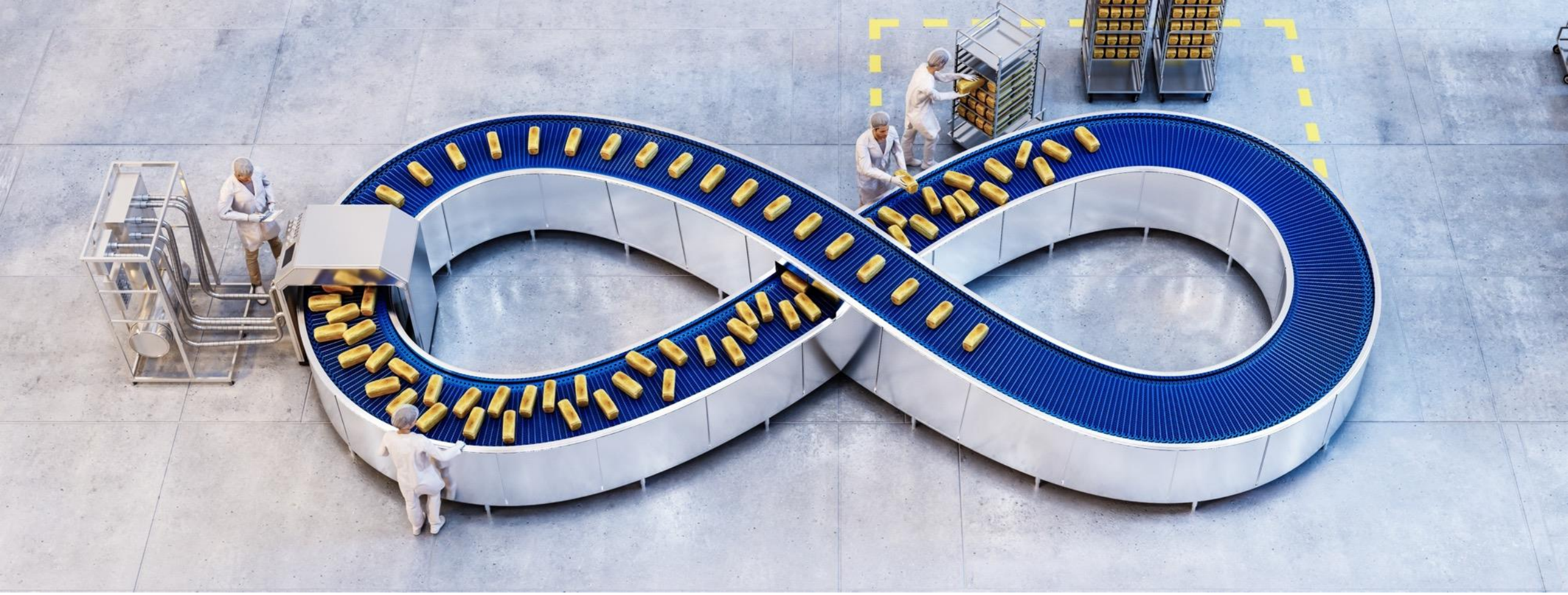


F&B CUSTOMER DAY 2018 | SURABAYA , SEPTEMBER 5, 2018

ABB’s Power Quality Solution

Setting a new level of efficiency & productivity for F&B industries

Ferdinand Sibarani, Product Specialist

What is the significance of power quality?

It’s the prerequisite to achieve system’s efficiency & productivity!

Power Quality Challenges

Utility / supply related power quality issues

- Utilities endeavor to supply reliable & consistent electric power, however many factors beyond control can cause voltage/power disturbances;

- Common causes:
  - lightning,
  - thunderstorm, high winds,
  - heavy rain,
  - traffic accidents,
  - construction works,
  - animals,
  - switching operation, etc.;

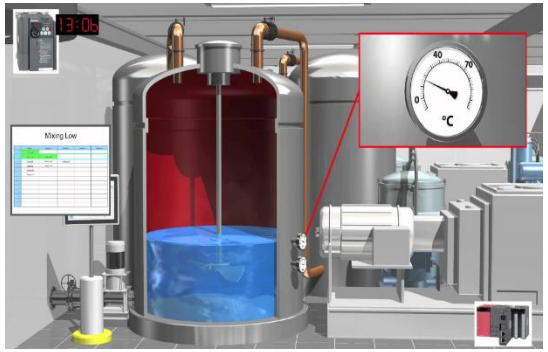
Power Quality Challenges

Modern F&B industries apply more sensitive equipment

Dairy processing

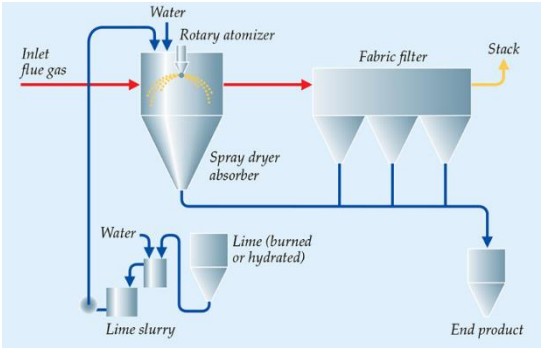
Packaging lines

High speed bottling



Batch process

Climate control



Dryer process

Impacts of Poor Power Quality

Technically

- waste of material / resources / work in progress;
- uncontrolled / inconsistent product quality;
- plant down time and delays in delivery time;
- increased wear / malfunction of electrical component;
- reduced life expectancy / premature aging of the equipment;
- additional labor (for product reworks, etc.);
- human health, safety, and productivity;

Financially

150 billion Euros per year!

(European power quality survey in EU-25 countries, in 2003 -2004, among 62 companies from different industries & service sectors)

188 billion Dollars per year!

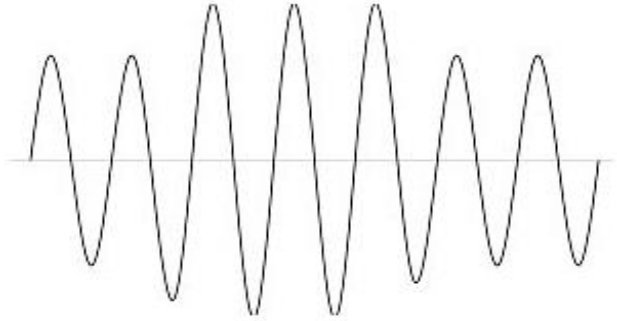
(EPRI & CEIDS survey in American industries in 2000)

Utility / Supply Related Power Quality Issues

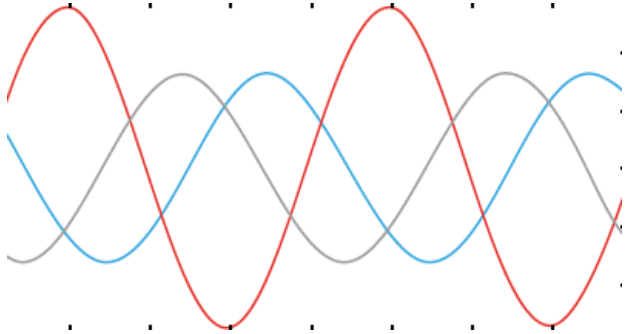
Voltage disturbances

Voltage dip / sag

Voltage surge / swell

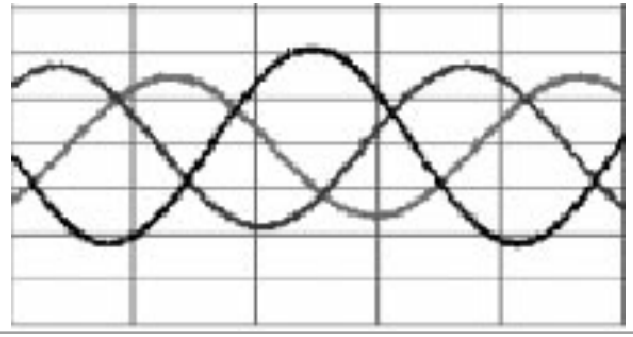


Voltage unbalance



Voltage flicker

Voltage phase angle error



What is the solution?

Traditional Solutions…?

On Load Tap Changer (OLTC)

Motor based voltage stabilizer

- lack speed of response;
- have limited correction potential;
- usually do not offer imbalance and phase correction.

Uninterruptible Power Supply (UPS)

- very expensive;
- less efficient;
- high operational cost (battery, space, AC)

Modern Solution Available

Active Voltage Conditioner

- extremely fast & accurate;
- power electronic based;

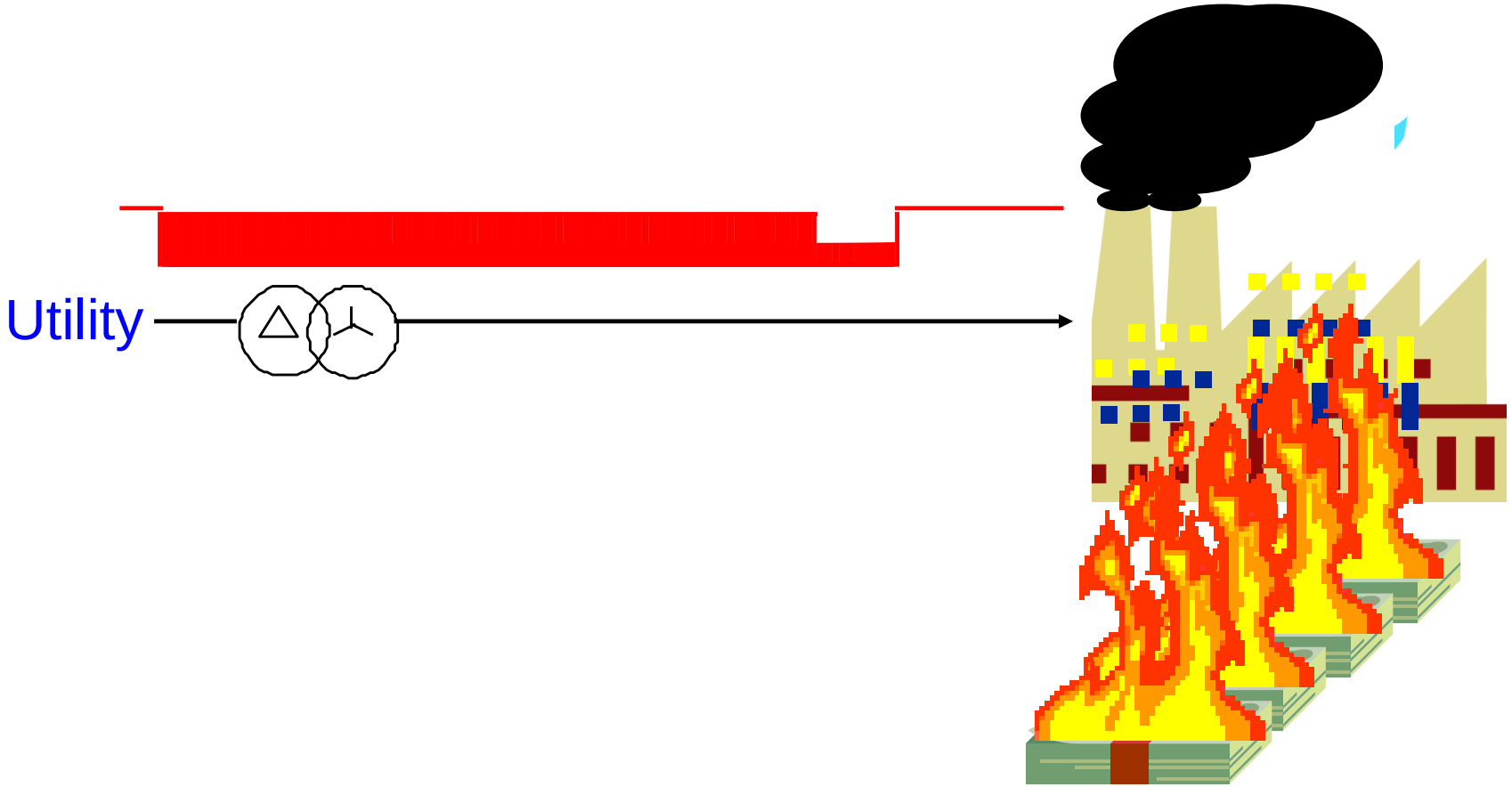
Features

- no energy storage required;
- correction of under & over voltage, even with regenerative loads;
- rugged overload capability;
- correction capabilities: 20% or 40%;
- low voltage solution, size per unit 150 kVA to 3.6 MVA;
- integrated event log;
- Ethernet connectivity;
- modular construction;

Benefits

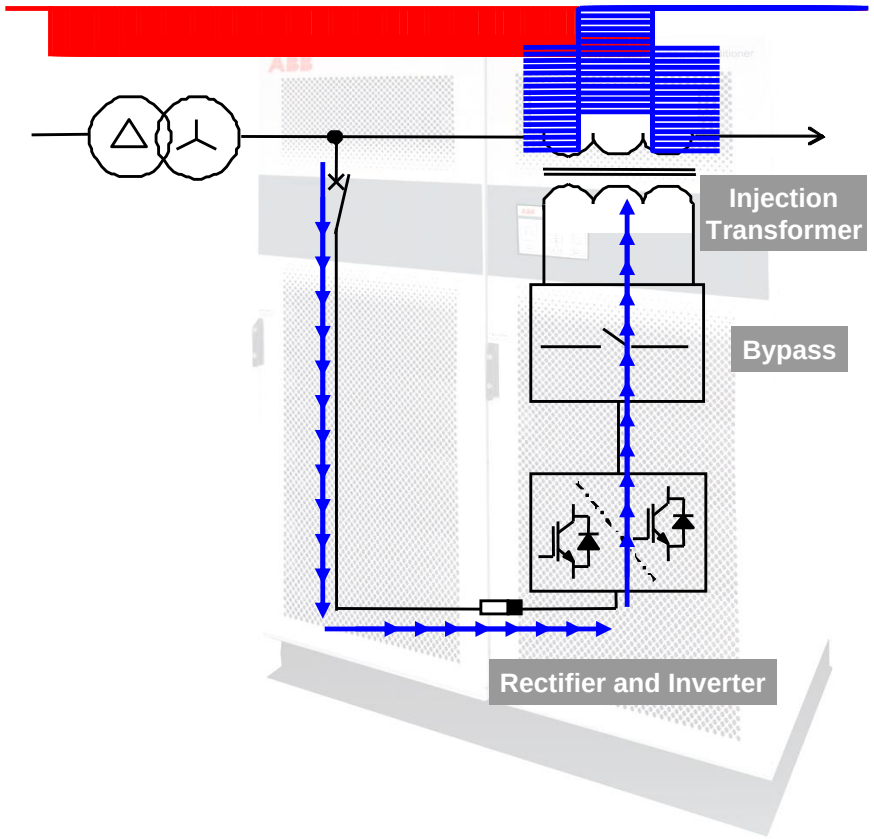
- small dimensions / footprint;
- high reliability;
- high efficiency;
- operating temperature range 0^0C–50^0 C;
- low cost of ownership;
- commonality of spares;
- low maintenance.

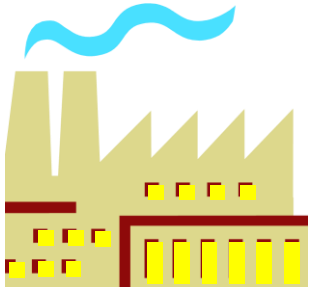
No Protection Against Voltage Disturbances

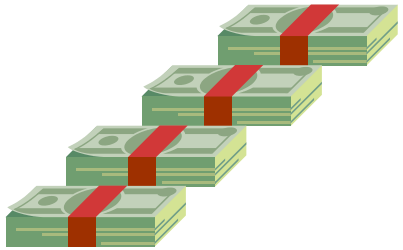


PCS100 AVC Dip / Sag Protection

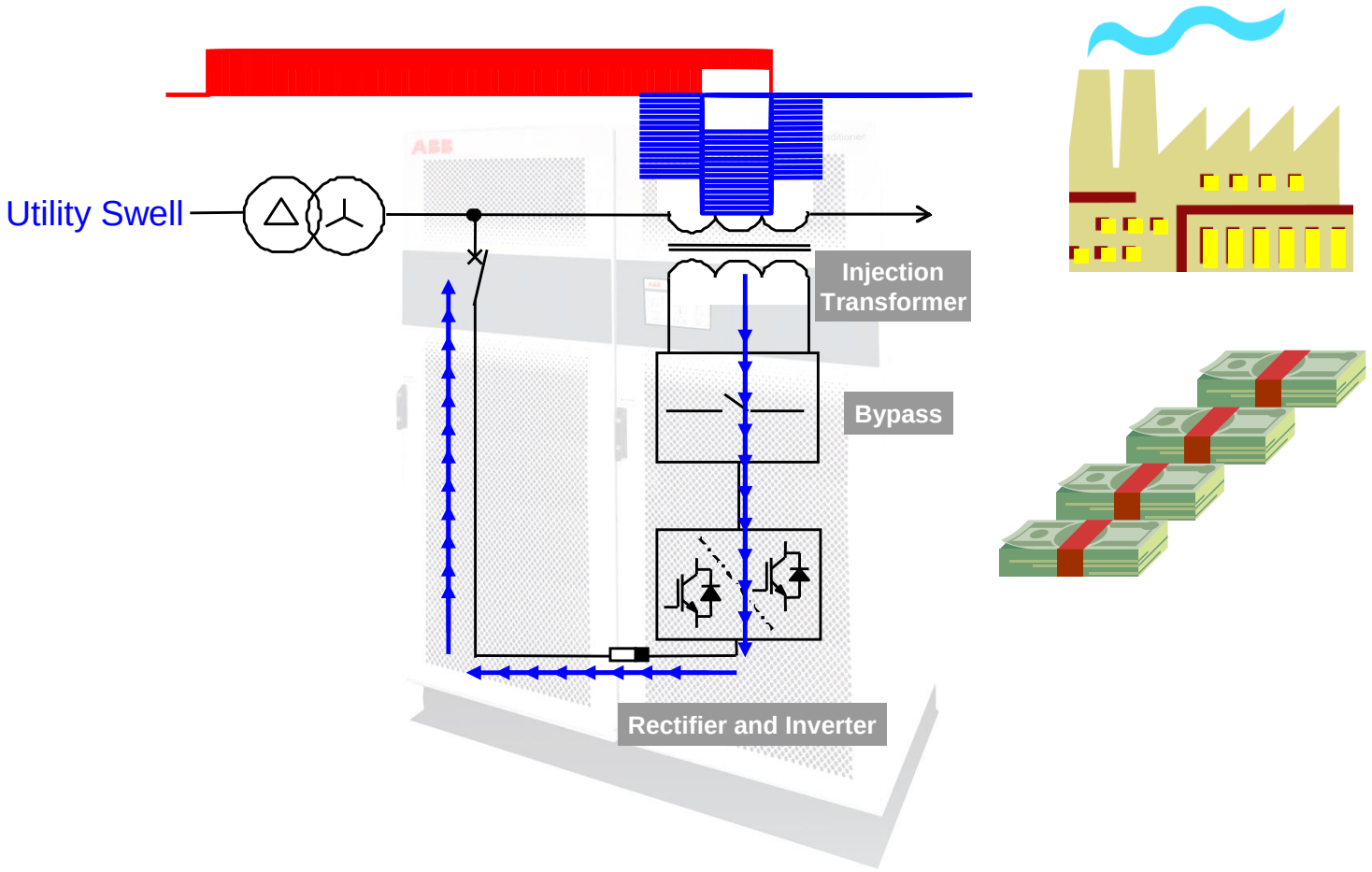
Utility Sag







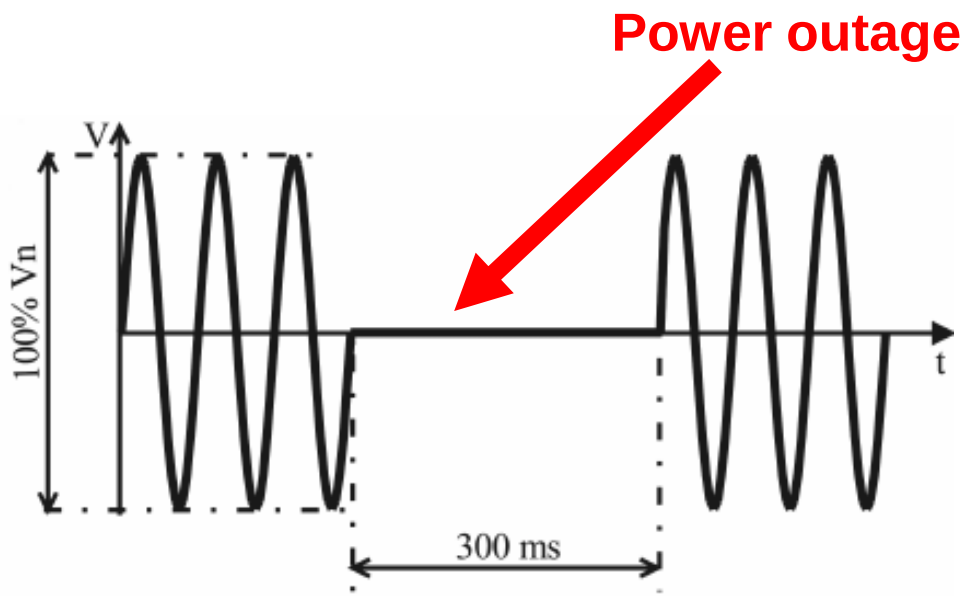
PCS100 AVC Surge / Swell Protection



Utility / Supply Related Power Quality Issues

Power outage

- Definition: loss of electric power, could last momentarily or continuously;
- Causes: temporary or permanent disturbance, e.g.: auto-recloser operation, etc;
- Effect: electrical and electronic equipment to trip or malfunction;



What is the solution?

Industrial UPS vs Commercial UPS

Description	Commercial UPS	Industrial UPS
Typical load	IT (computer, server), sensor, meter, control system, etc.	IT & Industrial e.g.: motors, drives, transformers, production tools, etc.
Topology	Double conversion	Single conversion
Maximum efficiency	95.5%	99.5%
Static switch design	Hybrid – electro mechanical	Full electronic
Failure in static switch power supply and / or microprocessor	May drop critical loads	Static switch fails to bypass source
Battery life time	2 years	10 years
Product / system life time	5 – 7 years	15 – 25 years

ABB's Commercial Stand Alone UPS

PowerValue 11 RT

– Parallelable up to 2 units
– System power 20 kVA
– Single-phase rack or tower convertible

PowerScale

– Parallelable up to 20 units
– System power 1000 kVA
– 3 different cabinets and configurations
– Three-phase standalone tower

PowerValue 11/31 T

– Parallelable up to 4 units
– System power 80 kVA
– Single in/three-phase out standalone tower

PowerWave 33

– Parallelable up to 10 units
– System power 5000 kW
– 10 different cabinets and configurations
– Three-phase standalone tower

ABB’s Commercial Modular UPS

DPA UPScale ST

– Parallelable up to 20 modules
– System power 400 kW
– 5 different cabinets and configurations

Conceptpower DPA

– Parallelable up to 30 modules
– System power 1500 kVA
– 2 different cabinets and configurations

DPA UPScale RI

– System power 80 kW
– Rack-independent UPS system
– 7 different subracks and configurations

Conceptpower DPA 500

– Parallelable up to 30 modules
– System power 3000 kW

PCS100 UPS-I (Industrial UPS – Low Voltage)

Features

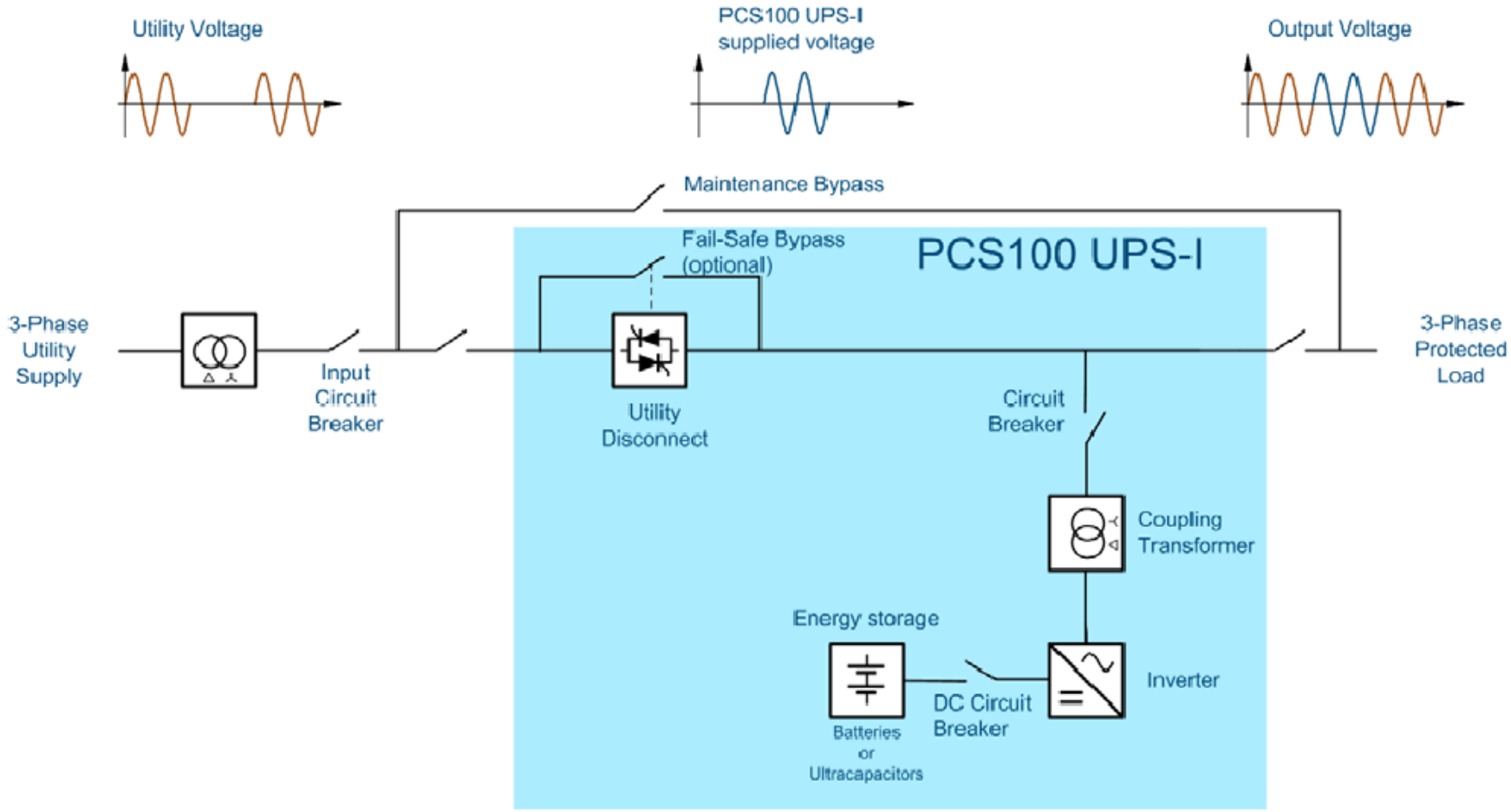
- single conversion;
- industrial grade, suitable for motors, pumps, compressors, drives, transformers, production tools, etc.;
- modular design with advanced redundancy ;
- very high fault current capacity;
- ultra-capacitor or battery storage;
- generator walk-in algorithm;
- Capacity 150 kVA to 3 MVA and voltage 208 V to 480 V

Benefits

- highest reliability;
- long lifetime energy storage;
- small footprint;
- highest efficiency (>99%) and availability;
- the lowest total cost of ownership;
- easy serviceability & maintenance.

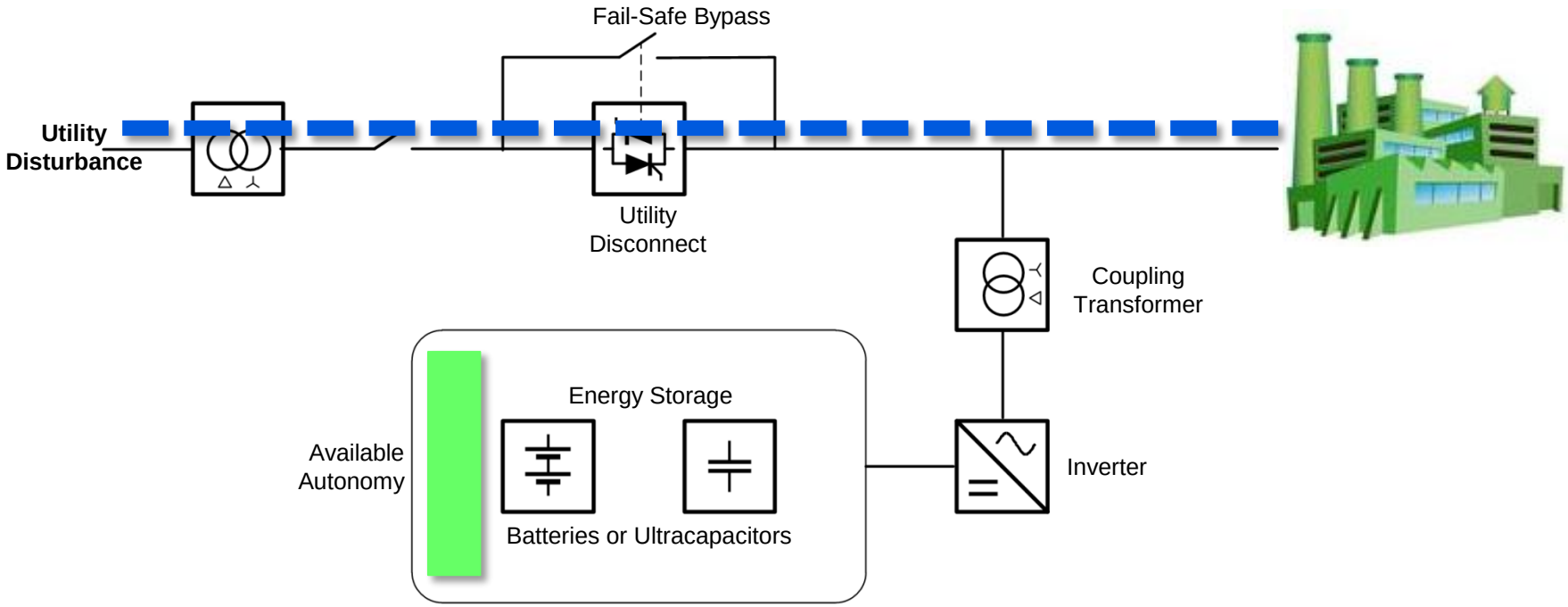
PCS100 UPS-I (Industrial UPS)

Single line diagram



PCS100 UPS-I (Industrial UPS)

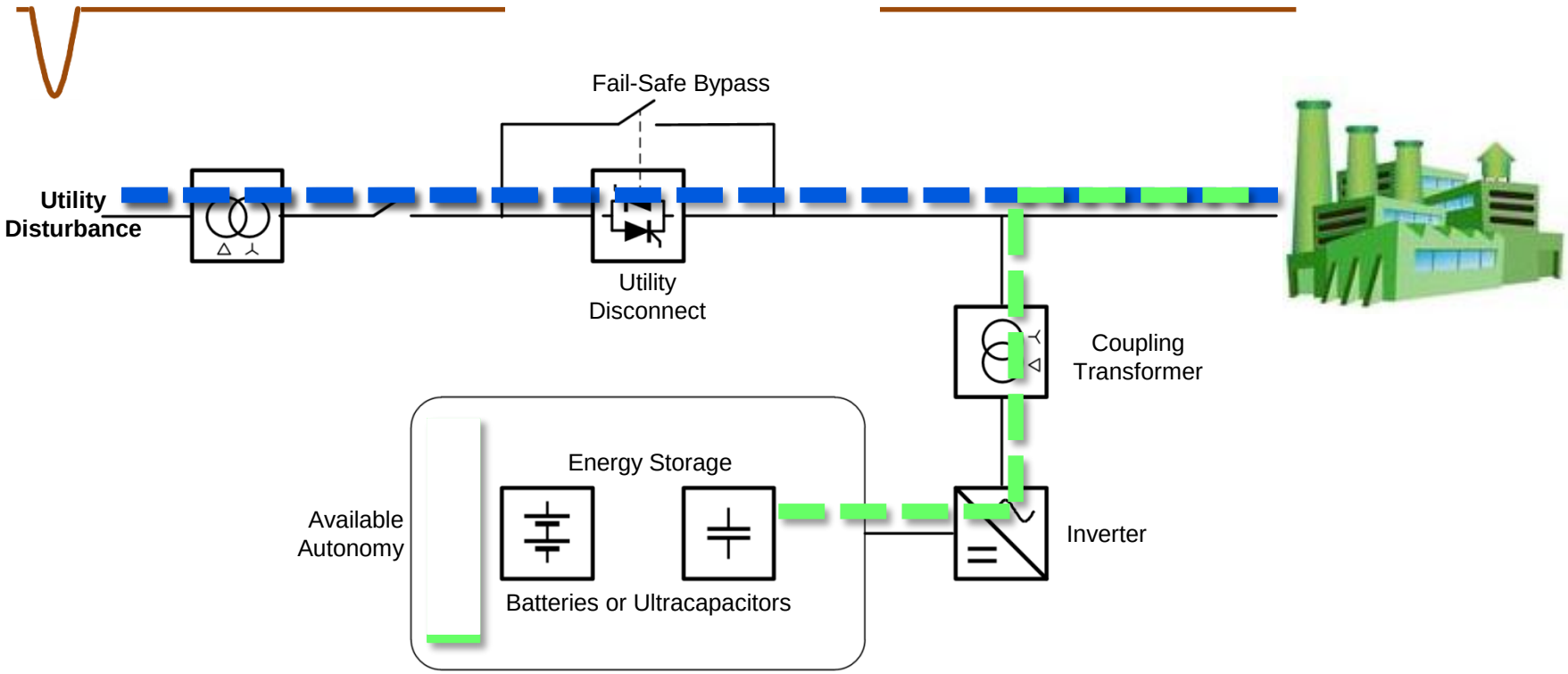
Utility voltage within limit



- Inverters → off, but synchronized with the utility voltage;
- Float charger → maintains the battery or ultra-capacitor storage.

PCS100 UPS-I (Industrial UPS)

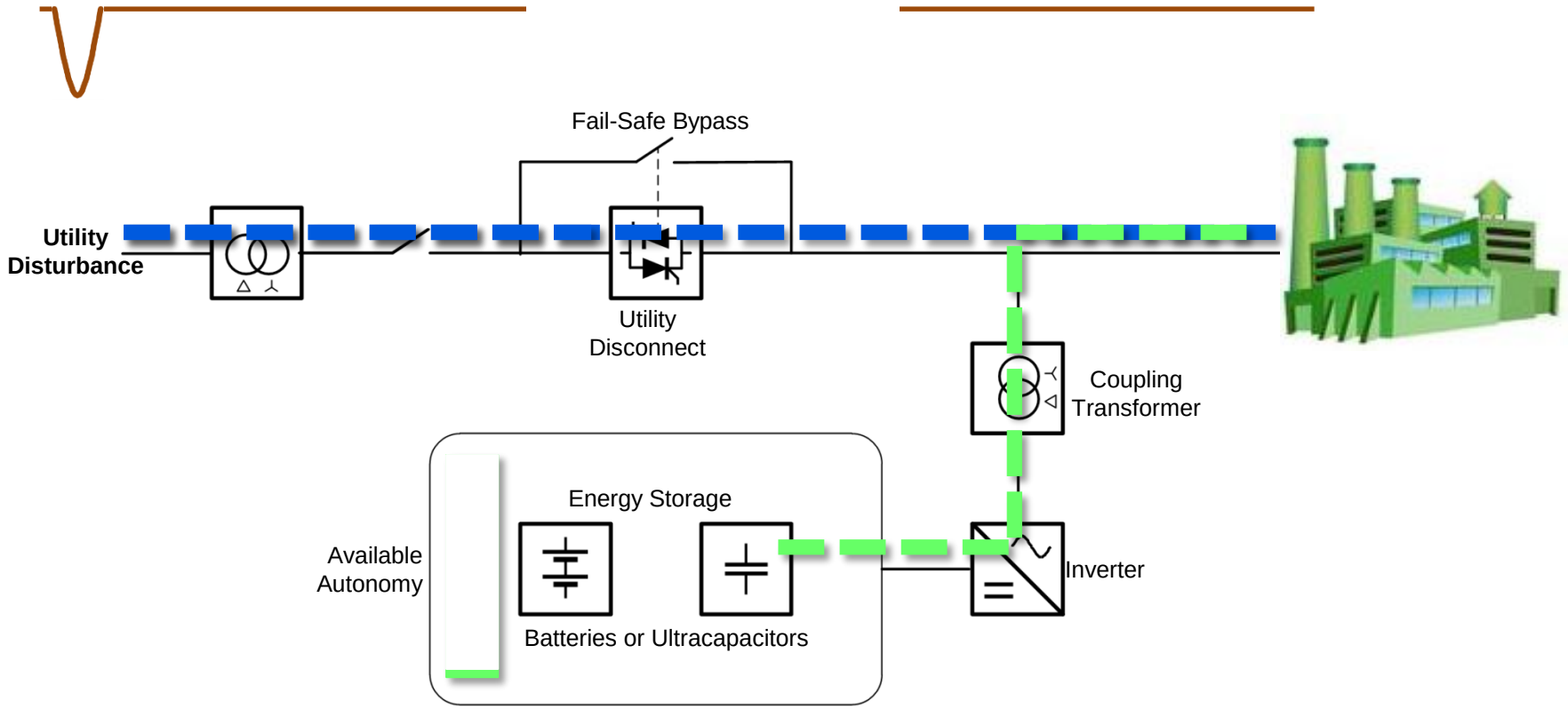
Utility disturbance occurs



Utility Disconnect → commutated off instantaneously with ABB's commutation technique

PCS100 UPS-I (Industrial UPS)

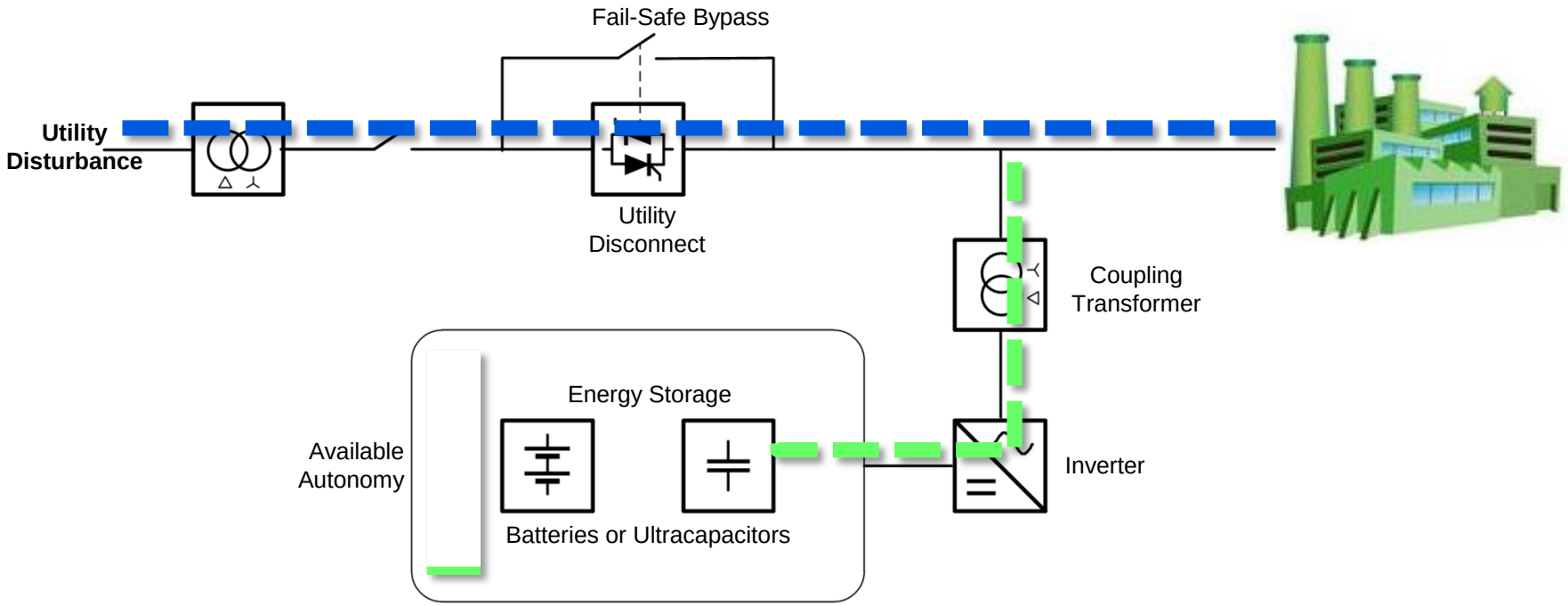
Utility disturbance occurs



Utility Disconnect → commutated off instantaneously with ABB's commutation technique

PCS100 UPS-I (Industrial UPS)

Utility voltage returns



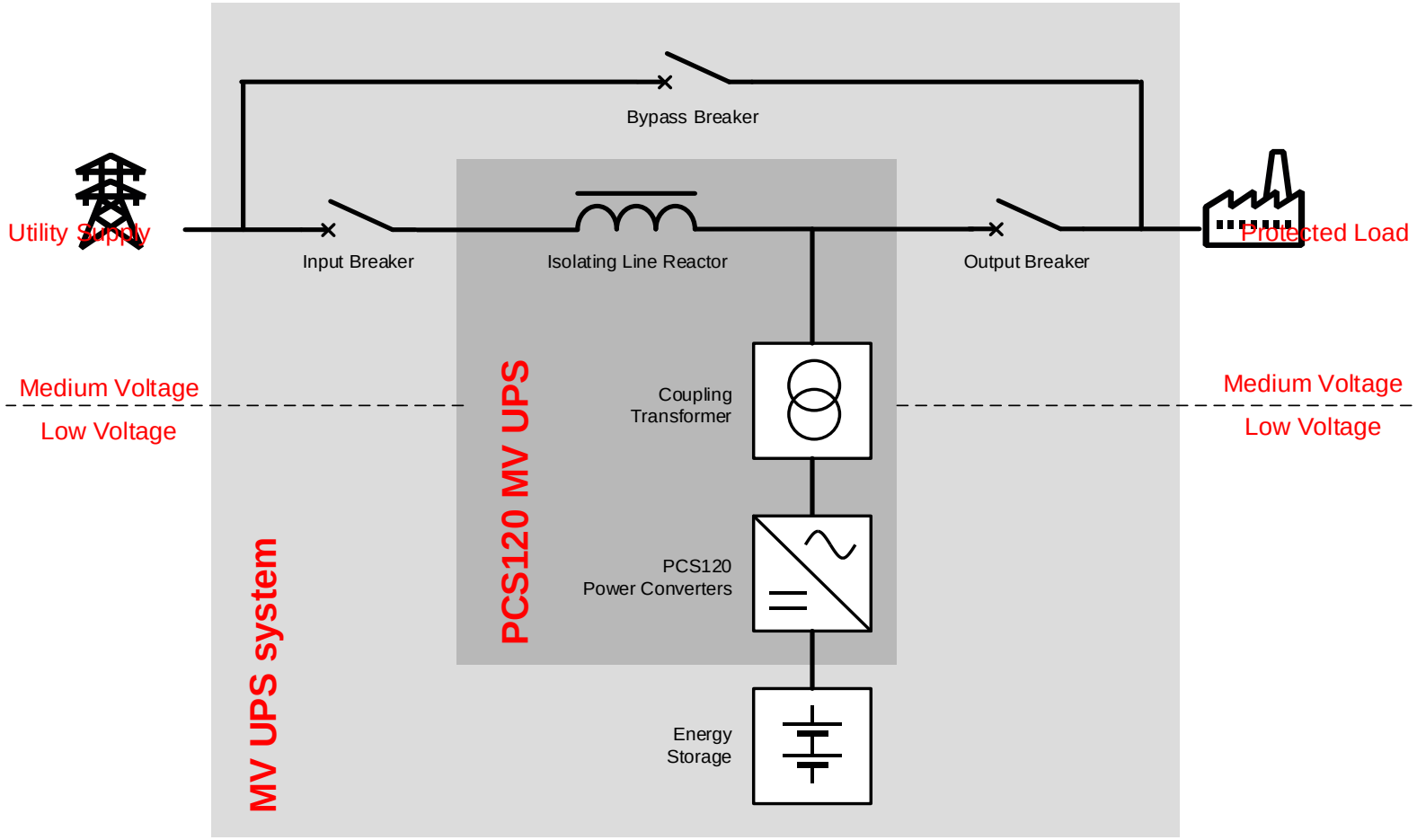
UPS-I → synchronizes and closes the Utility Disconnect;
UPS-I → softly transfer the load to the utility or generator;
UPS-I → energy storage is then rapidly recharged.

PCS120 MV UPS (Industrial UPS – Medium Voltage)

- Reduced cost (less current – less copper – less cable);
- Increased efficiency (less current – less losses);
- Performance → IEC 62040-3 Class 1;
- Modular & redundant architecture (n + n);
- Voltage → 6.6kV; 11kV, 20kV (IEC)
  → 15kV (UL)
- Capacity → 2.25MVA - >50MVA

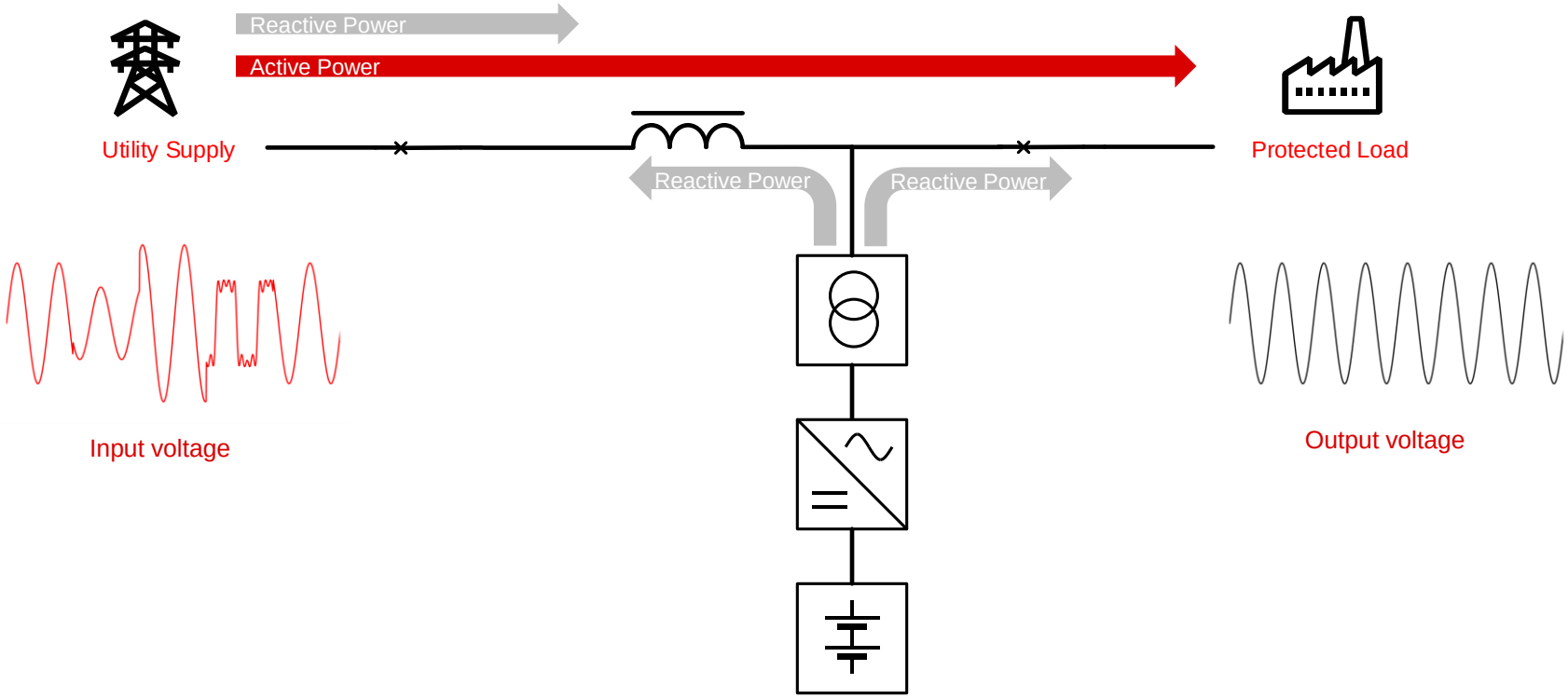
PCS120 MV UPS

Z-Impedance Isolated Static Converter (ZISC) Architecture



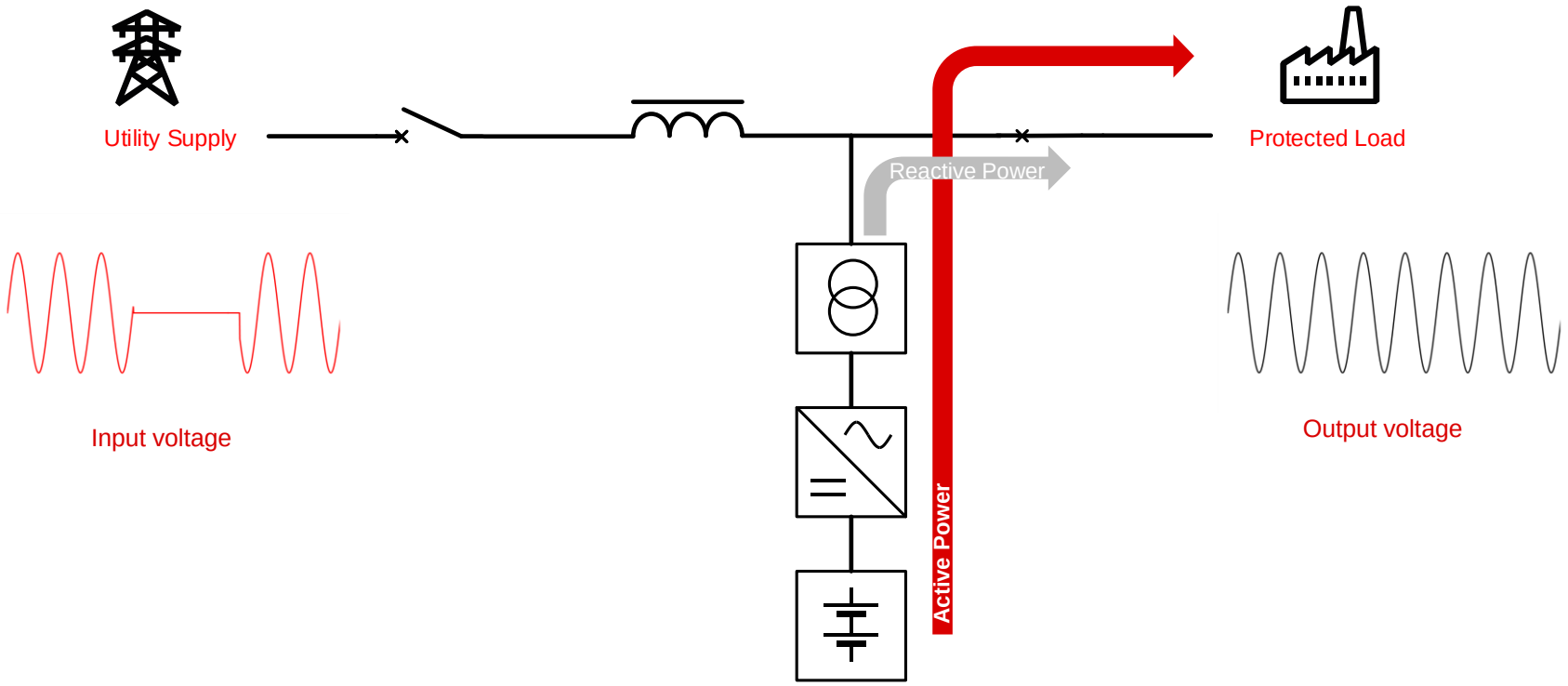
PCS120 MV UPS

Power Conditioning Mode



PCS120 MV UPS

Independent Mode



Industrial UPS vs Diesel Rotary UPS

Description	Diesel Rotary UPS	Industrial UPS
Topology	Electro-mechanical, not modular	Fully electronics, modular, redundant
Reliability	Low	High
Maximum efficiency	90%	99.5%
Maintenance cost	Very high	Much lower
Component failure rate	Very high / frequent	Very low
Product life time	< 10 years	20 – 25 years
Noise & vibration	High	Low
Air pollution	Yes	No

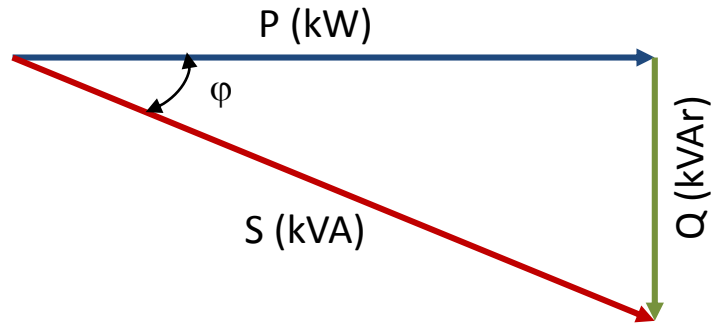
Load Related

Power Quality Issues

Load Related Issues

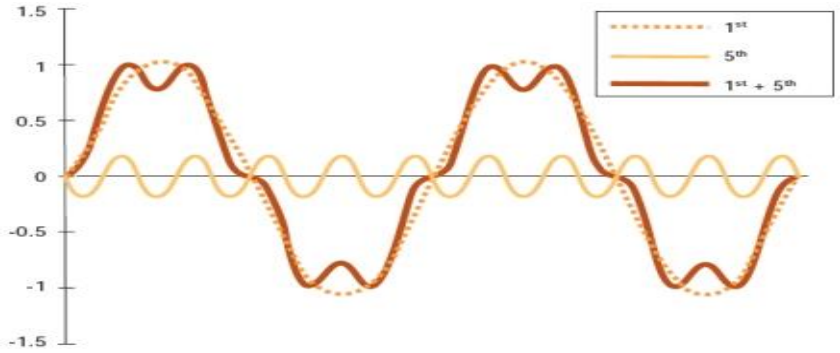
True power factor

Displacement Power Factor / Reactive Power



$$Displacement\ PF = \cos\varphi = \frac{P}{S}$$

Distortion Power Factor / Harmonic



$$Distortion\ PF = \frac{1}{\sqrt{(1 + THDi^2)}}$$

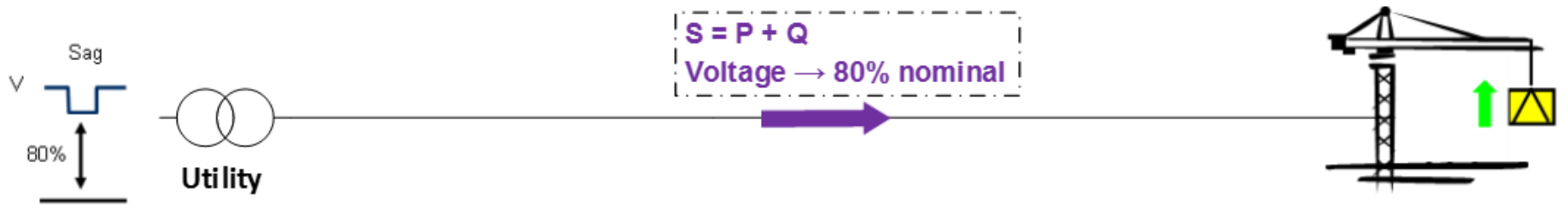
(Assuming THDv<10%)

True power factor =

displacement power factor x distortion power factor

Load Related Issues

Regenerative load



PF lagging

PF leading

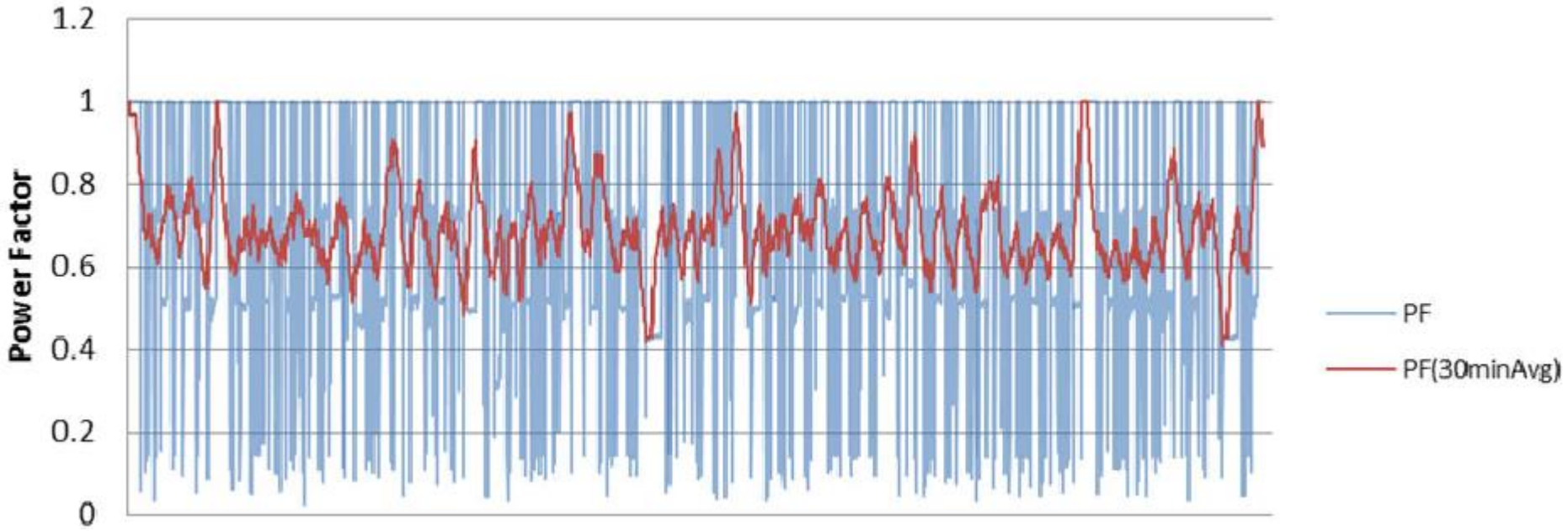
Load Related Issues

Dynamic load

Definition: load which draws high inrush current during start–up, and fast changing reactive current during operation;

Effect: power quality events e.g.: voltage sag / dip, voltage fluctuation / variation;

Examples: motor starting, welders, cranes, press, crusher, variable frequency drives (VFD);

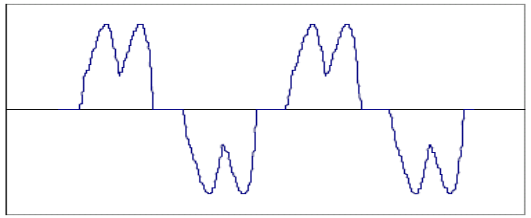


Background

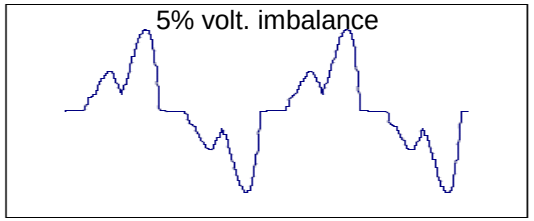
Load / current imbalance

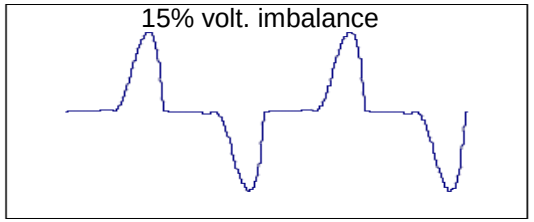
Root cause: single phase or line to line loads;

Effect: heating on motors, trip or malfunction on VSDs;



If supply is balanced, current waveform has double pulse per half cycle shape;





If supply is imbalanced, current deviates to a single pulse, causes more stress to diodes, and lead to tripping (DC-undervoltage) or malfunction (diodes, DC-caps.)

What is the solution?

Traditional Solutions…?

Capacitor bank:

- can only fix displacement power factor (reactive power);
- can only fix “lagging” power factor, but NOT “leading” power factor;
- vary in number of steps with delay (not suitable for dynamic load);
- reluctant to harmonics due to resonance effect;
- cannot fix current imbalance;
- cannot / very limited capability to stabilize voltage;
- require large space;

Harmonic filter:

- can only fix distortion power factor (harmonics);
- cannot fix current imbalance ;
- cannot / very limited capability to stabilize voltage;
- require large space;

Modern Solution

PQCR

- fix displacement power factor (reactive power), both leading and lagging;
- fix distortion power factor (harmonics);
- fix current imbalance;
- fix inrush generated dip/sag;
- fix voltage flicker;
- stabilize voltage (over & under voltage);
- compact dimension;
- long life time with minimum maintenance;

Reactive Power Conditioner

Technical comparison

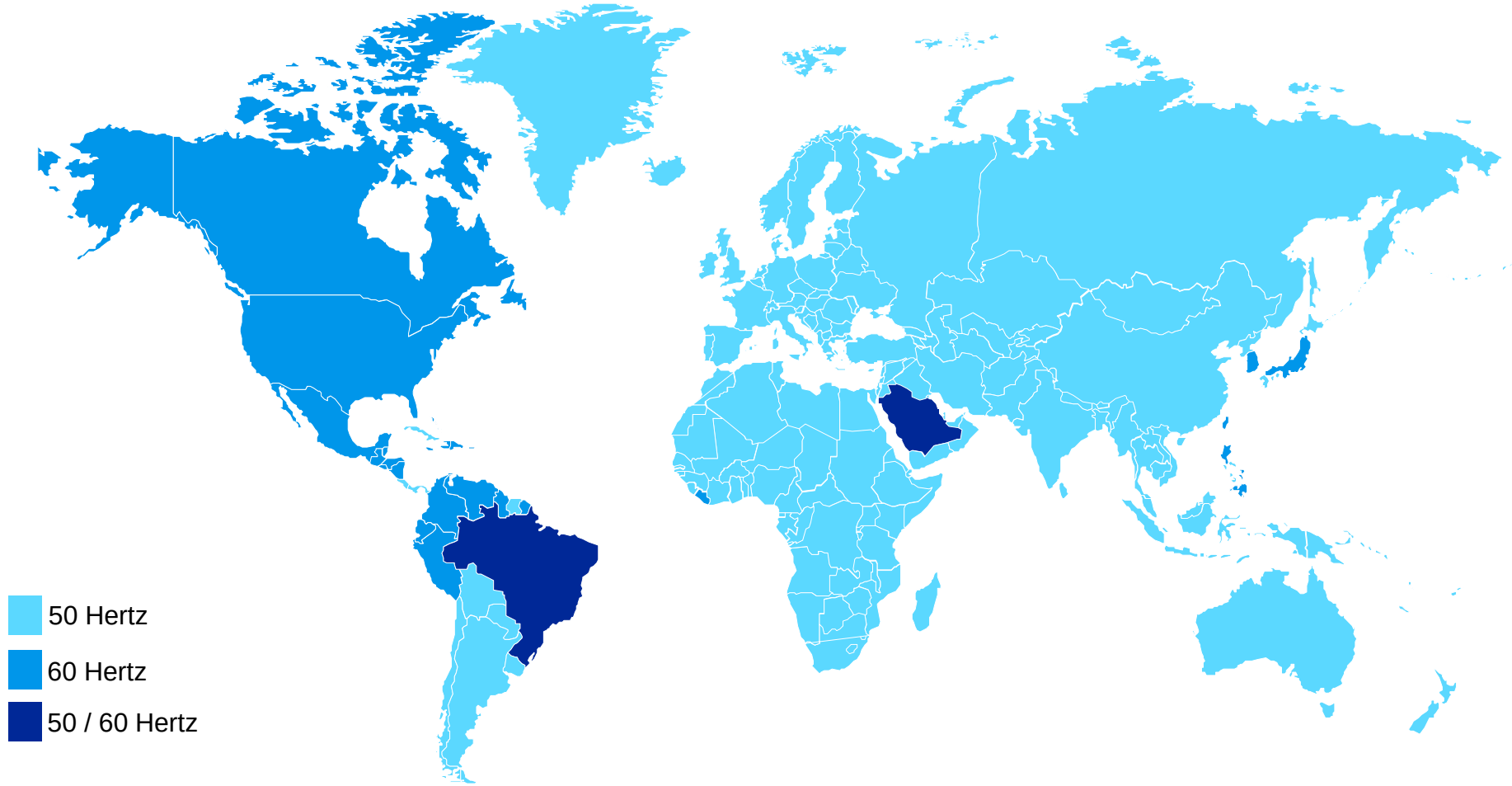
2MVA transformer (6% impedance), feeding 400V bus with mixed reactive & harmonic industrial loads of 1.5MVA:

	No Compensation	VAR only (capacitor bank)	Harmonics only (active filter)	PQCR
Displacement PF	0.85	0.99	0.85	1.00
5th harmonic current	30%	30%	0%	0%
7th harmonic current	12%	12%	0%	0%
11th harmonic current	5%	5%	0%	5%
13th harmonic current	2%	2%	0%	2%
THDi	33%	33%	0%	5%
Distortion PF	0.950	0.950	1.000	0.999
Total PF	0.808	0.941	0.850	0.999
Load Voltage	389 V	397 V	389 V	400 V
Transformer Loading	93%	80%	88%	75%

Frequency Related

Power Quality Issues

The World’s Frequency Map



Traditional Solutions…?

Grid frequency converter

- this is a modified UPS;
- not modular, less reliable;
- less efficient, needs large space & air conditioner;
- capacity per unit is 500 kVA only; .

Variable speed drive

- high harmonic (no harmonic filter);
- output voltage varies, depends on the input;
- no bi-directional & synchronize capability.

Rotary converter

- less efficient;
- difficult & costly maintenance;
- output frequency varies, depends on the input;
- high MTTR (e.g. bearing replacement);
- require large space;
- very high noise;

Modern Solution

PCS100 Static Frequency Converter

- **Marine certified!;**
- Specifically designed to convert frequency of 60Hz to 50Hz, or vice versa;
- Convert input voltage to a different output voltage if required by the load;
- Proven power electronics (IGBT) technology - no moving elements - low maintenance;
- Modular & redundant architecture – high reliability;
- Capacity: 125 kVA to 2000 kVA per unit or higher;
- Built-in synchronizer, and power control functions;

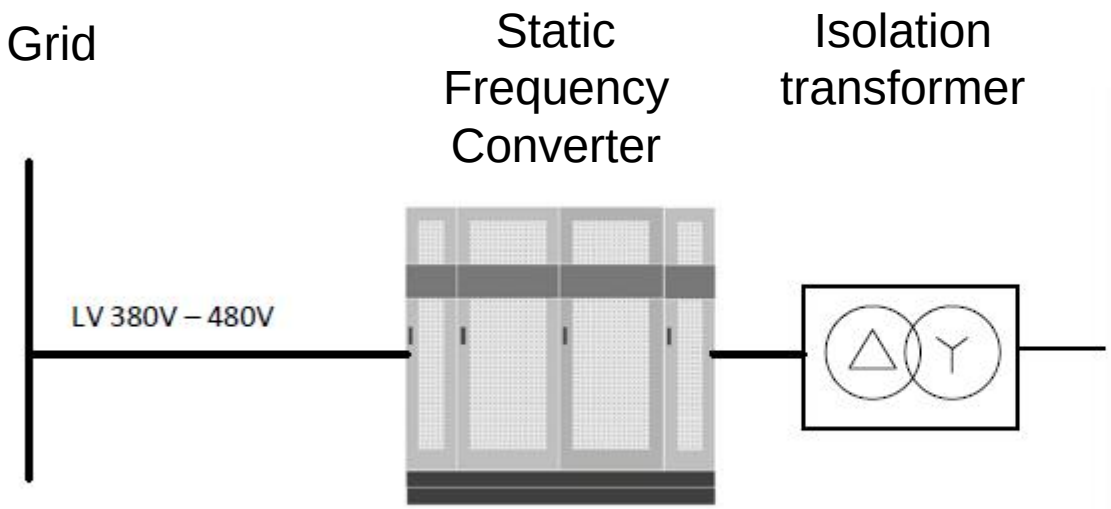
Modern Solution

PCS100 Static Frequency Converter

- Compact design – small footprint - high power density;
- Precise output frequency & voltage generation, independent of input fluctuation;
- Bi-directional power flow – industrial & heavy duty grade;
- Excellent Mean Time To Repair (MTTR) – a few minutes to replace broken module;
- Remote monitoring and control through Ethernet, Modbus-TCP/IP protocols;

PCS100 Static Frequency Converter

Industrial application



SFC to power relocated 50Hz / 60 Hz machinery in a 60Hz / 50 Hz country

ABB’s Local Engineering & Technical Support

- ✓ Pre-purchase engineering;
- ✓ Installation and commissioning;
- ✓ Technical support;
- ✓ Training;
- ✓ Preventive and corrective maintenance and maintenance spare parts kits
- ✓ Retrofit and refurbishment;
- ✓ Globally available, supported by regional service hubs and operating in more than 100 countries
- ✓ Spare part availability and stocking
- ✓ On-site repairs
- ✓ 24 x 365 local support line

Project References

PCS100 AVC

South Kalimantan - Indonesia

Customer

PT Indonesia Bulk Terminal

– Indonesia's mining and energy group;
– ADARO group of companies;

Issue

Power quality events:

– Voltage dips & swells;
– Continuously fluctuated supply;

ABB's solution

– 1 x PCS100 AVC-30, 600 kVA;
– COD: 28 April 2014;

PCS100 AVC

Port Moresby – Papua New Guinea

Customer

The Government of PNG

– At Taurama Aquatic Center & Indoor Sport Complex, for the 15th Pacific Games;

Issue

Power quality events

– Protection against unstable / fluctuated supply for sensitive loads within the stadium;

ABB's solution

– 2 x PCS100 AVC-30, 600 kVA;

– COD: 04 July 2015;

PCS100 AVC & PCS100 UPS-I (Industrial UPS)

Yogyakarta - Indonesia

Customer

PT Sarihusada Generasi Mahardhika

– Indonesia's largest milk powder producer;

– DANONE group of company;

Issue

Power quality events

– Voltage dips & swells;

– Unstable / fluctuated supply;

– Short term power outages;

ABB's solution

– 1 x PCS100 AVC-40, 150 kVA;

– 1 x PCS100 UPS-I, 150 kVA;

– COD: 18 January 2017;

PCS100 AVC - Active Voltage Conditioner

Cikedokan, West Java - Indonesia

Customer

PT Coca Cola Amatil Indonesia

- Major bottling partner of the Coca Cola Company;
- The largest Australian investment business in Indonesia;

Issue

- Voltage regulation for new coating, and blow molding machine;
- Unstable / fluctuated supply

ABB's solution

- 1 x PCS100 AVC-20, 500 kVA;
- COD: 07 March 2017

PCS100 SFC – Static Frequency Conditioner

Tenau, Flores - Indonesia

Customer

PT PELINDO 3

– State-owned enterprise in port services & operation

Issue

– 50 / 60 Hz conversion for container crane auxiliaries;
– Unstable / fluctuated supply

ABB's solution

– 1 x PCS100 SFC, 250 kVA;
– COD: 18 October 2017

PCS100 SFC – Static Frequency Conditioner

Surabaya, East Java - Indonesia

Customer

PT PELINDO 3

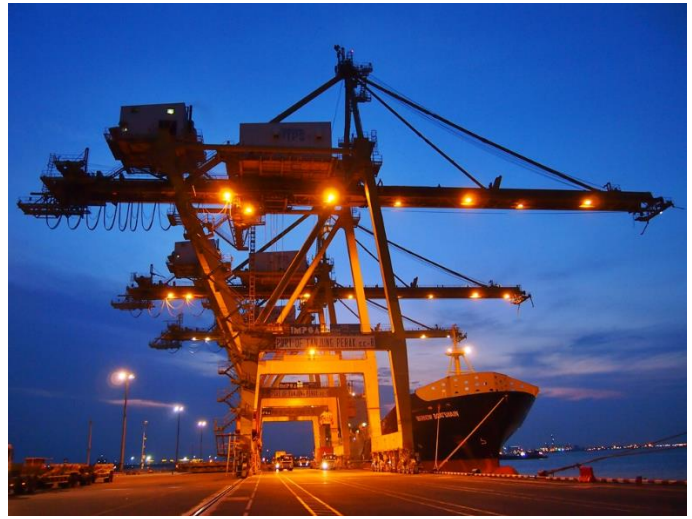
– State-owned enterprise in port services & operation

Issue

– 50 / 60 Hz conversion for container crane auxiliaries;
– Unstable / fluctuated supply

ABB's solution

– 1 x PCS100 SFC, 250 kVA;
– COD: 13 April 2018



PCS100 AVC - Active Voltage Conditioner

Pekanbaru, Riau – Indonesia

Customer

PT PLN (Persero) Pembangkitan Sumatera Bagian Utara,

Sektor Pembangkitan Pekanbaru,

Pusat Listrik Balai Pungut

PT. PLN (PERSERO)

Issue

– Unstable / fluctuated supply for fuel feeder pump of the diesel / gas engine power plants;

ABB's solution

- 1 x PCS100 AVC-40, 150 kVA;
- COD: 14 May 2018

PCS100 AVC - Active Voltage Conditioner

Port Moresby – Papua New Guinea

Customer

The government of PNG

– Star Mountain Plaza project;

– Including 5 star hotel, convention center, apartment & malls;

Issue

– Unstable / fluctuated utility supply;

– Dynamic & highly inductive loads;

ABB's solution

- 1 x PCS100 AVC-20, 1000 kVA;
- 1 x PCS100 AVC-20, 1500 kVA;
- 1 x PCS100 RPC, 416 kVAr;
- COD: 25 July 2018

PQCR – Reactive Power Compensation

Kendari, South East Sulawesi - Indonesia

Customer

PT PELINDO 4

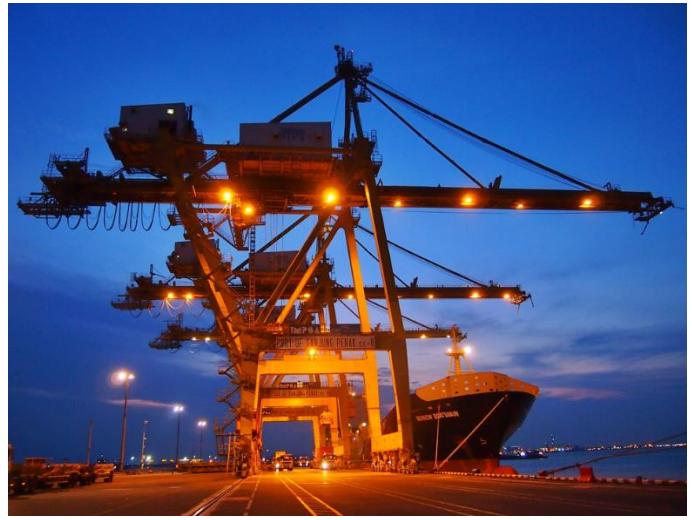
– State-owned enterprise in port services & operation

Issue

– Highly dynamic regenerative loads (lagging & leading power factor);
– Load imbalance;

ABB's solution

– PQCR: 2000 kVA;
– COD: in progress



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