AMBRA SANNINO, IEEE PES SE Chapter, October 2018

New trends in AC transmission and distribution

Sustainability, digitalization, electrification

About myself

Quick introduction

Ambra Sannino

M.Sc. in Electrical Engineering, University of **Palermo**, April 1997

Ph.D in Power Systems, University of Palermo, January 2001

– ”Applying power electronics in industrial power systems for improving power quality”

D.Sc. (docent) in Power Systems, Chalmers Univ, Dec 2003

April - Sept 1998: Internship ABB Corporate Research, DE

Jan 2001 - Dec 2004: **Chalmers** University, Göteborg, SE

– Assistant Prof, from Dec 2003 Associate Prof

Oct 2004- Aug 2009: **ABB** Corporate Research, SE

– R&D Engineer, project leader, from February 2008 group manager

Sept 2009 – Dec 2012: R&D Manager at **ABB FACTS**

Jan 2013 – Dec 2016: Technology Manager at **ABB Substations**

Jan 2017 – present: Head of Global Product Management at **ABB System Integration**

ABB Power Grids - System Integration

Unrivalled experience in delivering grid solutions for a variety of applications

Solar

Wind

Rail Power Supply

E-mobility

Data centers

Ports

Industry

Utility

Substations for grid connection
Product portfolio overview

Air-insulated substations (AIS)

A versatile concept for all types of applications and environments, at a comparatively lower cost.

Several highly flexible switchgear layouts are possible. ABB has global expertise in all types of AIS applications.

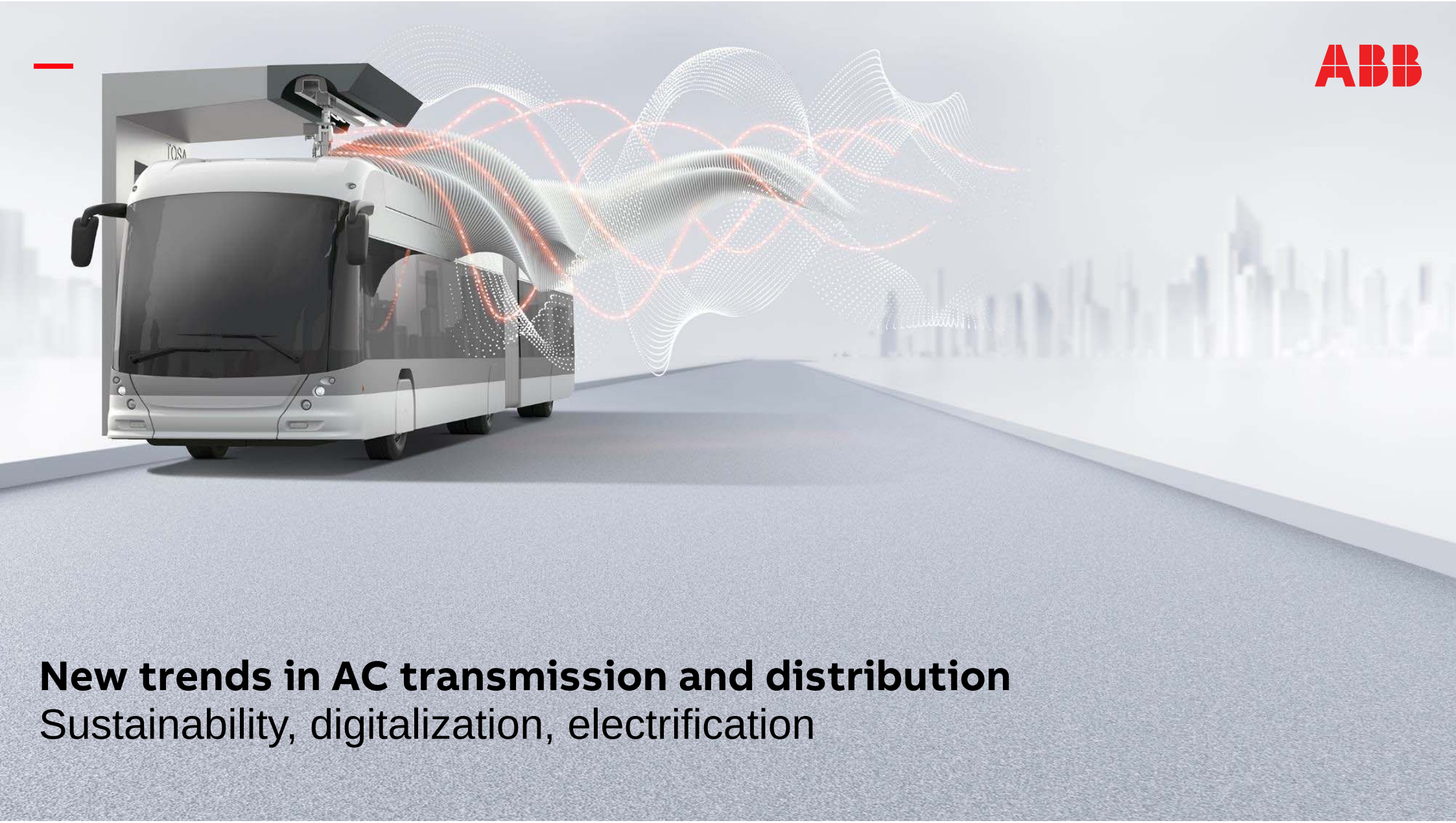
Hybrid substations

Hybrid substations reduce the installation footprint by integrating several functions in fewer components.

Erection and commissioning are faster due to reduced civil works. A flexible approach allows for various combinations of busbar and cable connections to suit the specific site needs.

Gas-insulated substations (GIS)

A substation with all active switchgear components fully encapsulated offers a very compact footprint and fast execution due to pre-testing.
Further advantages are robustness against environmental conditions and low maintenance needs. ABB pioneered GIS technology in 1967.



New trends in AC transmission and distribution

Sustainability, digitalization, electrification

We connect power, safely and reliably

… in a fast-changing energy and power grid environment

Both types of load and methods of generating are changing

Generation

New energy sources:
- High variability
- Low predictability
- Energy storage

Connect safely and reliably

Consumption

New loads:
- Highly distributed and variable (EV charging)
- Concentrated, extremely critical (data centers)

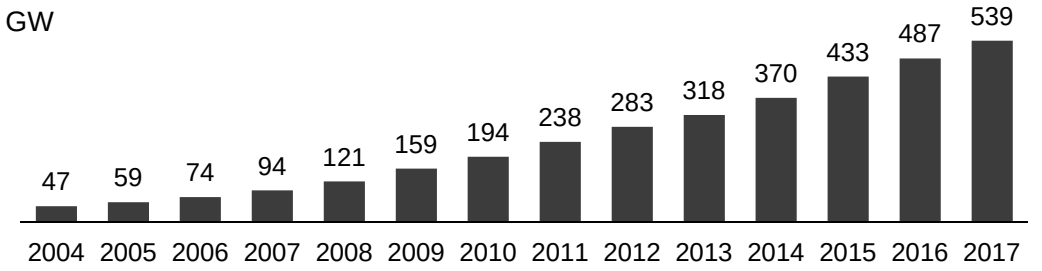
Limiting environmental impact is a key priority

Wind and solar deployment in 2017

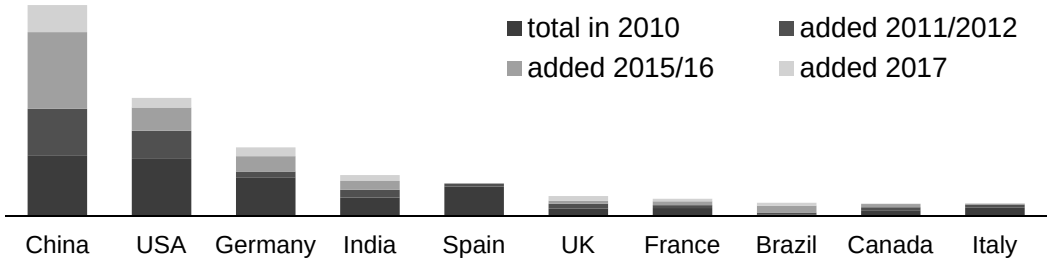
Again a record year of installation of new renewables

Wind power

Global capacity 2004 – 2017

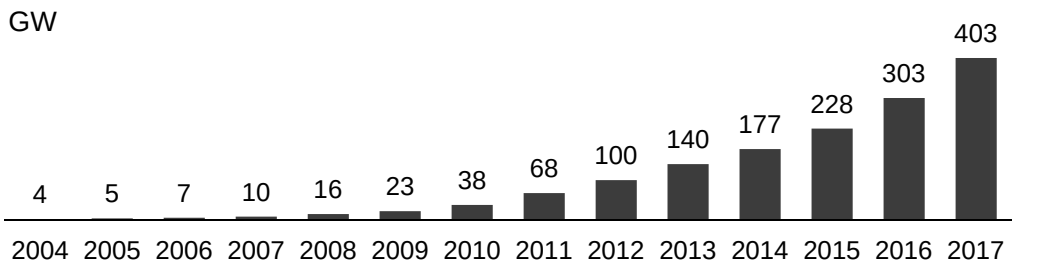


Top 10 countries, capacity 2017

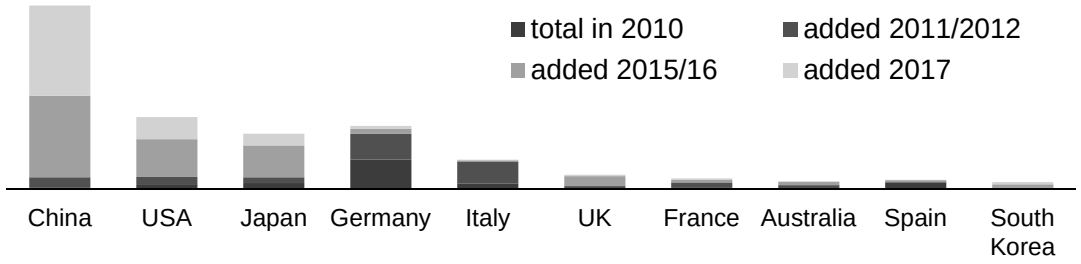


Solar PV

Global capacity 2004 – 2017



Top 10 countries, capacity 2017

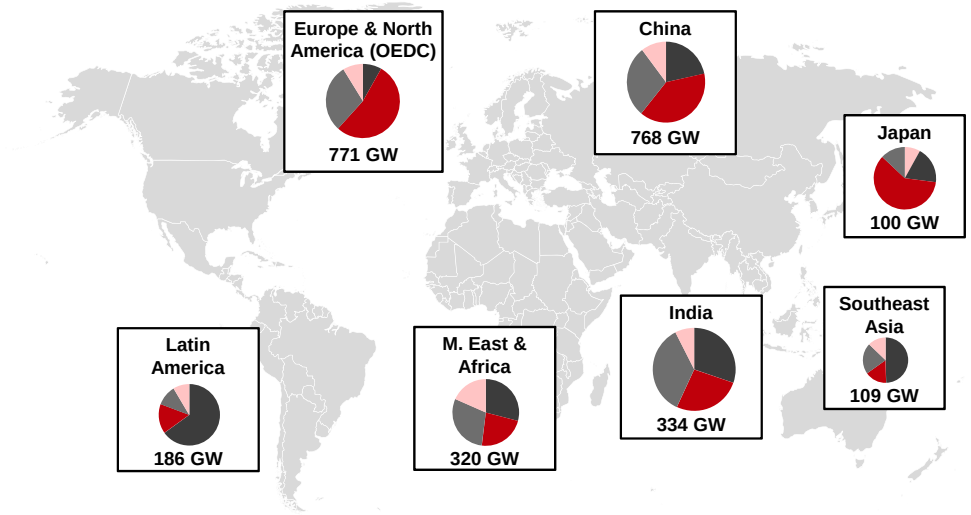


Source: IRENA Statistics

Renewable energy

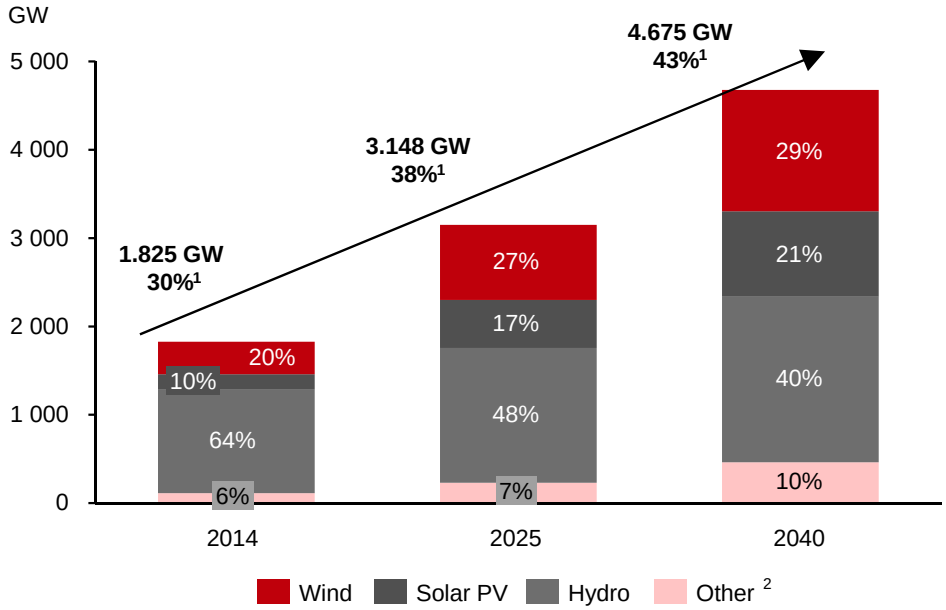
Global installed capacity more than double by 2040

Net capacity additions 2014-2040



IEA New policies scenario

Hydro | Wind | Solar PV | Other renewables



Wind and solar amount to 50% of total renewables in 2040

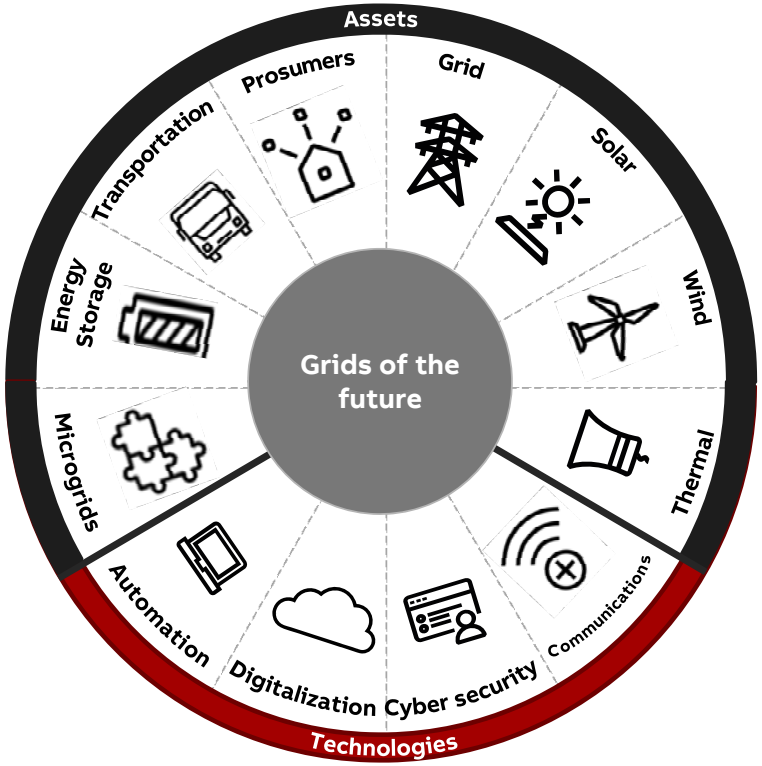
Source: McKinsey 2011, UNEP 2009, EIU 2012
[1] Share of total power capacity
[2] Other include bioenergy, geothermal, CSP and marine

Renewables industry overview

Irreversible growth of renewables supported by the market economics

Renewable become important part of modern power grids

- Wind and solar technologies become cost competitive and the preferred choice for new generating facilities in many countries
- Renewable integration is a key topic, to ensure a proper functioning of the future power grid
- Balancing electricity supply and demand at any time requires a stronger and smarter grid
- Power transmission interconnections need to be enhanced to facilitate optimum utilization of renewables and balancing of loads
- Distribution networks need more control, supervision and functionality than in the past
- Digitalization and real time communication to play an vital role for renewable integration in power systems



Current challenges and changes facing utilities

Infrastructure is aging while demand continues to grow

Aging infrastructure

70%

of transformers in the US

are more than 25 years old.

Reliability

Pressure

is increasing

to continually improve reliability and customer satisfaction.

Customer engagement

25+

billion devices

will be connected to the Internet of Things (IoT) by 2020. (Exclusive of smartphones, tablets or computers.)

Business model disruption

20%

of the energy retail market

will be served by non-utility players.

Risk
Avoid > Manage

Performance
Exceed > Meet or beat

Cost
Minimize > Optimize

Aging workforce

40%

of electric and gas utilities staff

will be eligible for retirement in the next 5 years.

Renewables penetration

8-10%

capacity increase

Since 2010. And over 150GW is being added year on year (2/3 of all new capacity).

Spending justification

Totex focus

and cost constraints

driven by continued revenue challenges and regulatory changes.

Cyber security

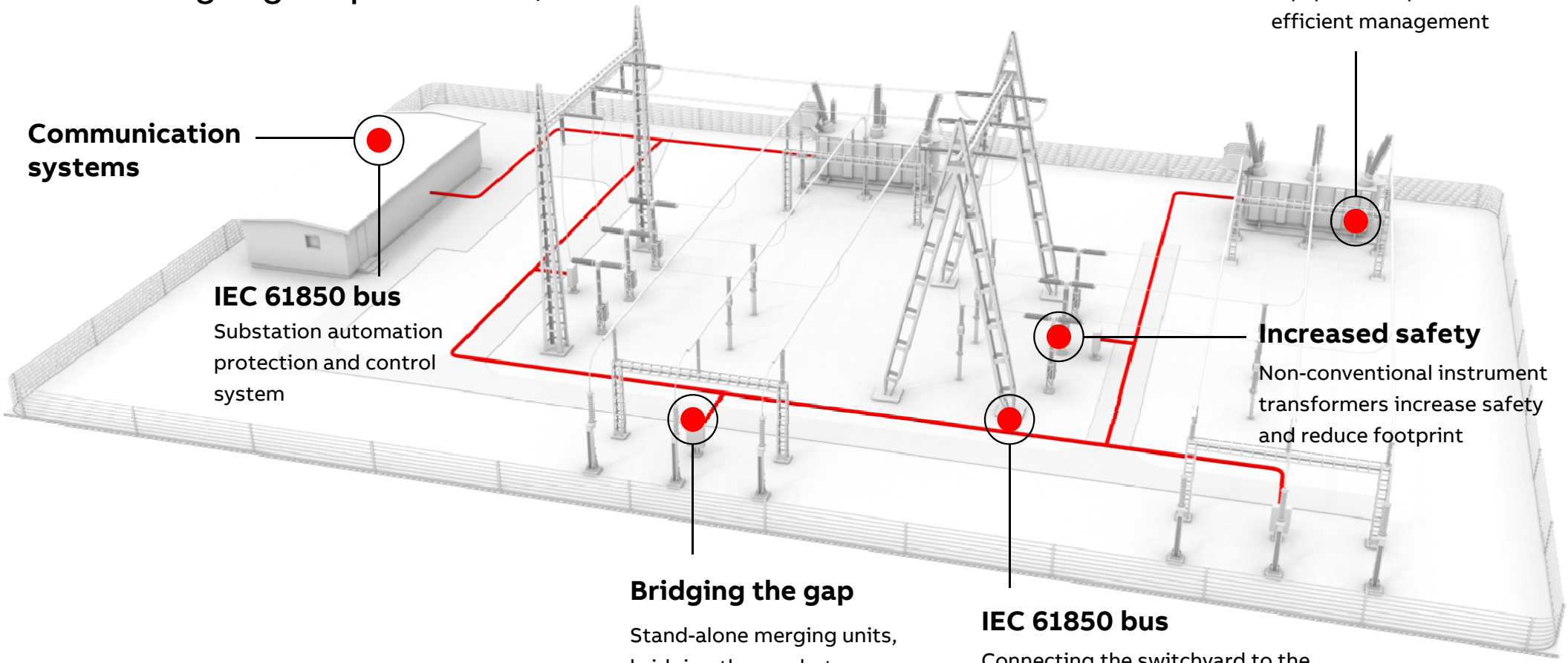
50%

IoT device manufacturers

will not be able to address threats from weak authentication practices.

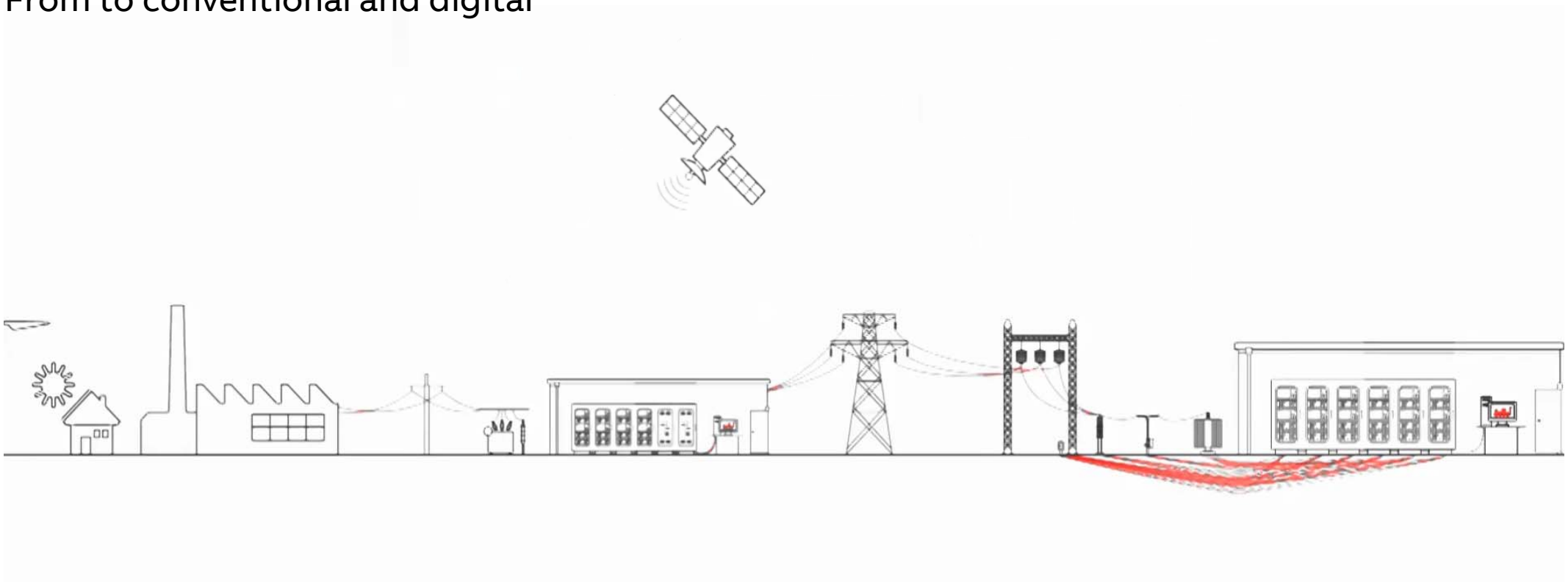
What is a digital substation?

Embracing digital protection, control and communications



What is a digital substation

From to conventional and digital



Digital substations reduce cabling, need less space and increase safety

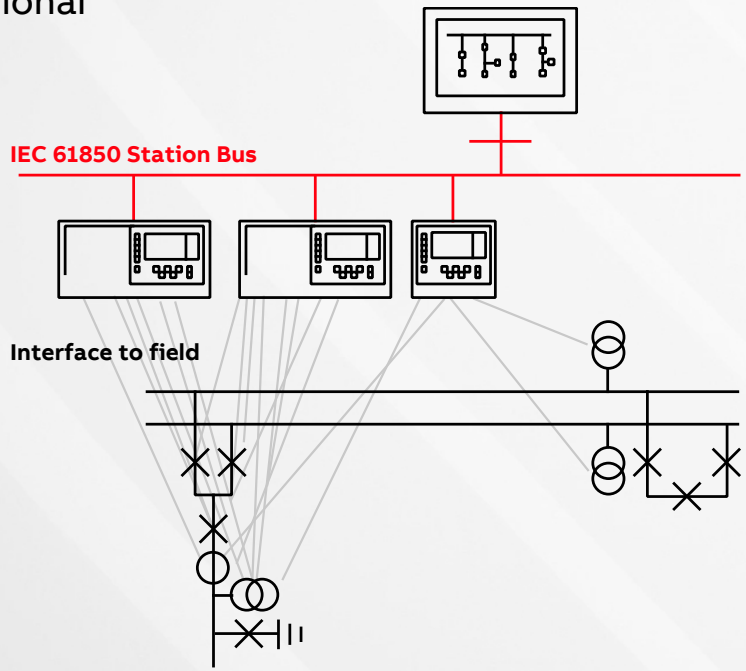
APP

Video

Conventional vs digital substations

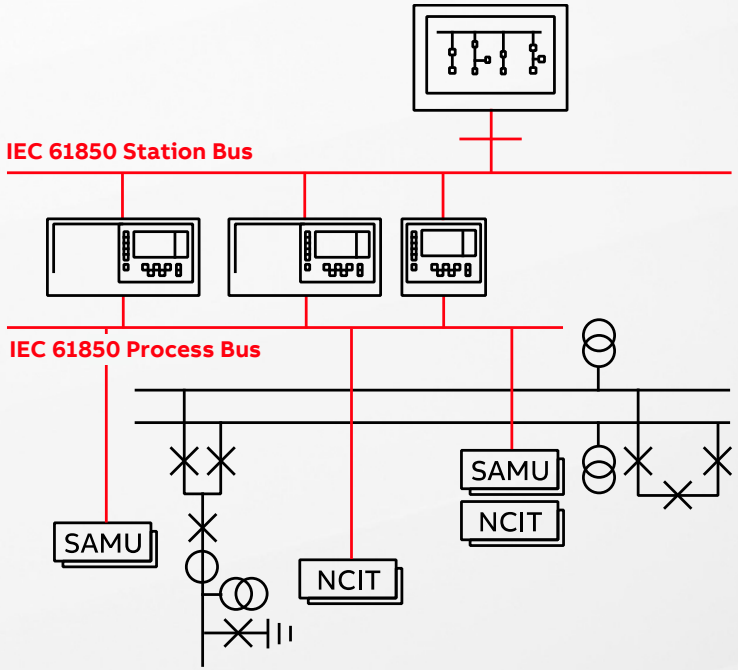
From point-to-point copper wire connections to an optical fiber bus

Conventional



Thousands of hardwired point-to-point connections

Digital



Process bus reduces cabling and distributes information efficiently

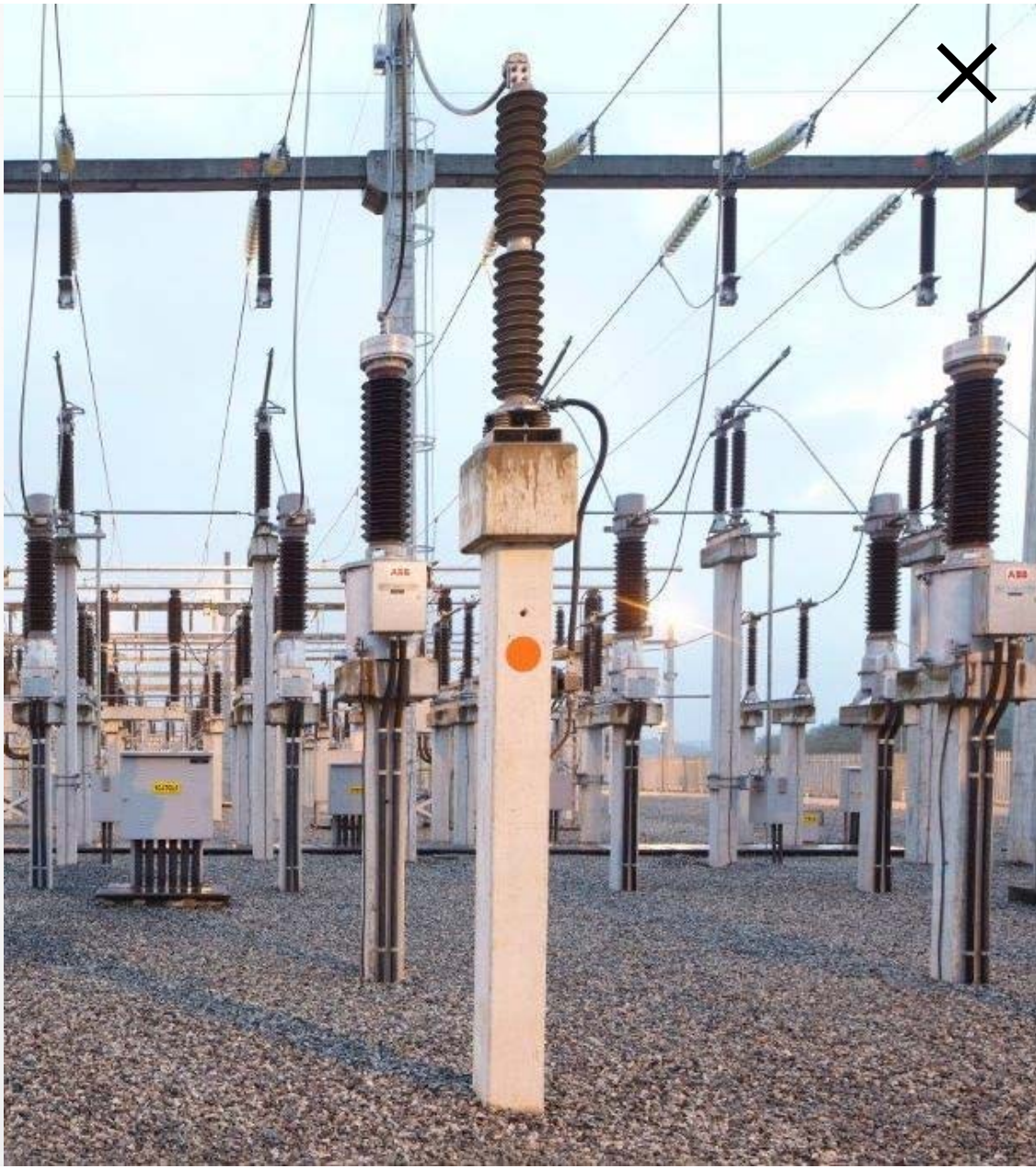
Digital substations
Case study

Customer: Juazeiro – ATLAS RE (BR)

Customer needs
The city of Juazeiro, northeastern Brazil, will install Latin America's first digitally-enabled substation. The new 230 kV substation and connection bay will deliver power from a 156 MW photovoltaic (PV) power plant under development in the area.

ABB's response
ABB will deliver the entire substation and provide a SCADA system, IEDs for protection and control and state-of-the-art SAM600 merging units in the switchyard, all conforming to the IEC61850 open communications standard.

Customer benefits
The digital substation is an ABB Ability™ based technology which will help the customer to enhance asset observability and controllability, increasing overall system reliability and safety while optimizing costs.



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Limiting environmental impact is a key priority

Could e-transport threaten power systems?

Do not panic!

gtm: A Wood Mackenzie Business

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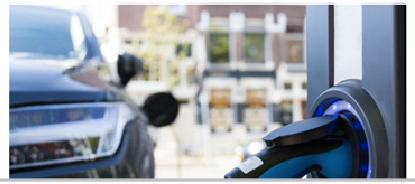

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Handelsblatt GLOBAL

ELECTRICAL FAILURE?

Electric cars pose blackout threat to German cities

The power grid isn't prepared for the approaching electric car boom. German utilities and researchers are sounding the alarm - and so are experts in other countries.

The Guardian

Electric cars will fuel huge demand for power, says National Grid

Increase in peak electricity demand could be more than capacity of planned Hinkley Point C nuclear power station by 2030

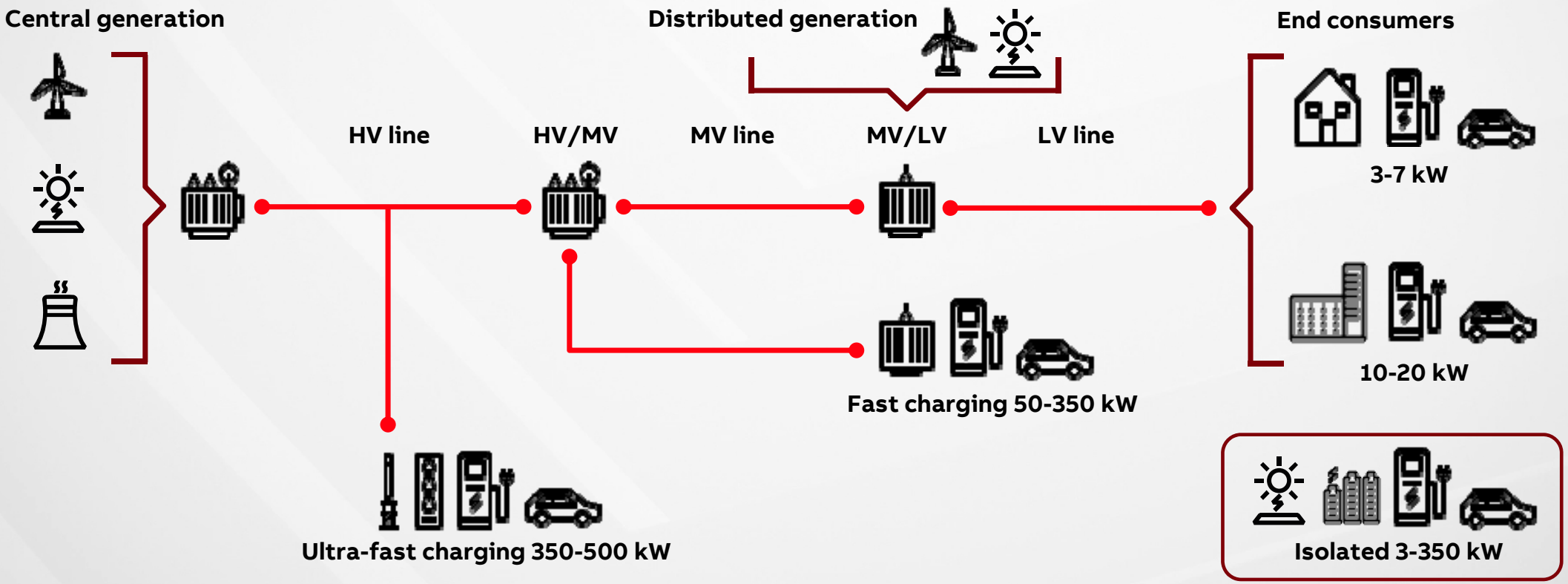
The Sun motors

POWER CUT Charging just SIX electric cars at once on the same road could lead to local power outages across the UK

Britain is facing a major energy crisis, as the growing use of electric cars could see large power cuts across the country

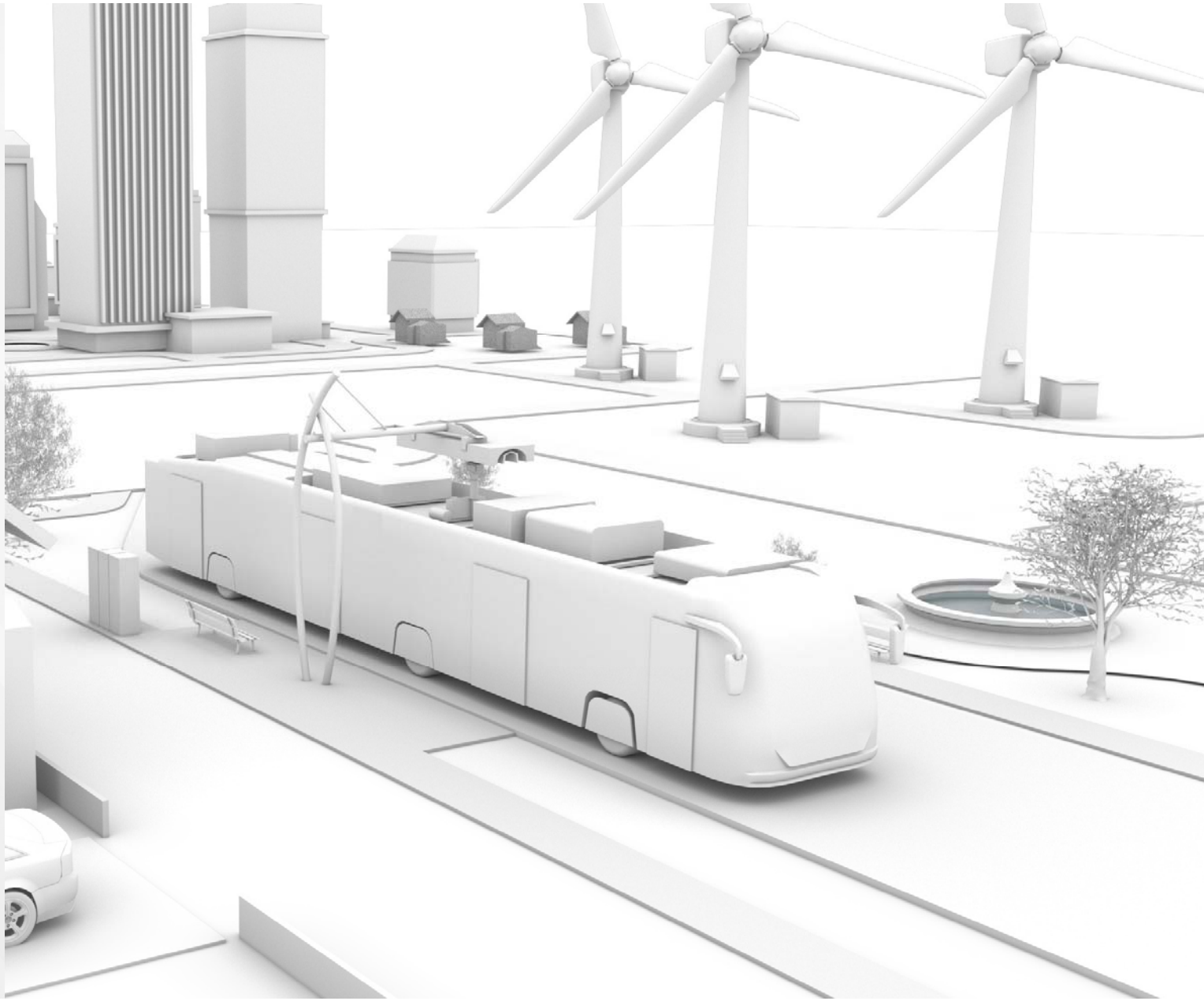
Where the electric vehicles are plugged to the grid?

There is a large variety of options from low to high voltage grid levels



A revolution in transport
Why e-buses?

- Long range between charges isn’t needed (the route is known and we have to stop)
- Quiet
- Flexible routing (not limited by overhead wires or rails)
- Buses spend most of their time out on the roads and not parked
- Rapid deployment as infrastructure needs are limited



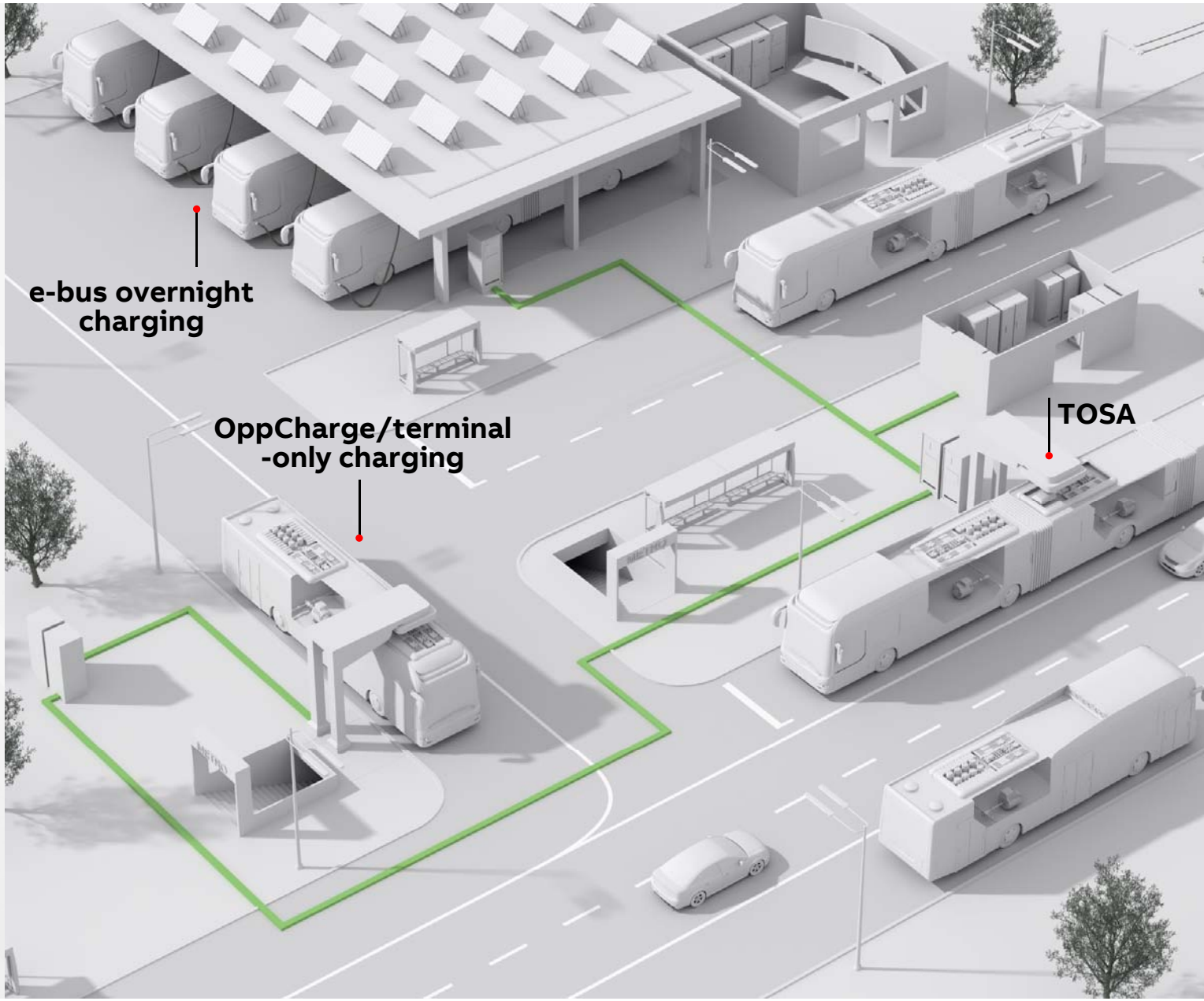
TOSA e-bus flash charging

e-bus solutions, infrastructure and tools

TOSA
Catenary-free high-capacity fully electric articulated bus system with 15-second flash charging at selected bus stops.

OppCharge
DC fast-chargers for buses employing terminal-only charging.

Overnight charging
Includes chargers of the TOSA or Oppcharge type and complete depot supply systems which may include energy storage.



Let’s write the future

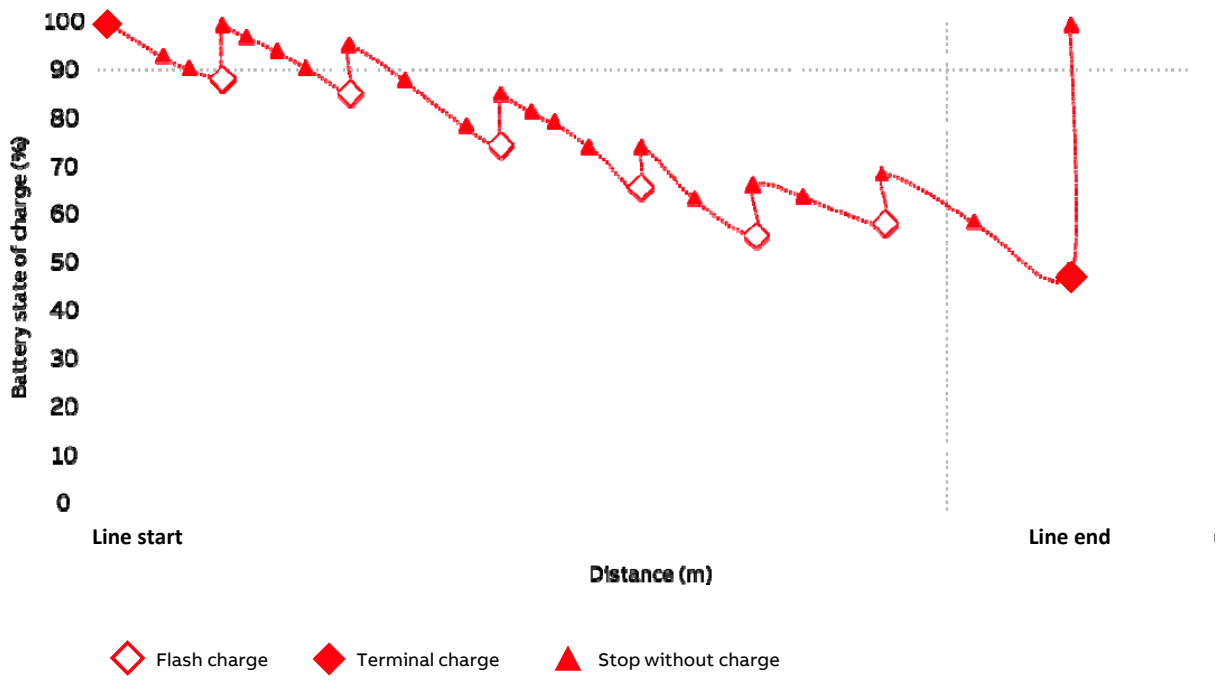
abb.com/future

ABB

TOSA charging concept
Intelligent energy management system

The combination of terminal and flash (or intermediate) chargers ensures the on-board energy storage is completely refilled at the end of the line without requiring longer stopping times.

High energy efficiency and cost efficiency



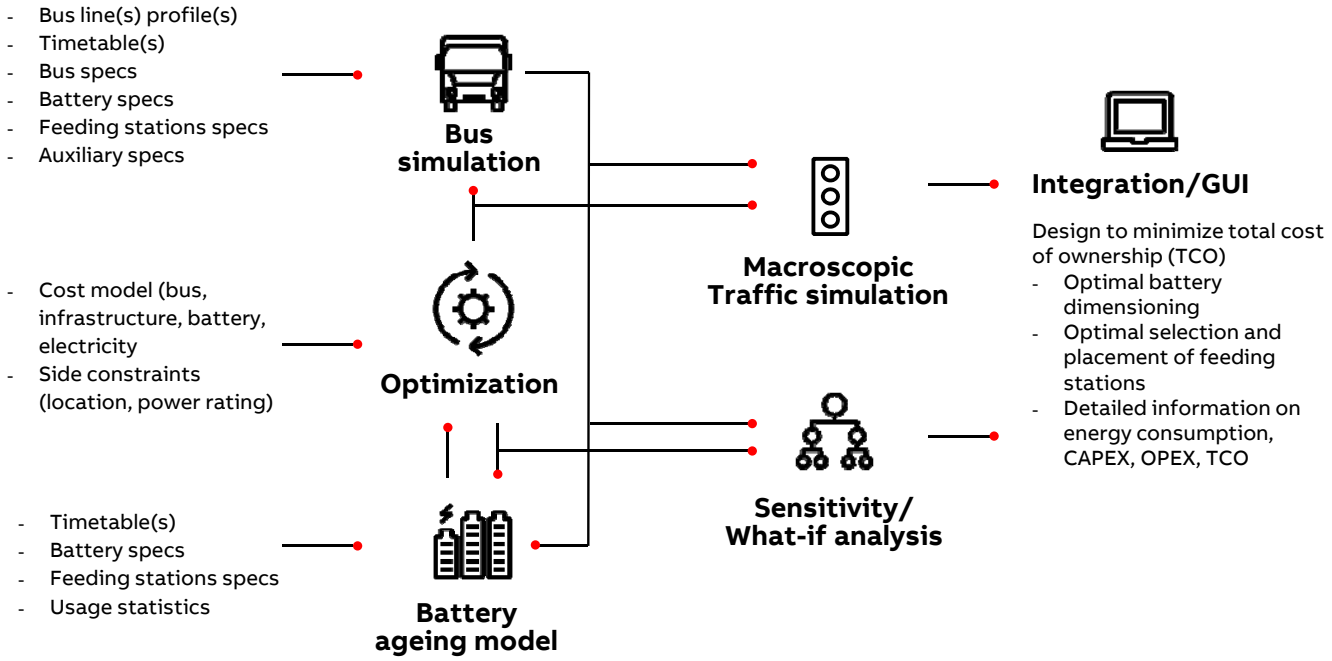
TOSA e-bus flash charging
myTOSA

myTOSA is a software tool for optimizing the design of the e-bus system.

It brings together many elements such as: a model of the bus; the batteries including their aging; the route and traffic simulations. The tool then provides a cost-optimized system design.

Video

myTOSA software diagram



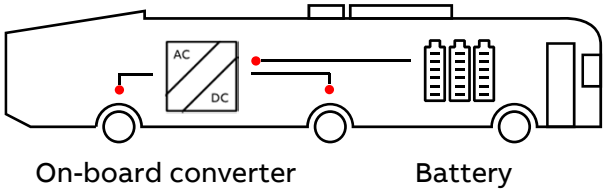
TOSA e-bus flash charging

What makes us different?

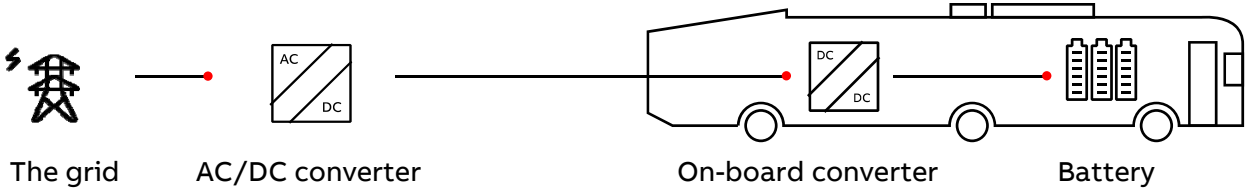
The TOSA concept uses the on-board converter to provide a simple, reliable interface for efficient battery charging.

It can also recuperate energy generated during braking.

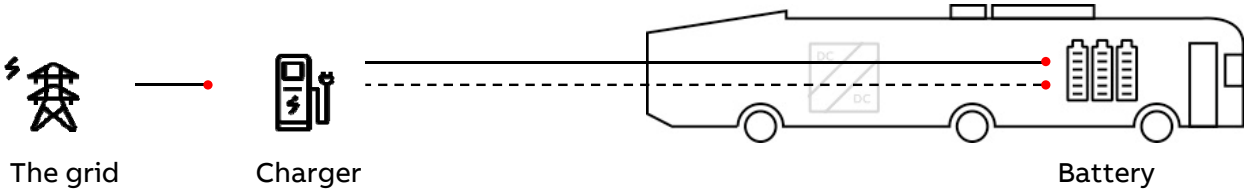
Driving mode (both systems)



TOSA



The others



TOSA e-bus flash charging

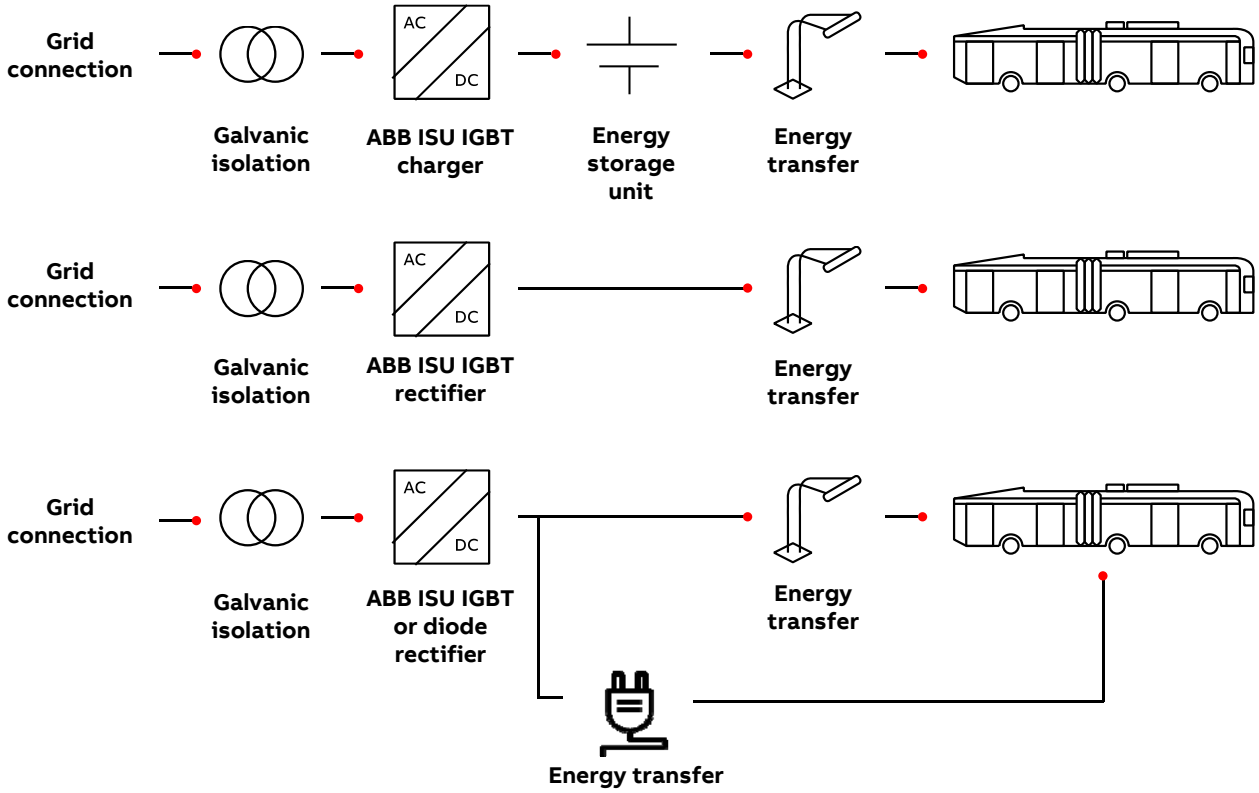
TOSA e-bus system infrastructure

Energy storage for peak shaving designed according to both local grid requirements and the bus line's operational needs.

Three types of chargers:

- Flash charging stations at selected bus stops (15-20 seconds)
- Terminal feeding stations (4-5 min)
- Depot stations (~30 min)

Flash/Terminus/Depot feeding stations



TOSA e-bus flash charging

Emission-free public transport with Line 23, connecting Geneva's airport with the suburbs

Video

Line 23

18.75m
bus length

133
passengers per bus

Technology

13 out of 50
stops flash charging stations

600kW 20sec
flash charging

Vital statistics

10,000+
passengers a day travel on the route

>600,000km
per year

Benefits

1,000t
CO_2
Reduction of emissions per year for 600,000 km

10 decibels noise level reduction
Half the noise pollution generated by diesel buses

TOSA e-bus flash charging

Emission-free Busway BRT line 4, connecting historic center with municipalities on the southern side of the River Loire in Nantes, France

Line 4

24m
bus length

20
buses

>155
Passenger capacity per bus
1 bus every 2mins 30sec

Technology

6/34
stops flash charging stations

600kW
10 to 40sec
flash charging

An environmental issue
Emissions from vessels during port stay

More than
100,000
Vessels dock at

4,500
Ports worldwide
…resulting in

+
Noise

+
Emissions
CO_2, SO_x, NO_x and PPM

+
Vibration

900 million
metric tons of CO_2, SO_X, NO_X
and PPM emitted annually

Equal to
220
coal-fired plants

Benefits
With shore-to-ship power solutions

1 Cruise ship connected to the grid in the port

Could annually save
CO_2
emissions

Equivalent to about
2,500
Cars

Video

Shore-to-ship power

What does a shore-to-ship power supply do?

Main incoming station | Power cables | Shore-side substation | Berth terminal | On-board installation

Shore-to-ship power
Gothenburg, Sweden
First 50/60 Hz shore connection

Customer needs

Shoreside power supply to a vast number of Stena Line vessels while at berth

ABB's response

- Turnkey 11kV Grid Integration, including safe+ GIS switchgear six bays 50Hz, four bays 60Hz, and two transformers type Resibloc
- Two static frequency converters 1250kVA
- PLC system type AC500

Customer benefits

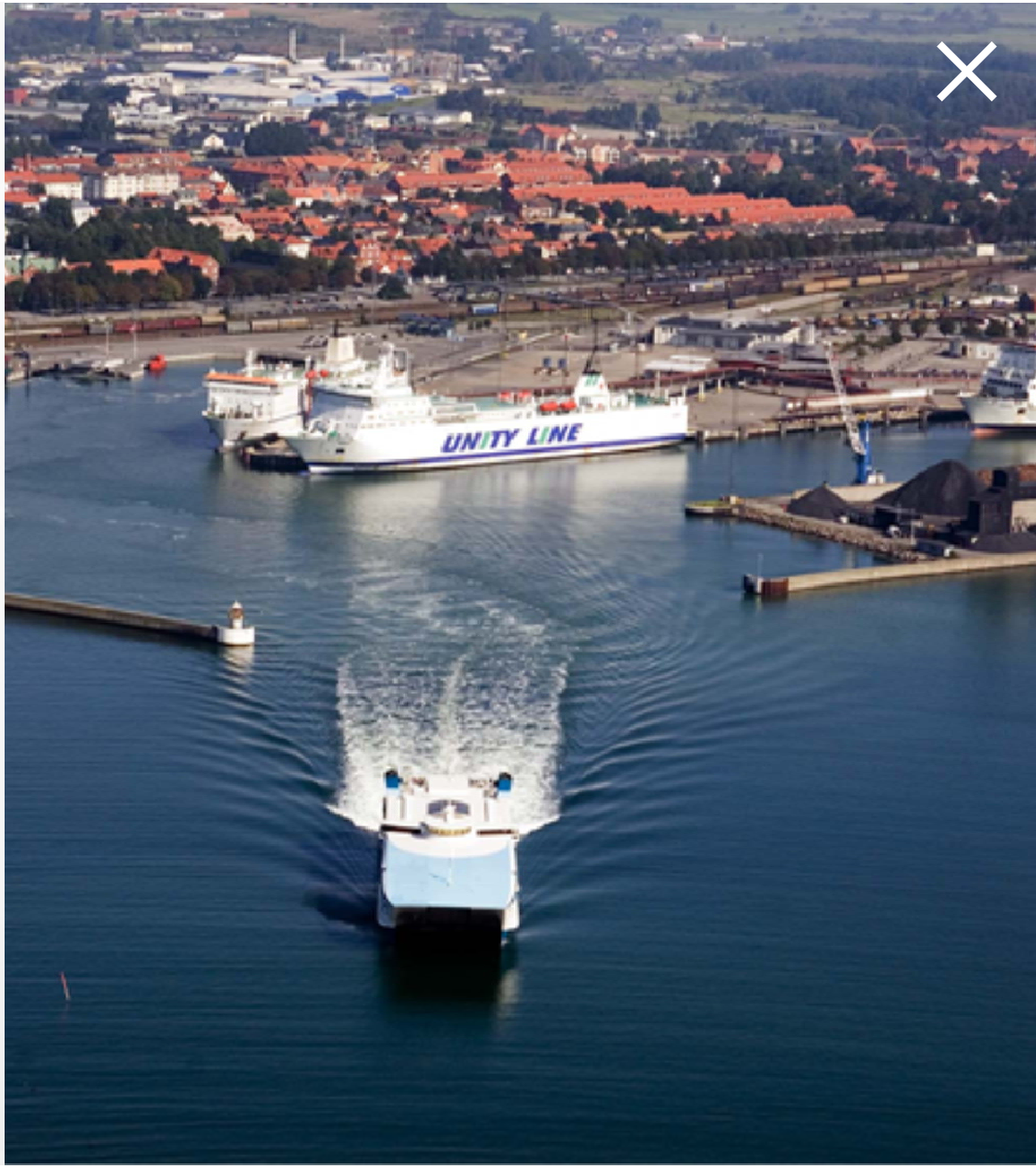
- Dependable project execution from design to start-up, and state-of-the-art equipment
- Reliable shoreside power supply to ferries
- Reduced emissions, low-frequency noise and vibrations
- Better environment for passengers, crew, dockworkers and local residents

Shore-to-ship power Ystad, Sweden
First 50/60 Hz shore connection

Customer needs
Minimize the negative environmental impact of the vessels remaining at berth

ABB's response
Turnkey 12kV substations including:
- MV switchgear
- Input/output transformers
- 6,25 MVA frequency converter

Customer benefits
- Double frequency vessels supply full flexibility (50 Hz and 60 Hz) and reliability
- Pre-engineered solution with short delivery and commissioning time
- Support for port electrical grid seamless integration of shore-to-ship power
- Reduced emissions, low-frequency noise and vibrations



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Digitalization – both digital SS and digital tools and processes

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Consumption

New loads:
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Electrification of transportation

Limiting environmental impact is a key priority

ABB