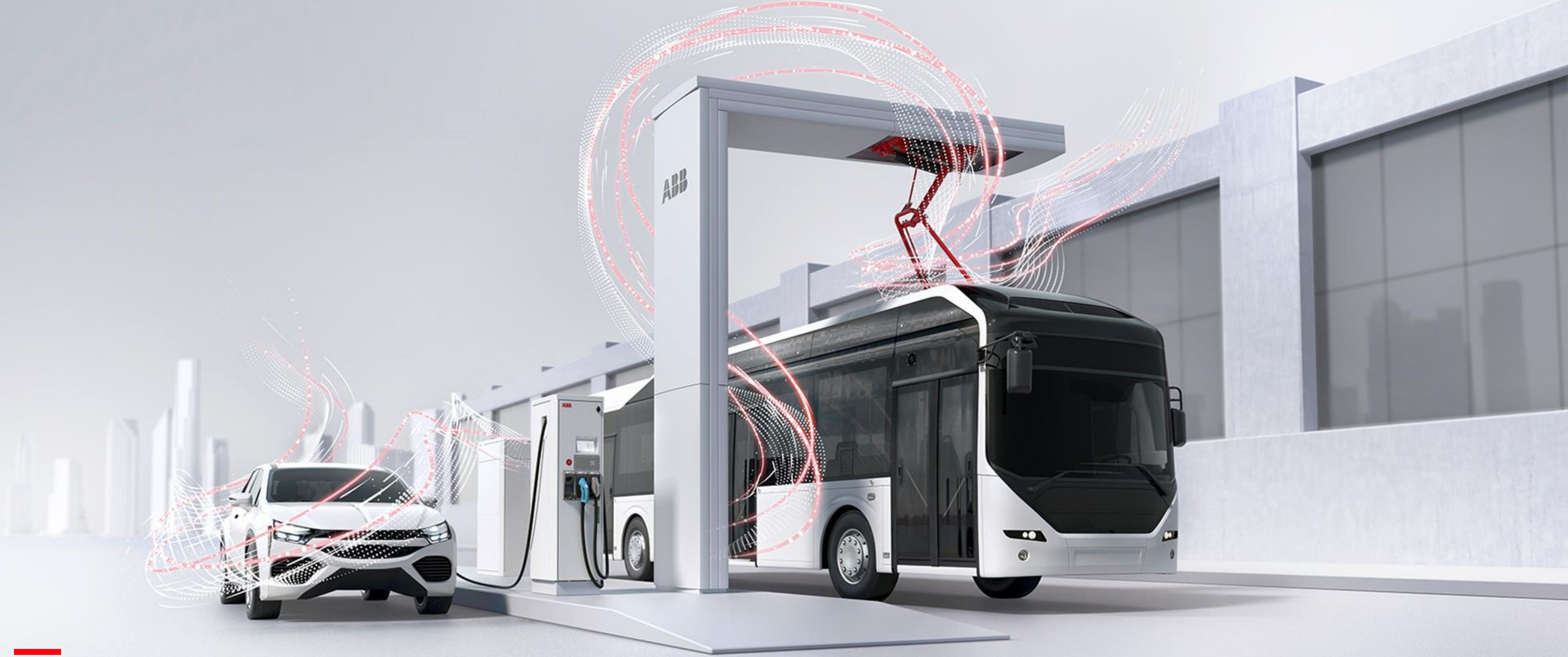
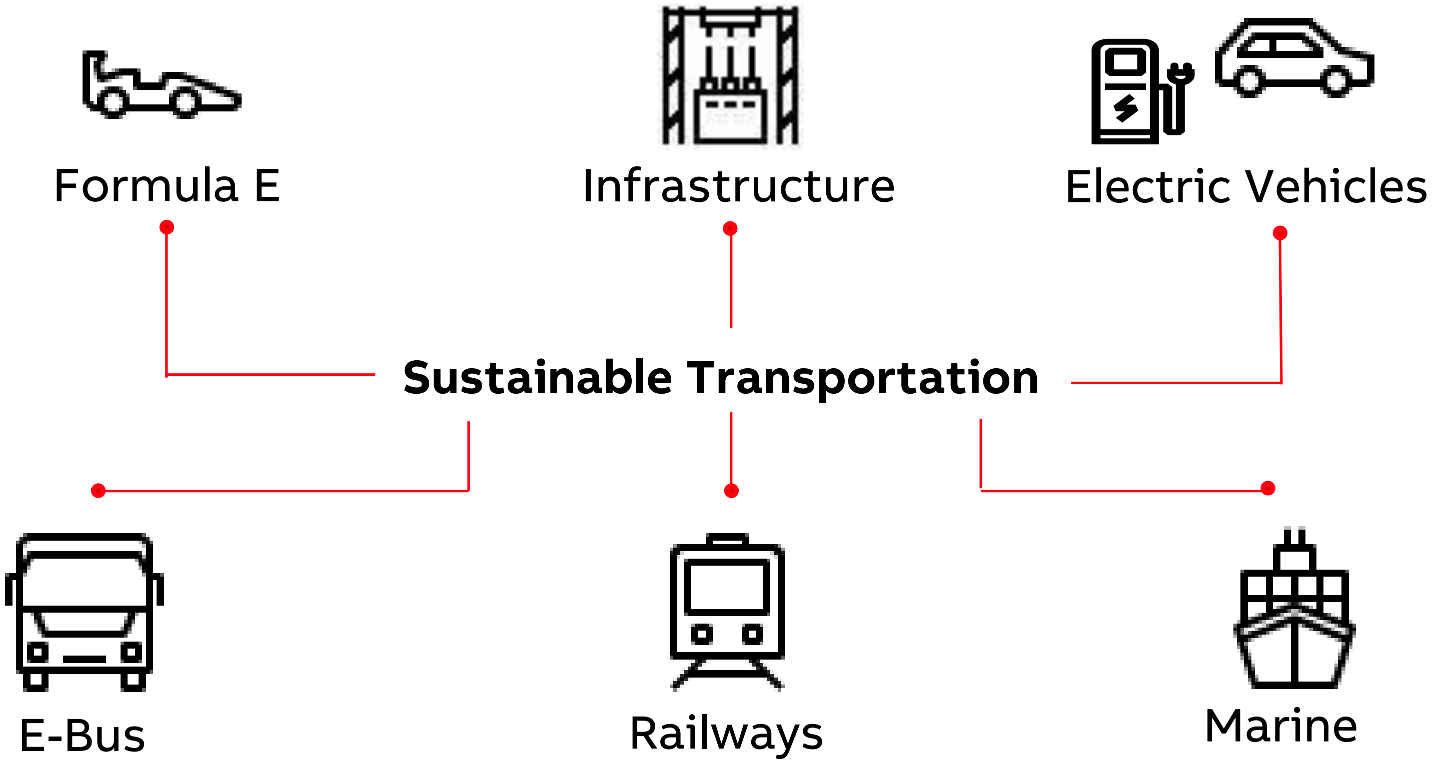



Filippo Passante, Genova Smart Week, November 2018

# Sustainable Transportation
## Impact on Power Systems

# Sustainable transportation

ABB is at the forefront of e-mobility and sustainable transportation



# Sustainable Transportation
## Smart Port and Shore-to-ship power

# 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**

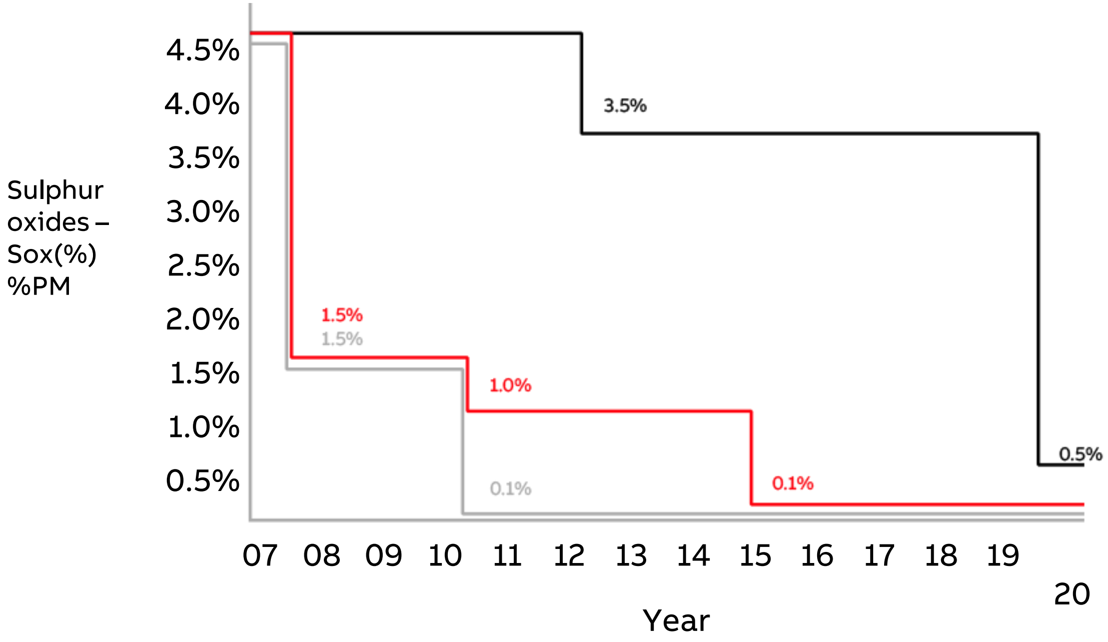
# Ship emissions
## Current and ongoing regulations

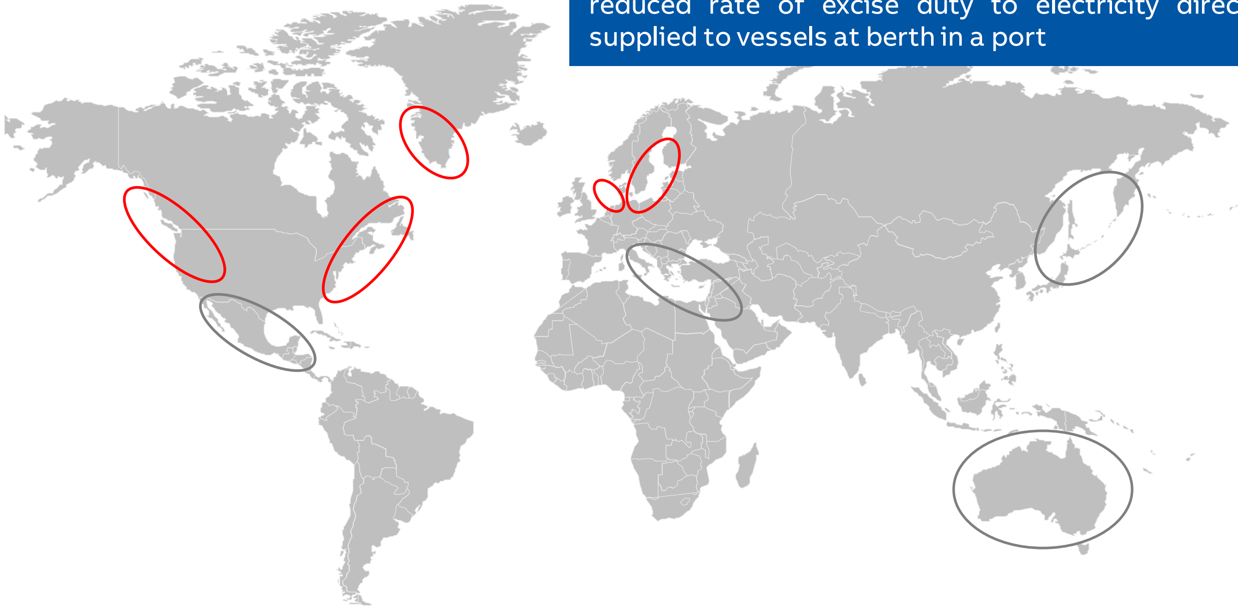
**24 September 2018**

By voting the Ertrug Report, the Transport committee of the EU Parliament pointed out that disparities in energy taxation for shore-side supply for ships should be addressed

**2 October 2018**

Decision (EU) 2018/1491 authorizing Spain to apply a reduced rate of excise duty to electricity directly supplied to vessels at berth in a port



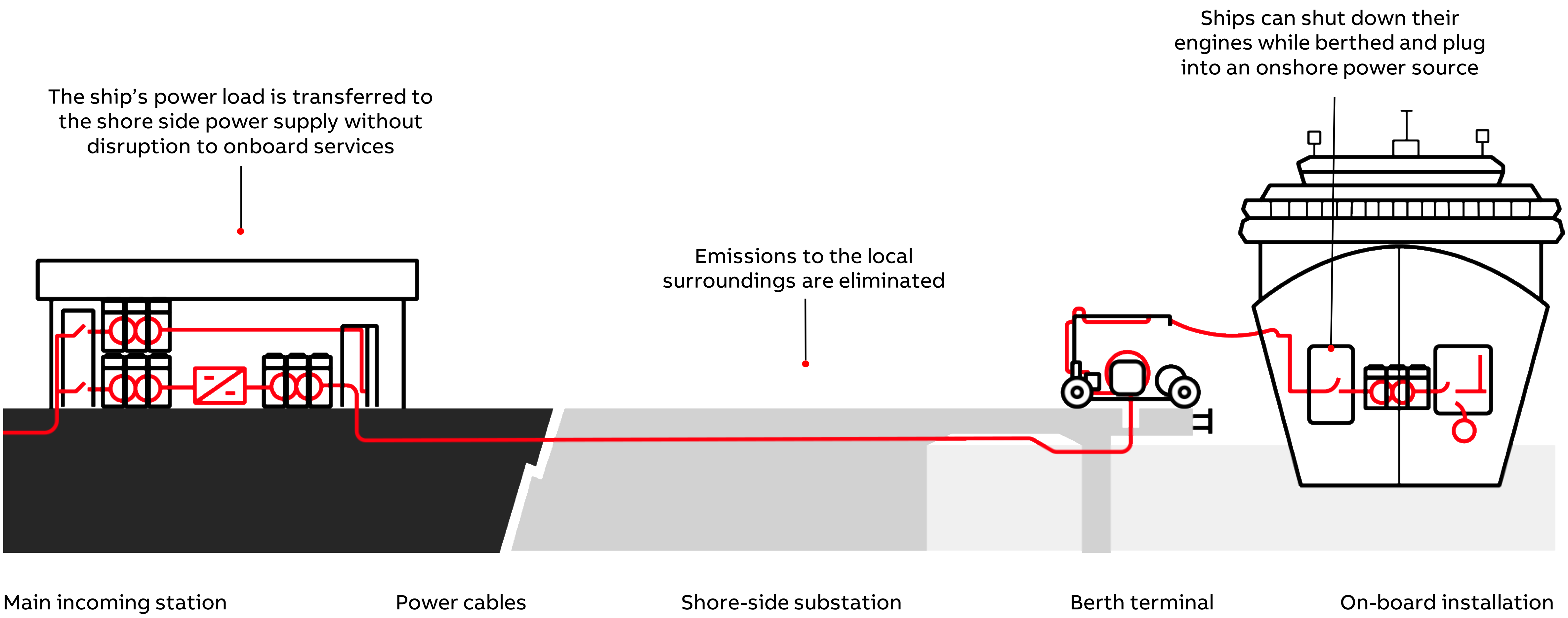



- Global Sulphur Limit (International Maritime Organization)
- Sulphur Emission Control Areas (SECA)
- EU Regulations (during vessel port stay)

- Existing Emission Control Area
- Potential future Emission Control Area

# Shore-to-ship power

## The ABB solution to eradicate ship emissions at berth

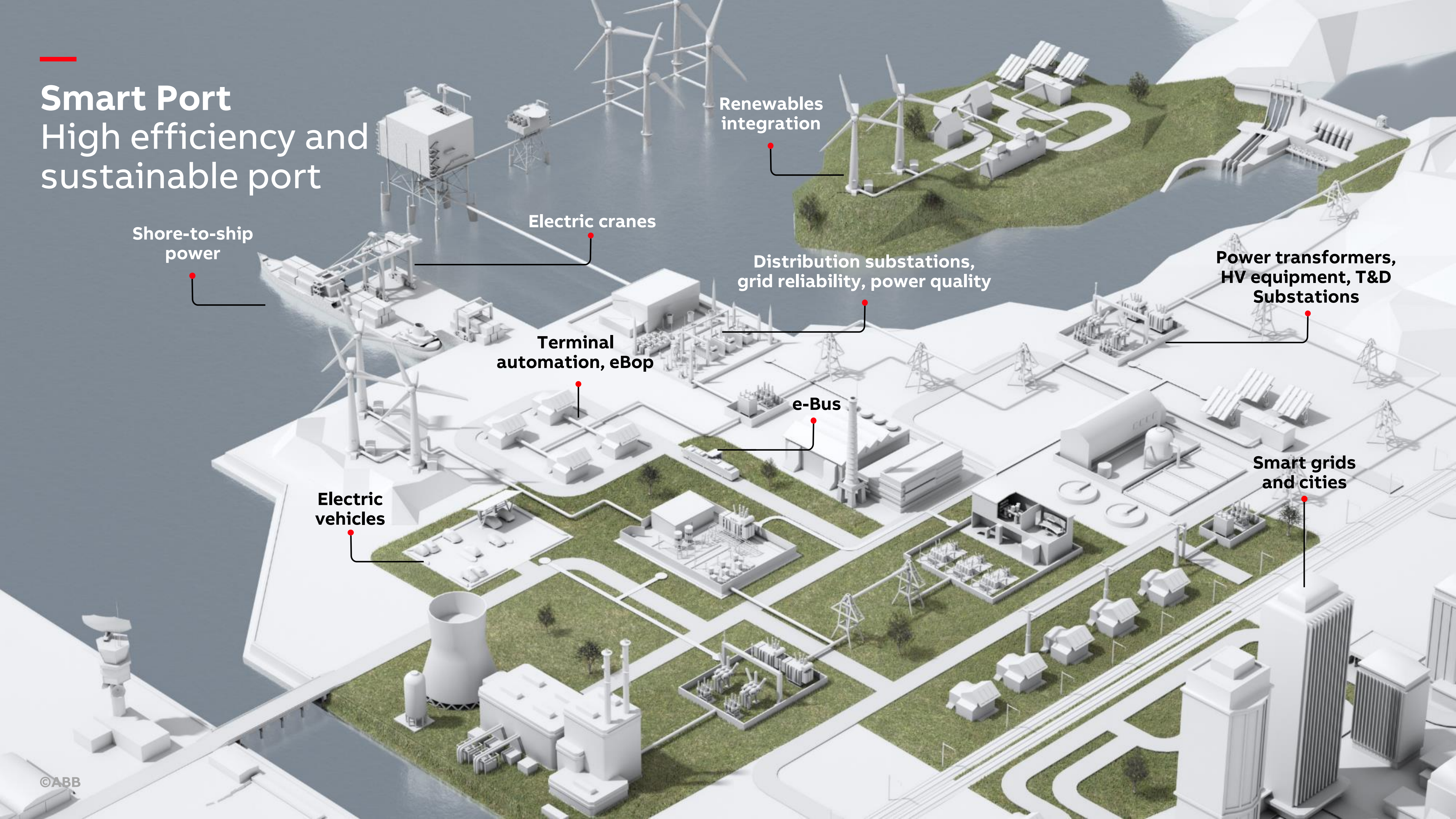


# Shore-to-ship power
## Specific requirements for each type of vessel

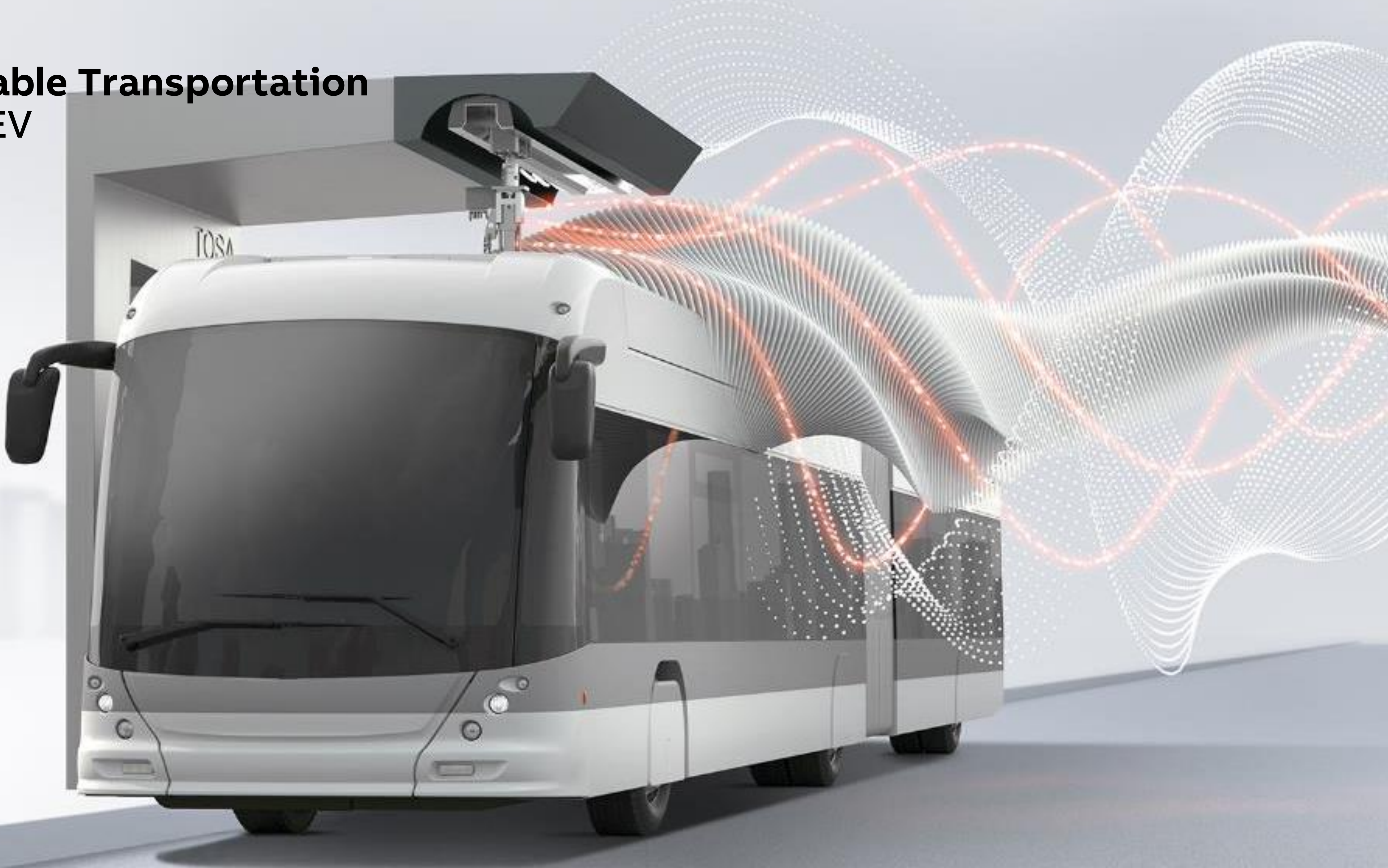
- 🔴 HVSC or LVSC – Low Power
- ⚫ HVSC – High Power
- ⚪ Special Application

| Characteristics | 🔴 RORO/Ferry | ⚫🔴 Container | ⚫ Cruise | ⚪ LNG/Tanker/ FSU/FPSO | ⚪ Shipyard/Navy |
|---|---|---|---|---|---|
| **Voltage** | 11 kV or low voltage | 6.6 kV | 6.6 and 11kV | 6.6 kV | 6.6, 11 kV or low voltage |
| **Max power consumption** | 6,5 MVA | 7,5 MVA | 16/20 MVA | 10 MVA | Case by case |
| **Frequency** | 60 and 50 Hz | 60 Hz mainly | 60 Hz mainly | 60Hz | 50 and 60 Hz |
| **Plugs/cables (per connection)** | 1 | 2 | 4+1 | 2/3 | Case by case |
| **Transformer** | Onboard | Onshore | Onshore | Onshore | Case by case |
| **Layout** | Not critical | Critical | Critical | Critical | Not critical |
| **Load profile** | Partially controlled | Partially controlled | Flat profile | Flat profile | Case by case |
| **Protect selectivity** | Critical | Not critical | Critical | Critical | Case by case |
| **Cable management system** | Mid cost | Low cost | High cost | Mid cost | Case by case |

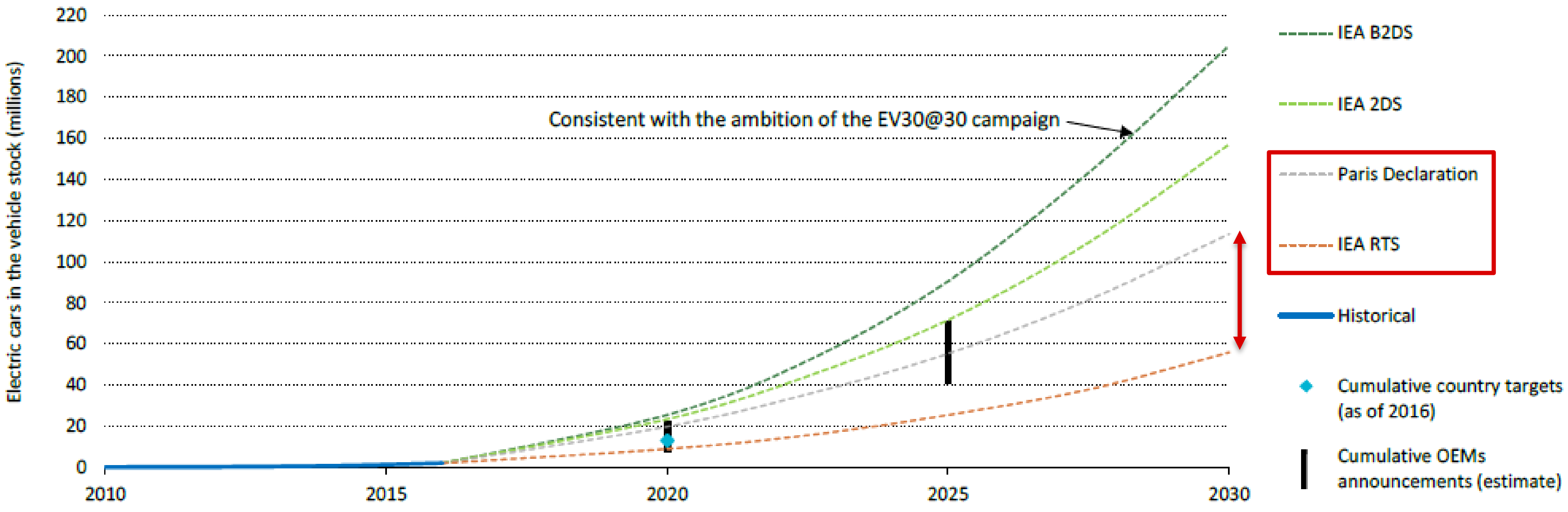
# Smart Port
## High efficiency and sustainable port



# **Sustainable Transportation**
Plug-in EV



# Are plug-in EV relevant to Power Systems?
## Deployment scenarios for the stock of electric cars to 2030




The most realistic scenarios, project a total number of cars in 2030 between 60 and 110M (between 2 and 5M in Italy[1])

If unconstrained, the charging demand of this exponential expansion of vehicles, potentially threatens the normal operation of current power systems.

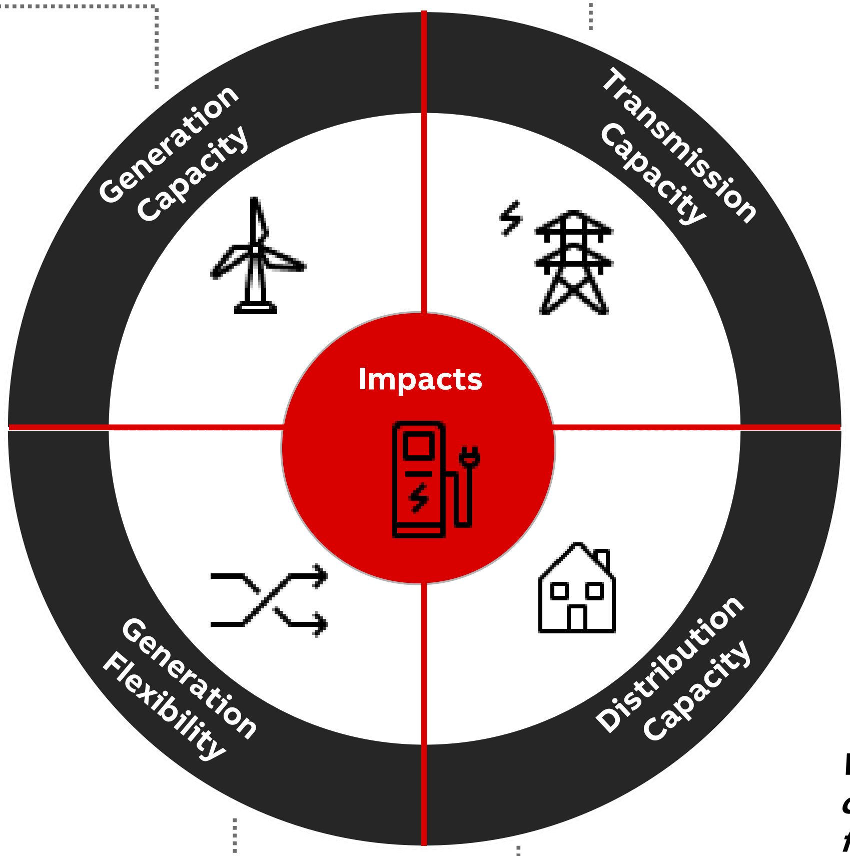


1) European House Ambrosetti projection, low and high scenarios

# How do PEVs affect Power Systems?
## Main Impacts and Sections Affected

*Can the total generation match the future Demand?*

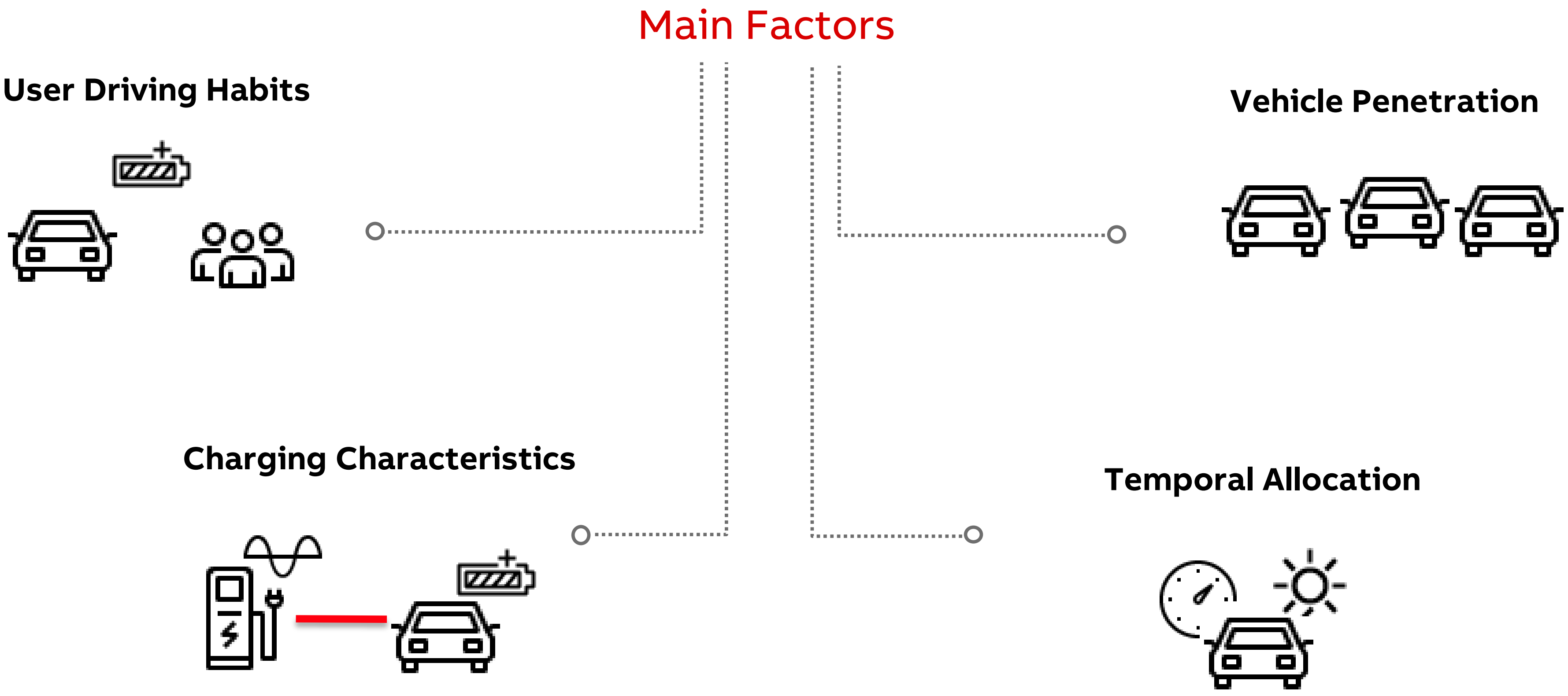
*Can the total transmission capacity cope with a large scale PEV demand?*




*Would the total generation be capable to adjust to the abrupt demand patterns of PEV?*

*Would distribution grids be capable to accommodate local future PEV demand?*

# What factors determine the Impact PEVs have?
PEVs network impacts depend on several factors.




PEVs do not behave as any other conventional load!

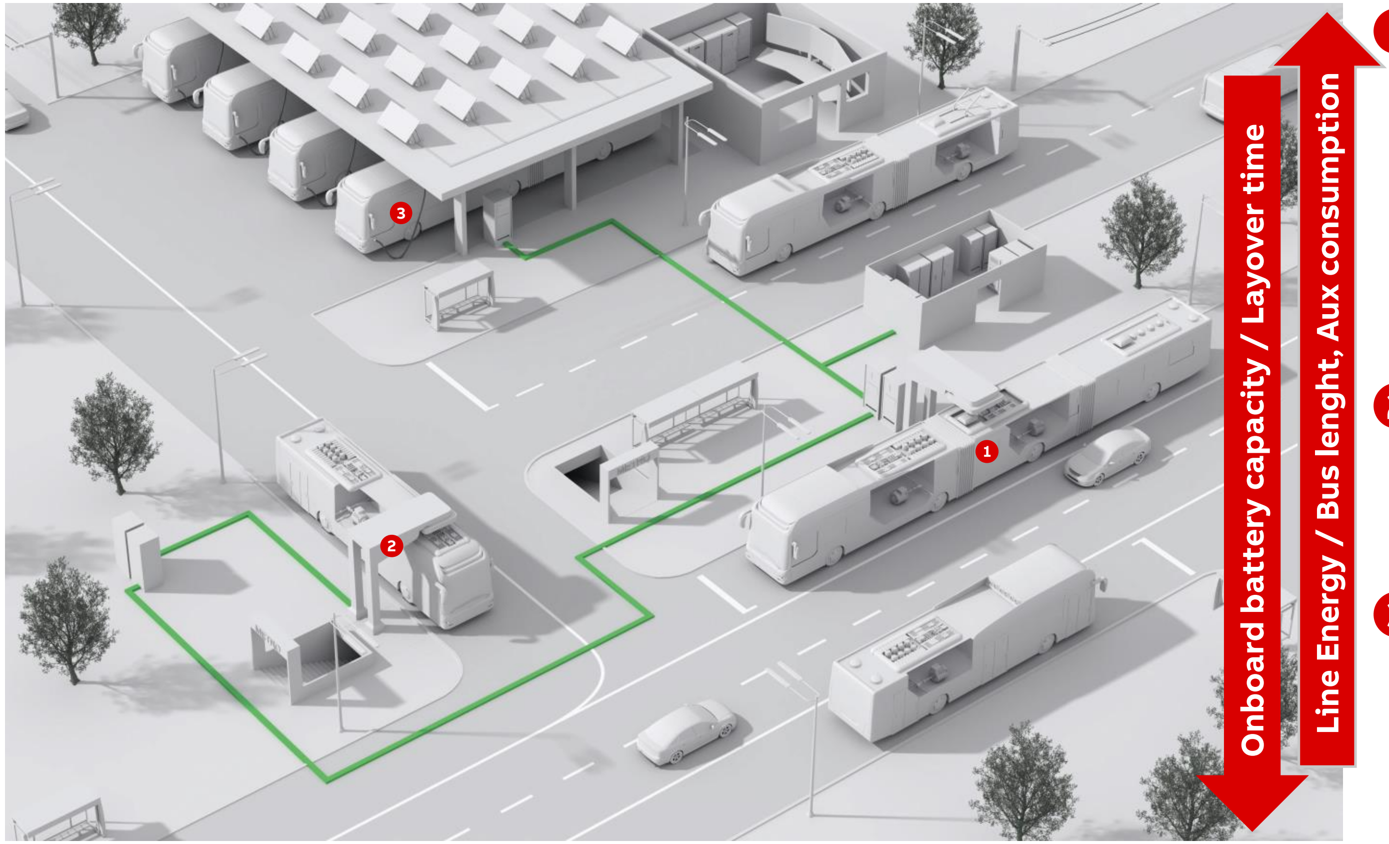
# Face a varied and evolving charging installed base

## Residential, commercial and public charging

| AC | DC | DC Fast | DC High Power |
|---|---|---|---|
| 3-22 kW | 20-25 kW | 50 KW | 150 to 350kW+ |
| 4-16 hours | 1-3 hours | 20-90 min | 10-20 min |

# Additional impacts from e-Bus Systems deployment

## Different needs, different solutions, different impacts on the power system




**1 Flash charging**

- 600 kW fully automated fast charging stations installed at some bus stops, 15-20 second charging time, <1s connection time
- IEC 61851-23 compliant
- Cost-optimal onboard batteries
- Energy storage for peak shaving available
- TCO optimized system solution

**2 Opportunity charging**

- Charge electric buses in 3–6 minutes
- Automated 4-pole rooftop connection IEC 61851-23 standard
- Power available from 150 kW to 600 kW

**3 Overnight charging**

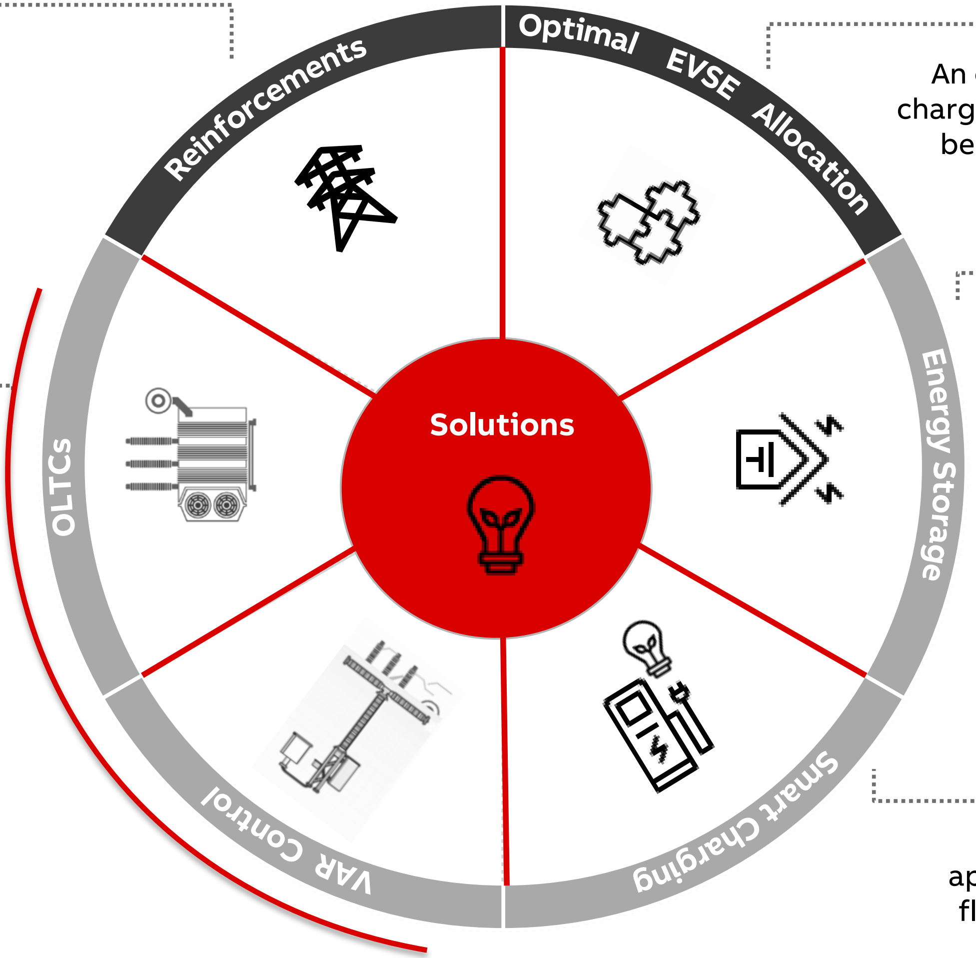
- Chargers from 50 kW to 150 kW (high power fast charging)
- A single 150 kW charger can charge up to 3 buses reducing the total charge load from 450 kW to 150 kW
- In an overnight session (6 hours) three 300 kWh buses can be fully charged

# Solutions
## Passive and Active Strategies

Passive Solutions

Network Reinforcements, although effective, are neither the most interesting nor cost effective alternative as they would remain heavily underused during massive periods of time.

An optimal allocation of the charging points can have limited benefits in the short term.




Can correct the impacts over the voltage profile, but they have practically no impact in the case of thermal asset Management. Furthermore OLTCs are not common on the MV/LV side and generally actuate on all three phases at the same time.

An optimal deployment of supporting batteries can potentially mitigate the vehicle's major impacts. Nonetheless unless recycled batteries are used the potential costs could be high.

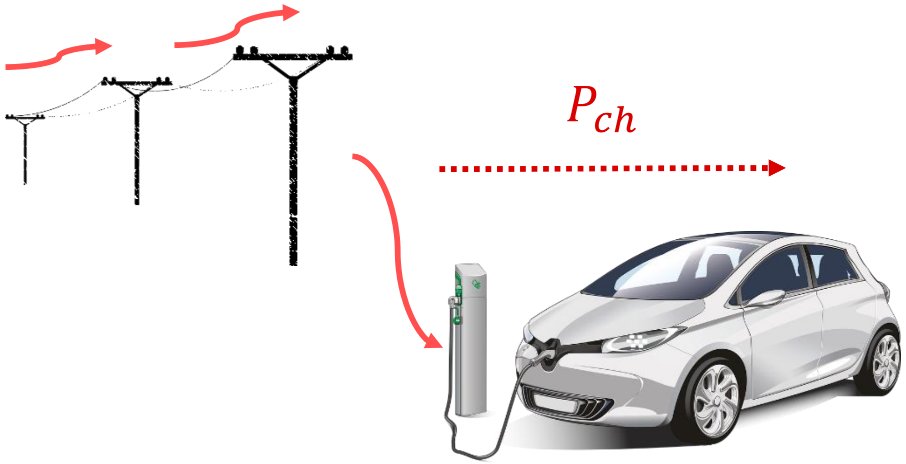
Smart Charging applications offer the most flexibility both in terms of impact mitigation and system cost design.

Active Network Management

# Smart Charging
## Grid-to-Vehicle and Vehicle-to-Grid

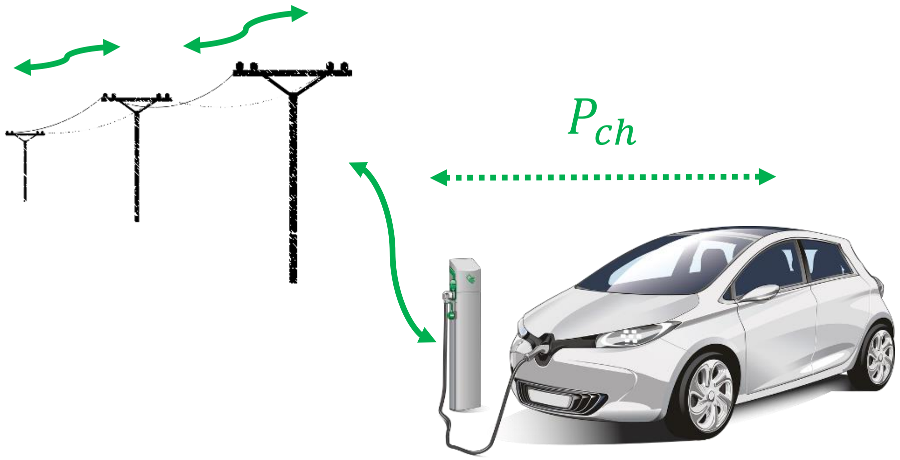
### G2V

G2V implies that the charging rate of the vehicle (Pch) can be dynamically adjusted.



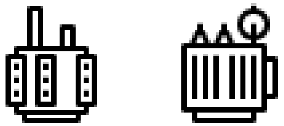

### V2G

V2G implies that the charging rate of the vehicle (Pch) cannot only be dynamically adjusted, but also the direction of the power flow can be changed



# Smart Charging
## Active Network Management

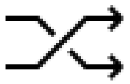
**Flexibility Services (Demand Response)**



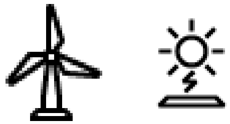
- Congestion Management
- Asset Usage Optimization

PQ management:

- Voltage limits
- Phase unbalances



Frequency Support (Microgrids)



- Renewable Energy Generation Support (Overproduction)
- Exploitation Optimization (Storage V2G)

# Smart Charging
## Active Charge Management

Minimize Total Impact | Maximum Economic Benefits | Minimize Network Losses

Maximize Self-Consumption | Maximize Renewable Integration

### Predictive

Can be more complex.
Critically depend on available data.
Must rely on real-time supervision.

### Real-Time

Limited by Data Size
Limited by Communication
Limited by Computation

### Centralized

Can deliver optimal solutions
Greater IT requirements

### Distributed

Lighter requirements
Requires coordination

# Solutions for remote control of charging infrastructures
## ABB Ability Collaborative Operations for electrical mobility

**Scalable**
Applicable to one station, small fleets, nation-wide networks of ABB or third-party charging stations

**Role-based access**
Every role, its data. Layered platform to access the right info depending on the user role

**SaaS, cloud-based**
Easy remote monitoring and control solution, to be performed autonomously or with ABB experts' support

No major IT investment

**Hubject-integrated**
Fully integrated with the leading EV-roaming platform in Europe

**Additional web-services**
- To geo-locate stations on third party websites
- For commercial operations

**Bespoke**
Fully customizable upon request
- Additional functions
- Company branding

ABB