



HYDROGEN SUMMIT & EXPO

# The Role of Power Quality in Hydrogen Production

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Merus Power Oyj

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# Merus Power Plc. - Briefly

**2008**

Founded

We design and manufacture Finnish innovative battery energy storage systems and power quality solutions.

Our business is based on scalable and modular power electronics, advanced software technology, and electrical and software engineering expertise.

**2021**

IPO to Nasdaq  
First North

**36M€**

Revenue  
2024

Our company is headquartered in the city of **Ylöjärvi, Finland**.

Our staff of **170+** people represents internationally valued expertise.



**70+**

Countries with  
our solutions

# Our scalable product portfolio

## Energy Storage solutions



Merus™ ESS  
Energy Storage System

## Power Quality solutions

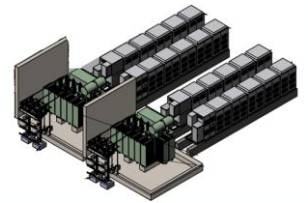
Merus™ A2  
Active Harmonic Filter



Merus™ HPQ  
Hybrid Power Compensator



Merus™ STATCOM  
Static Synchronous Compensator



Merus™ SVC  
Static Var Compensator



Low Voltage (200 V – 690 V)

Medium Voltage 1 kV – 36 kV

# Merus® Medium Voltage PQ Systems - References

➤ **2012 – GOLD MINE WITH DC WINDER AND VFD**  
10.8 MVar at 11 kV – Africa

➤ **2013 – METAL PLANT WITH DC EAF**  
2.75 cap to 2.75 ind MVar at 6.3 kV – Europe

➤ **2013 – STEEL PLANT WITH EAF**  
16 cap to 0 ind MVar at 33 kV – Africa

➤ **2014 – STEEL PLANT WITH EAF**  
16 cap to 0 ind MVar at 33 kV – Africa

➤ **2015 – STEEL PLANT WITH EAF**  
225 MVar at 33 kV – Europe

➤ **2016 – STEEL PLANT WITH EAF**  
45 cap to 3 ind MVar at 33 kV – Europe

➤ **2017 – MINE WITH DC WINDER AND VFD**  
4 cap to 0 ind MVar at 11 kV – Africa

➤ **2018 – STEEL PLANT WITH EAF**  
35 MVar at 11 kV – Europe

➤ **2018 – STEEL PLANT**  
28 MVar – Europe

➤ **2018 – STEEL PLANT (MODERNIZATION)**  
105 MVar at 22 kV – Asia

➤ **2018 – WIND FARM**  
MV AHF System at 33 kV – Australia

➤ **2019 – WIND FARM**  
MV AHF System at 33 kV – South Africa

➤ **2019 – STEEL PLANT**  
2x 155 MVar at 33 kV – Asia

➤ **2022 – STEEL PLANT**  
120 MVar at 33 kV – Asia

➤ **2022 – WIND FARM**  
MV AHF System at 33 kV – South Africa

➤ **2023 – STEEL PLANT**  
82 MVar at 21 kV – Europe

➤ **2023 – STEEL PLANT**  
140 MVar at 33 kV – Africa

➤ **2023 – SOLAR FARM**  
MV AHF System at 33 kV – South Africa

➤ **2023 – STEEL PLANT**  
80 MVar at 33 kV – Europe

➤ **2023 – SOLAR FARM**  
MV AHF System at 33 kV – South Africa

➤ **2025 – ILMENITE SMELTER WITH EAF**  
56 cap to 4 ind MVar at 35 kV - Asia

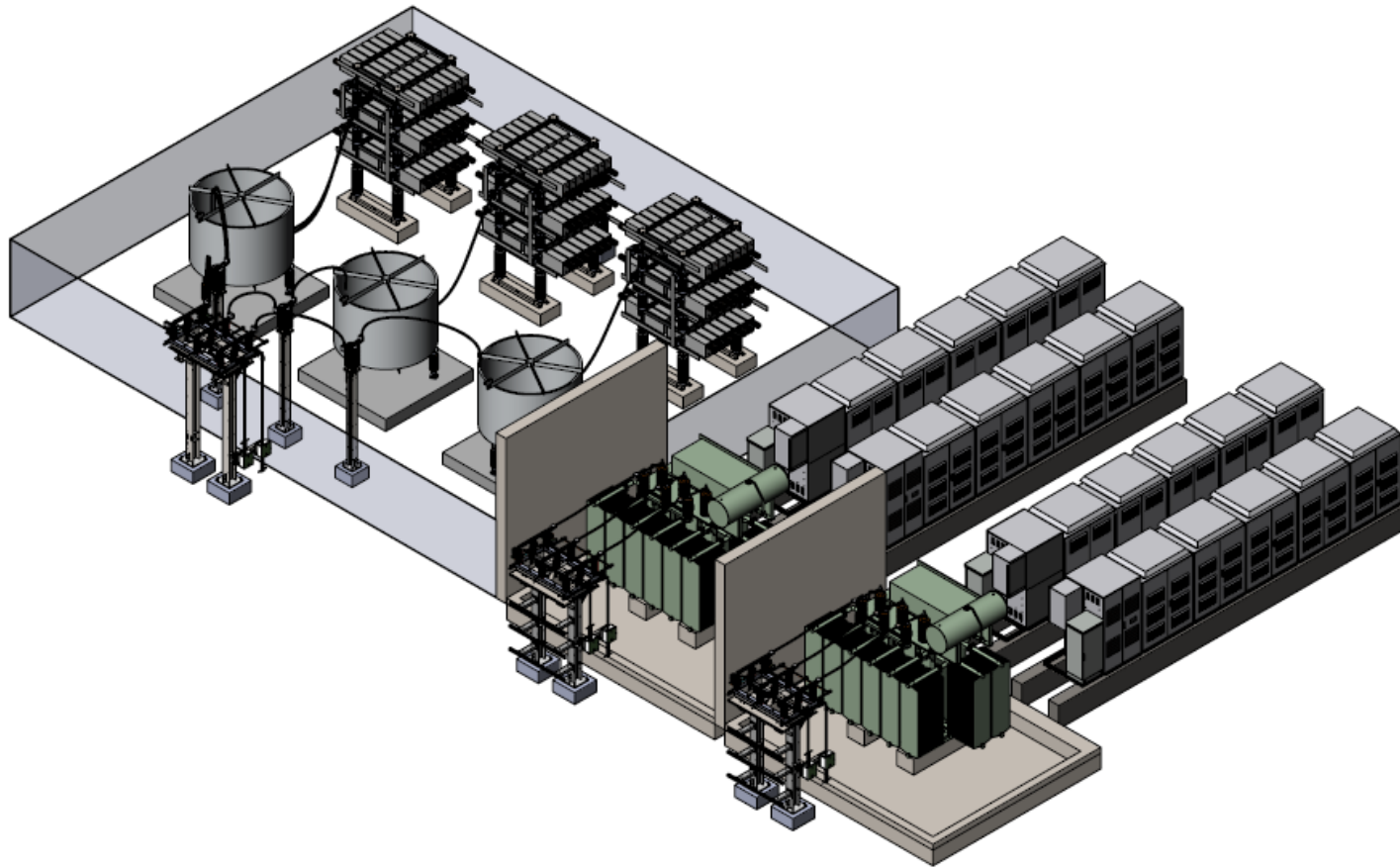
➤ **2025 – RAIL TRAFFIC POWER QUALITY**  
4 cap to 4 ind MVar at 110 kV – Europe  
6 cap to 6 ind MVar at 110 kV – Europe

**Total of 32 MV PQ projects sold since 2012  
with total capacity sold:**

**1531 MVar**

uth America  
(MODERNIZATION)  
ope  
(MODERNIZATION)  
(MODERNIZATION)  
PLANT

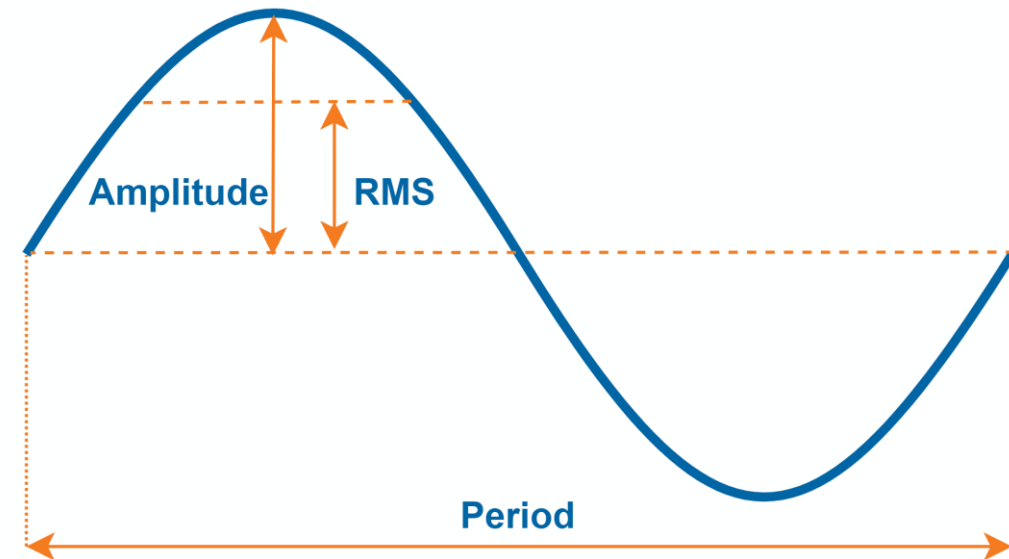
# The Role of Power Quality in Hydrogen Production



# What is Power Quality?

Power quality describes how well the voltage, current, and frequency supplied to equipment match ideal conditions for reliable operation. In an ideal system, the voltage is steady at the correct level, the frequency is stable, and the current waveforms are clean and sinusoidal.

<b>Voltage U</b>	<b>[Volt, V]</b>
<b>Current I</b>	<b>[Ampere, A]</b>
<b>Frequency f</b>	<b>[Hertz, Hz]</b>



# What Are The Power Quality Challenges?

Relevant in  
Hydrogen  
Production

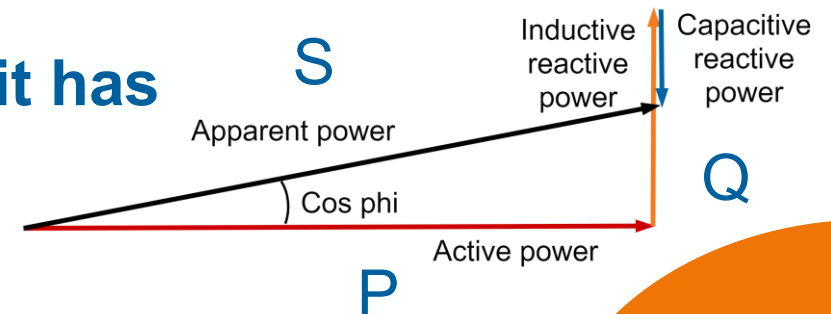
- **Maintain Power Factor (PF) at correct level**
  - Power factor is ratio between active power (MW) and apparent power (MVA)
- **Harmonics**
  - Harmonics are waveform distortions caused by non-linear loads.
- **Unbalance**
  - Unbalance occurs when phase voltages or currents in a three-phase system are not equal.
- **Flicker**
  - Flicker is rapid, repetitive voltage change.

# Power Factor and Reactive Power

- Power factor is ratio between active power (MW) and apparent power (MVA)
- $PF = \frac{\text{Active Power } P}{\text{Apparent Power } S}$
- The power factor is maintained (Typically 0.95) by Reactive Power (MVA<sub>r</sub>) compensation
- Reactive Power does not transfer any work, but it has important role in controlling the grid voltage.

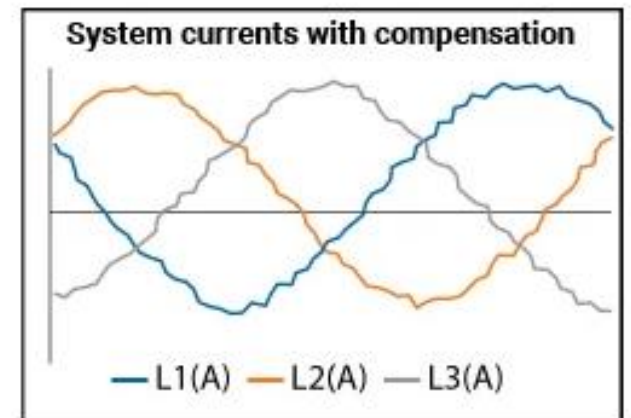
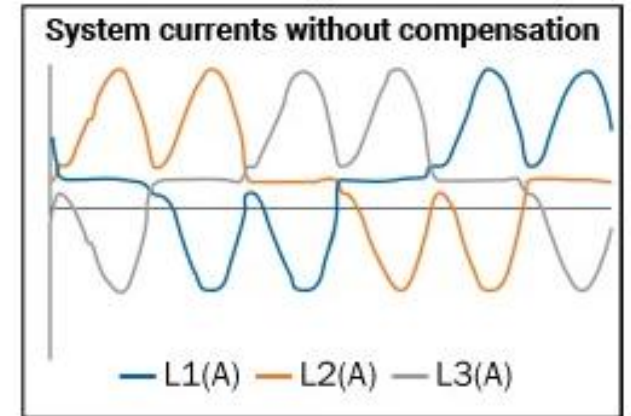
$$S = \sqrt{P^2 + Q^2}$$

S = Apparent Power  
P = Active Power  
Q = Reactive Power

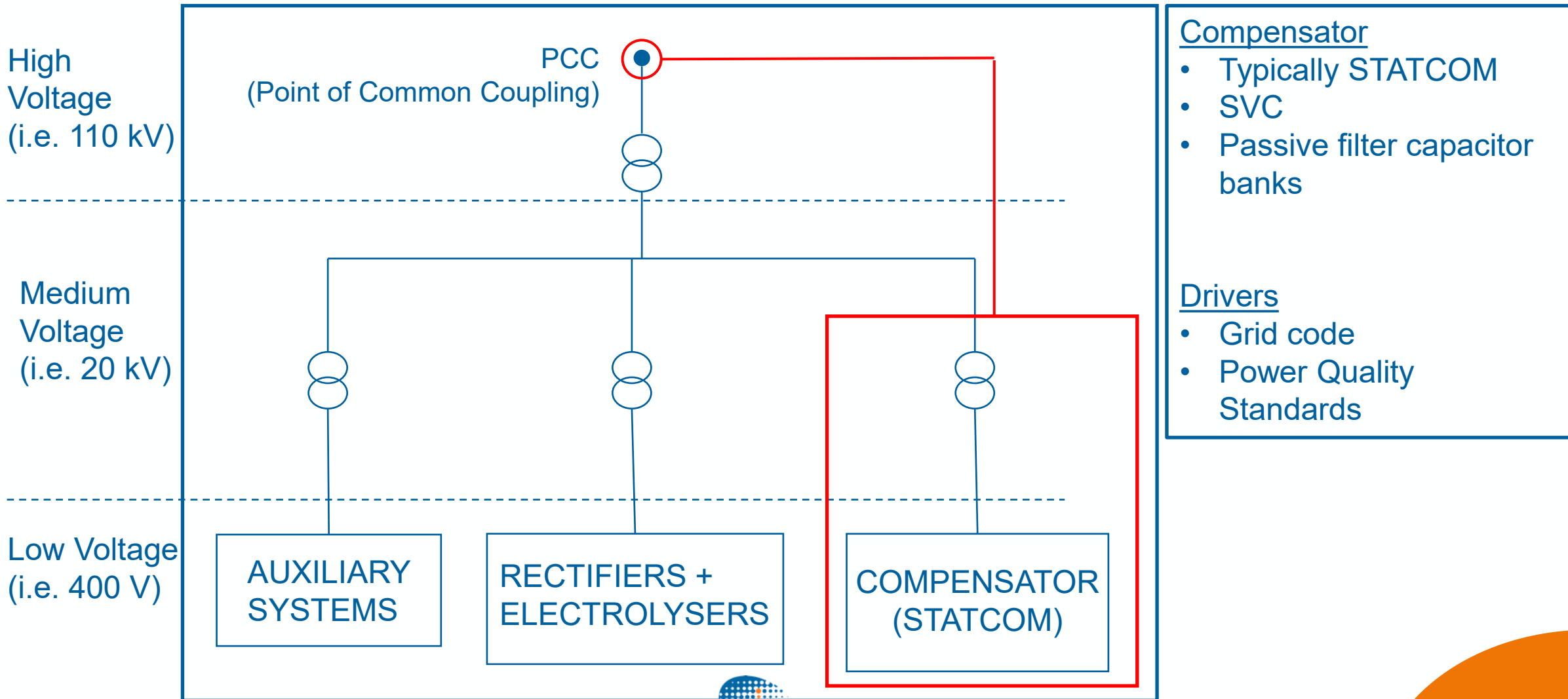


# Harmonics

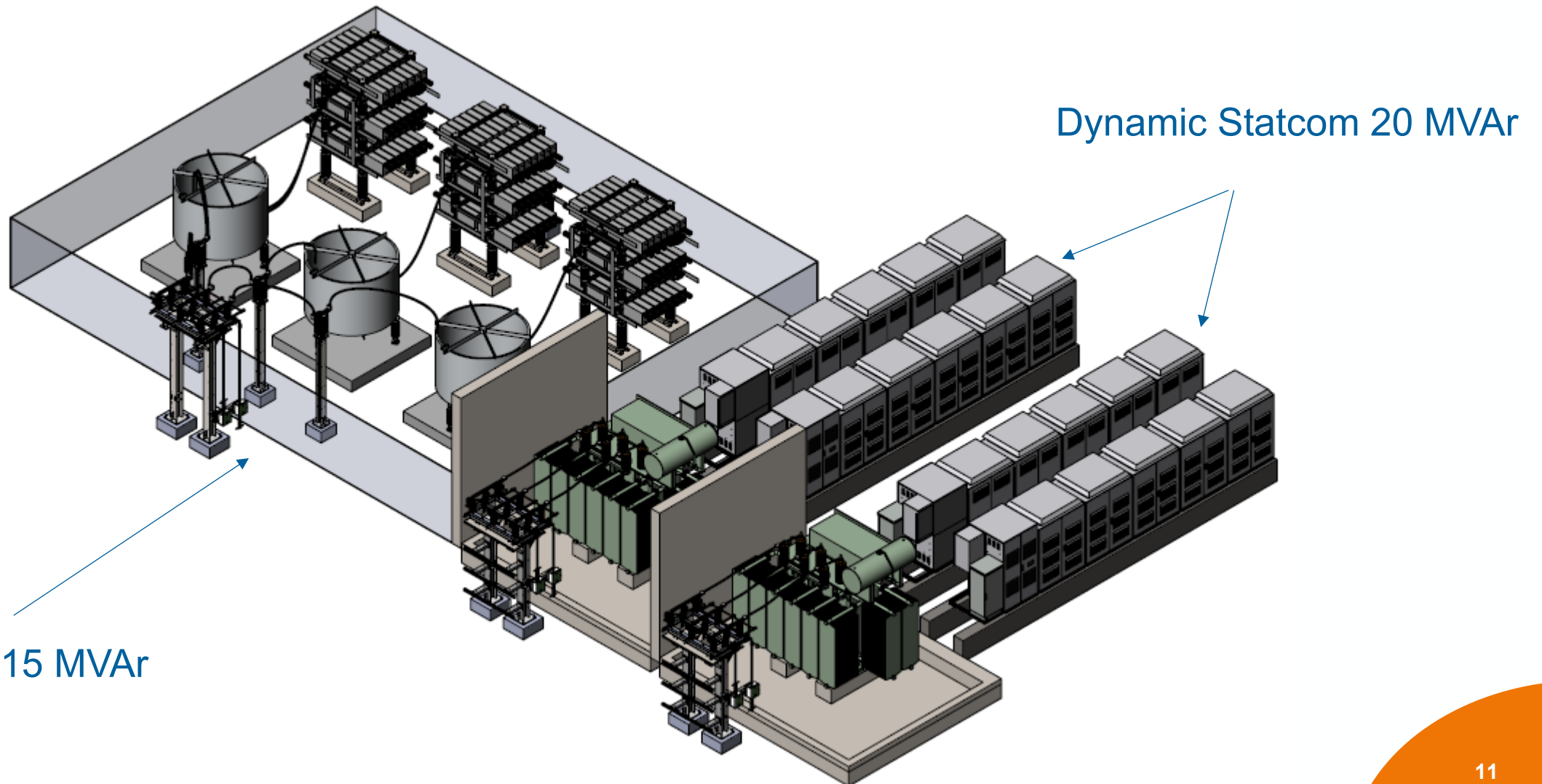
- Harmonics are distortion to pure sine wave
- Harmonics are multiples of the fundamental frequency
  - Standards typically define harmonics up to 50<sup>th</sup> harmonic order
- Standards and local grid owners define the maximum allowed number of harmonics in the grid
  - Limits:
    - THD, Total Harmonic Distortion
    - Individual harmonics



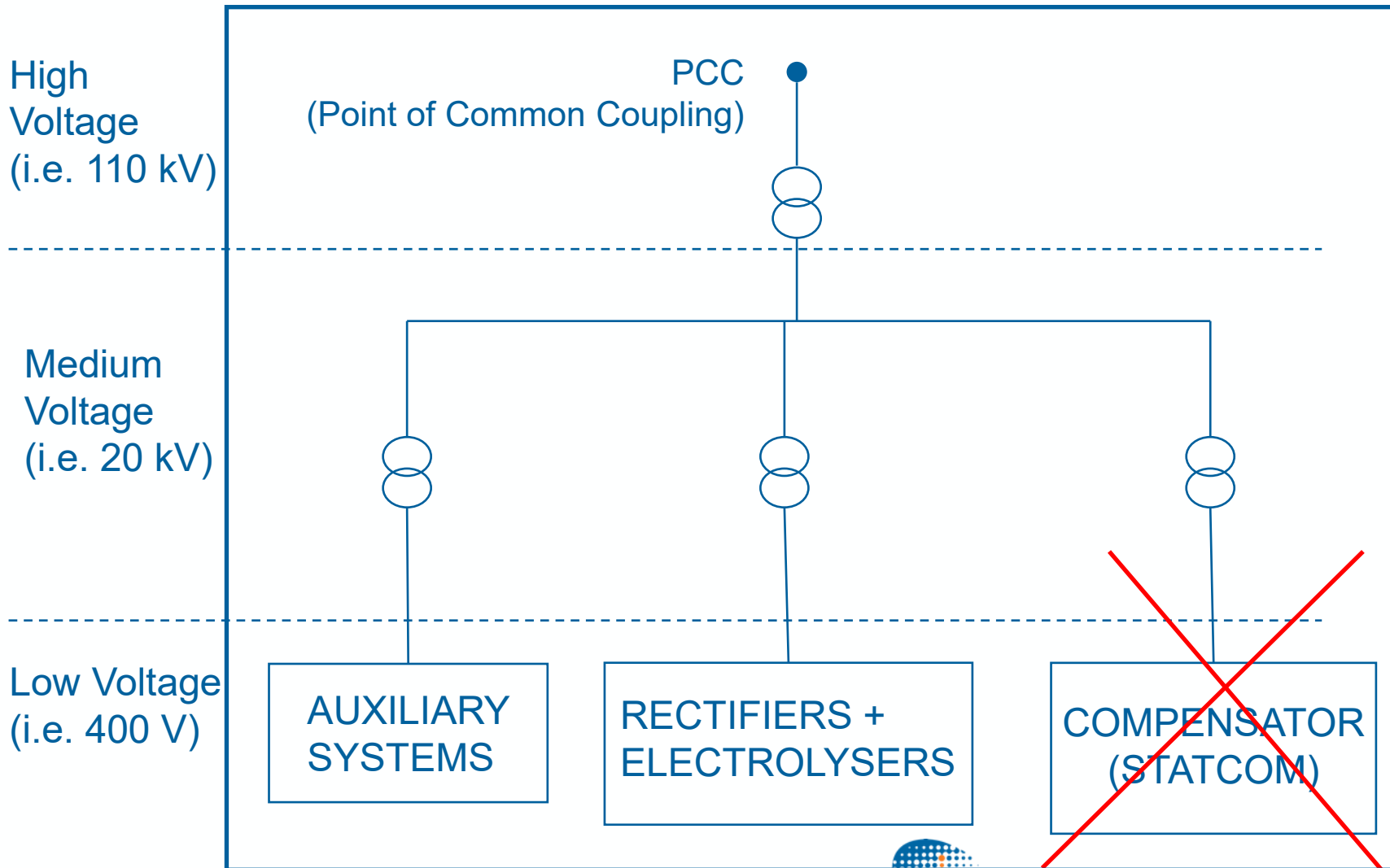
# Power Quality with Centralized MV Compensator



# Example of Centralized Medium Voltage Statcom



# Power Quality with Active Front End (AFE) Rectifiers



- Compensator
- No separate compensator
  - AFE Rectifiers / IGBT rectifiers
- Notes
- Aux systems may require separate compensation
  - Rectifier capacity might need oversizing
  - High CAPEX
  - Lower efficiency
  - Still preferred option by the H2 industry

# Efficiency Matters: A Simple Example of 100 MW Plant

## AFE / IGBT Rectifier

Rectifier power	100 MW
Efficiency	96 %
Average yearly load	80 %
Energy losses over a year	28032 MWh
Average energy price	70 Eur / MWh
The cost of lost energy	1.96 Meur

## Thyristor rectifier + STATCOM

Rectifier power	100 MW
Efficiency	99 %
Average yearly load	80 %
STATCOM power	30 MVA <sub>r</sub>
Efficiency	97 %
Energy losses over a year	13315 MWh
Average energy price	70 Eur / MWh
The cost of lost energy	0.93 Meur

OPEX DIFFERENCE IN ONE YEAR ~1 Meur

# What is Merus Power Offering for Hydrogen Production?

## We are One-Stop Shop for Power Quality

- Early estimation of compensation needs.
- Detailed grid study, if needed
- Final compensator sizing
- Simulation models for the grid owner, if needed
- Manufacturing of the compensator
  - In own factory in Finland
- Project delivery to the customer
- Commissioning
- Operation & Maintenance



# Thank you for your attention!

Meet Merus Power CTO Jyri Öörni today 12.00 –  
13.00 at our stand E131



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