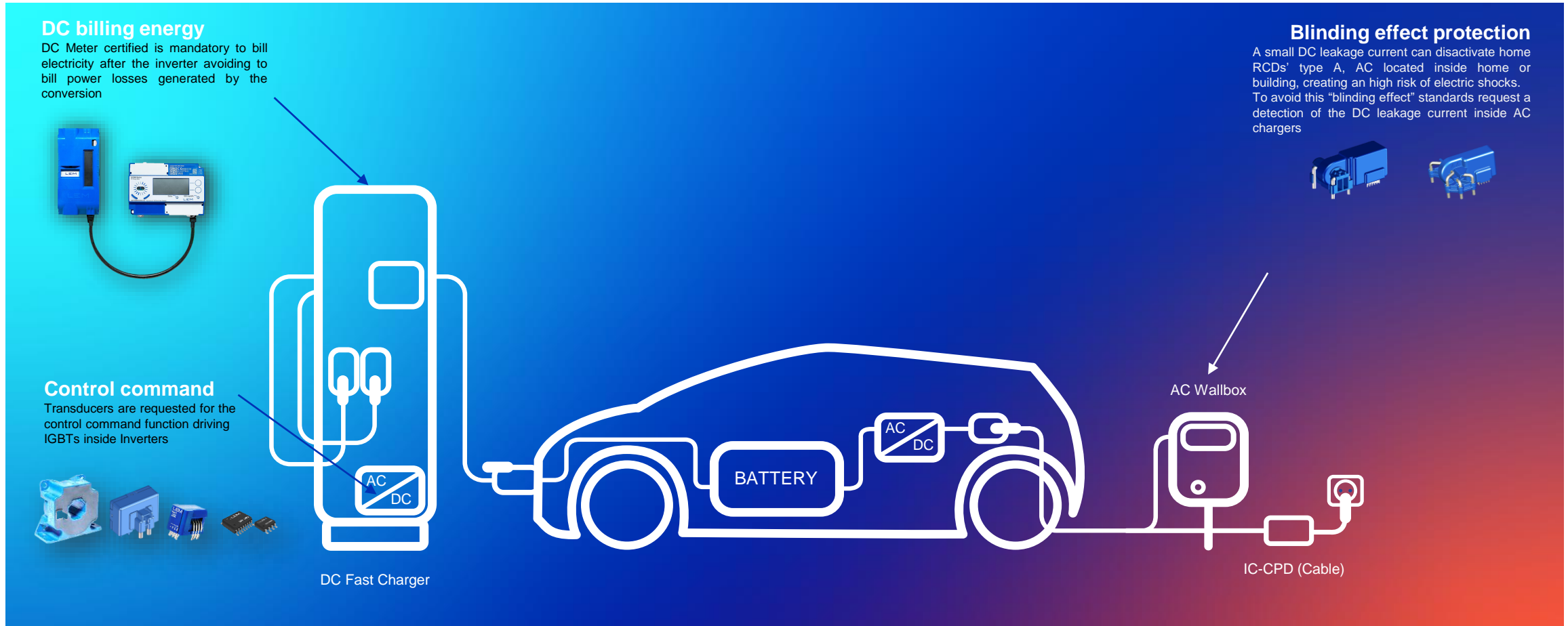# DCBM Series | LEM
Direct Current Billing Meter

Market needs

DC billing energy
DC Meter certified is mandatory to bill electricity after the inverter avoiding to bill power losses generated by the conversion

Blinding effect protection
A small DC leakage current can disactivate home RCDs' type A, AC located inside home or building, creating an high risk of electric shocks. To avoid this "blinding effect" standards request a detection of the DC leakage current inside AC chargers

Control command
Transducers are requested for the control command function driving IGBTs inside Inverters

AC Wallbox

DC Fast Charger

IC-CPD (Cable)

BATTERY

AC / DC

AC / DC

LEM

DC charging station architecture type

Power conversion losses

50 − 150kW

Power distribution

AC

DC

Conversion + charger

MV/LV
Transformer

Power conversion losses

> 350kW

> 350kW

Power distribution

AC

DC

DC

Conversion

Kiosk #1

#2
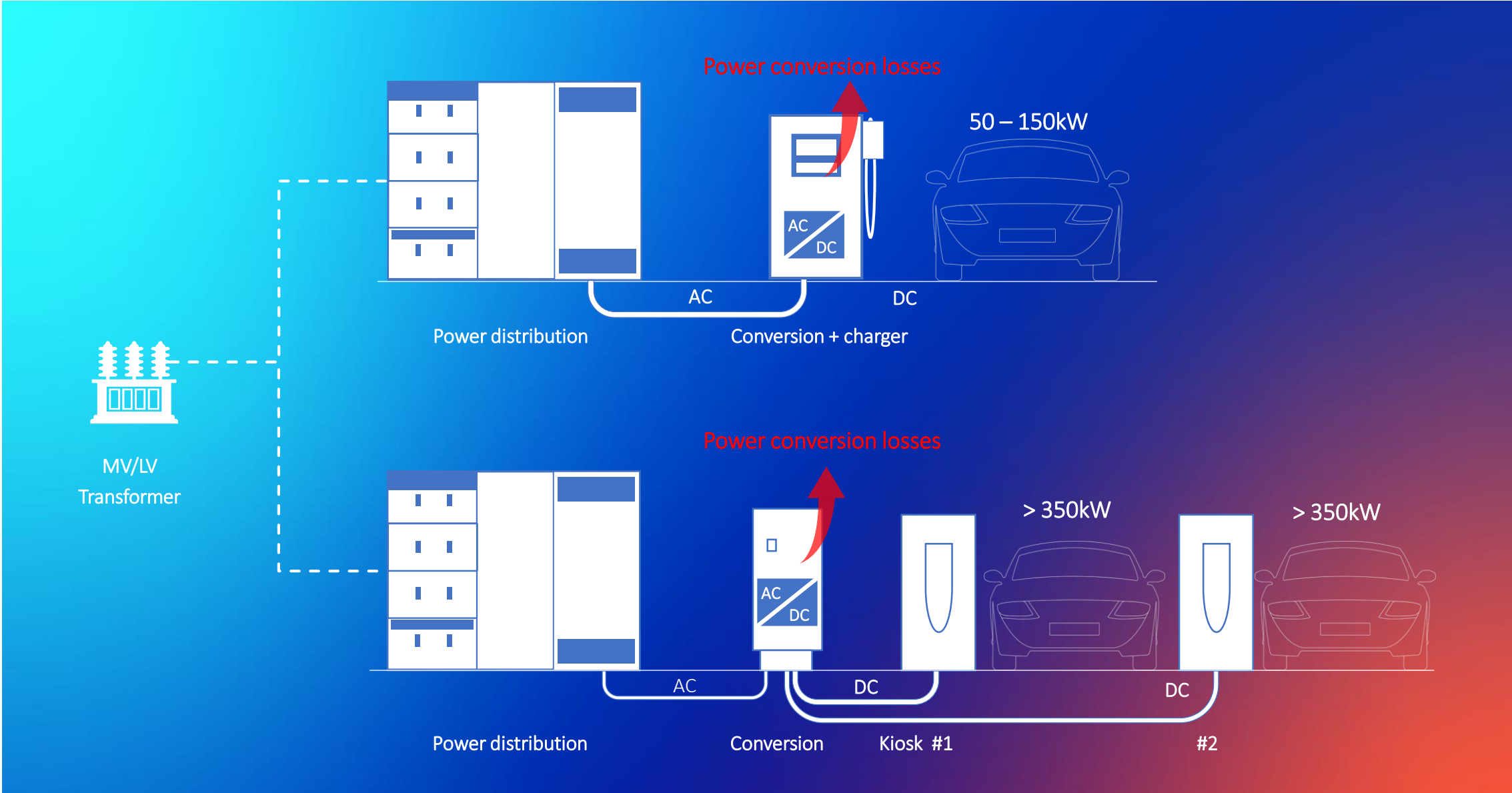
# Market needs & Technology

Market needs:

- DC Charging Stations for EVs' must implement a DC meter certified, compliant with "Eichrecht", meaning "German metrology legislation"

- Losses due to AC DC conversion should not be paid by EV owners. DC meter ensures the measure of DC energy
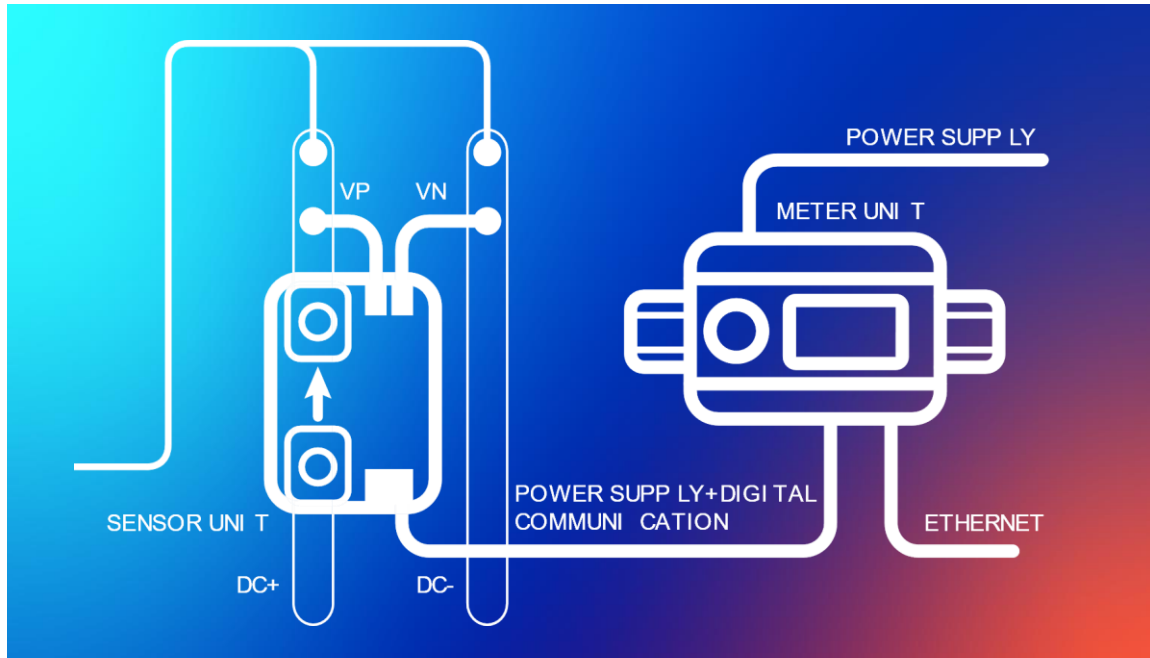
- **Senor Unit** measures the current, the voltage and insulates measures to send them to the Meter Unit. Two version are available, $400A_{max}$ or $600A_{max}$

- **Cable** transmits data from the Sensor Unit to the Meter Unit. The cable is robust for an external environment up to 1000 VDC conditions

- **Meter Unit** is the heart of the DC meter. It receives external data (IDs, Time,…) coming from the charger controller, receives measures coming from the Sensor Unit, combines data, signes data and transmits all the data package to the charger controller via an Ethernet physical communication layer
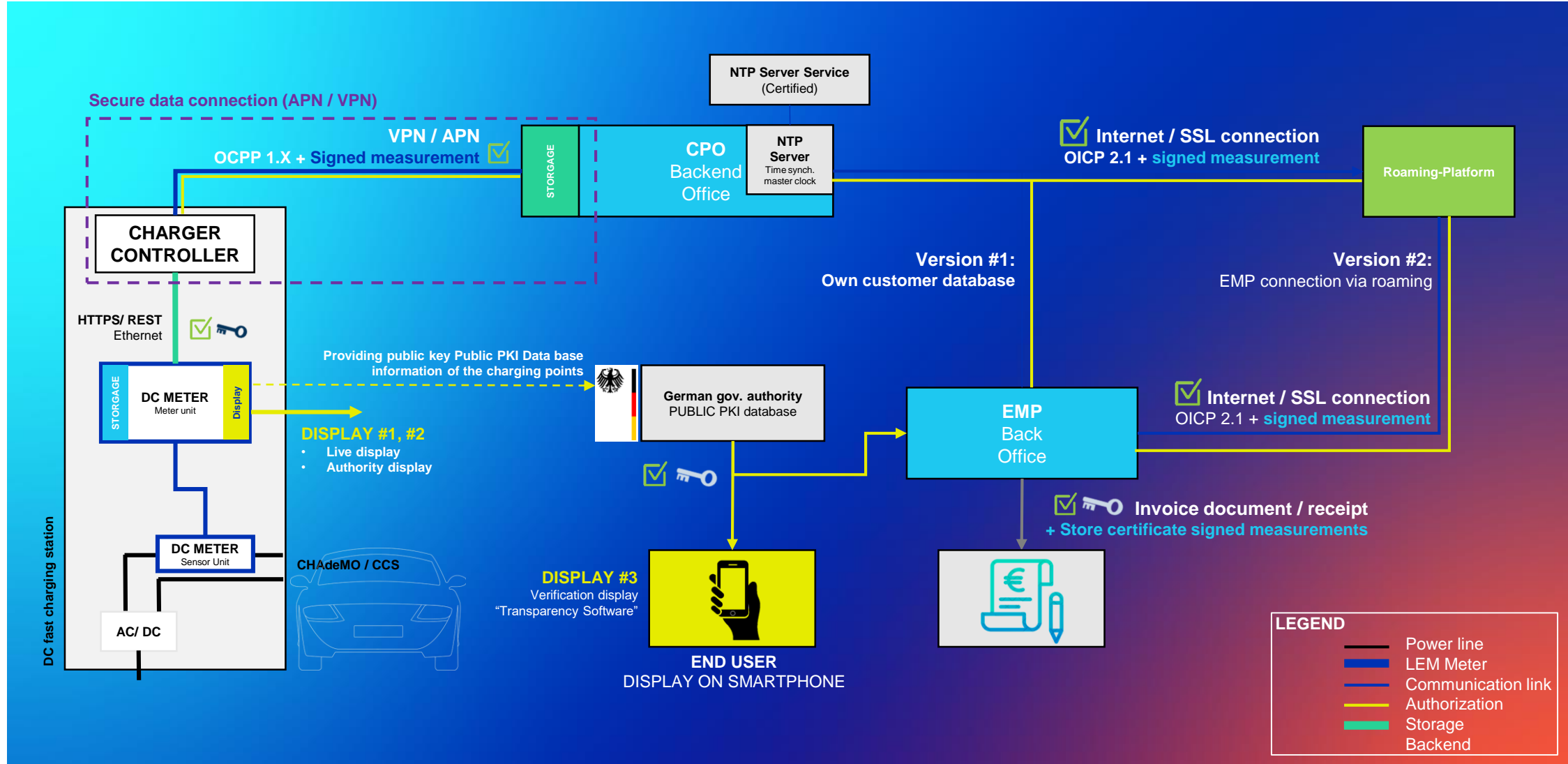
DCBM
Direct Current Billing Meter
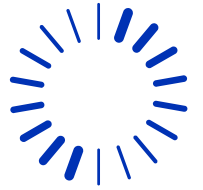
Main Features:

- Split module concept, very compact

- Cable lengths between Meter Unit and Sensor Unit: 30cm to 2m

- DCBM 400 I_{st} 320mA, I_{min} 4A, I_{tr} 8A, I_{max} 400A

- DCBM 600 I_{st} 480mA, I_{min} 6A, I_{tr} 12A, I_{max} 600A

- Voltage measurement from 150V to 1150V

- Bi-directional meter

- Class Accuracy B

- Supply voltage: 12V DC to 24V DC

- Meter Unit operating temperature range: -25°C to 70°C

- Sensor Unit operating temperature range: -40°C to 85°C

- Maximum Bus-bar operating temperature: 105°C

- IP 20 rating

- Instantaneous data provided with a refresh rate at 1Hz, Current, Voltage, temperature, Energy positive and negative

- Ethernet communication with HTTPS/REST protocol, NTP time synchro

- Fixe ip address or DHCP protocol

- Data encapsulated with OCMF protocol (SAFE, Software Alliance For E-mobility) and **signed data**

- Rated insulation voltage at 1000VDC, Reinforced according to the IEC 60664-1 standard (4400 VRMS isolation test voltage), PD2, OVC2, Impulse withstand voltage 1.2/50µs at 8kV, working altitude 2000m

- Certified DC meter compliant with **VDE-AR-E-2418-3-100**

DCBM
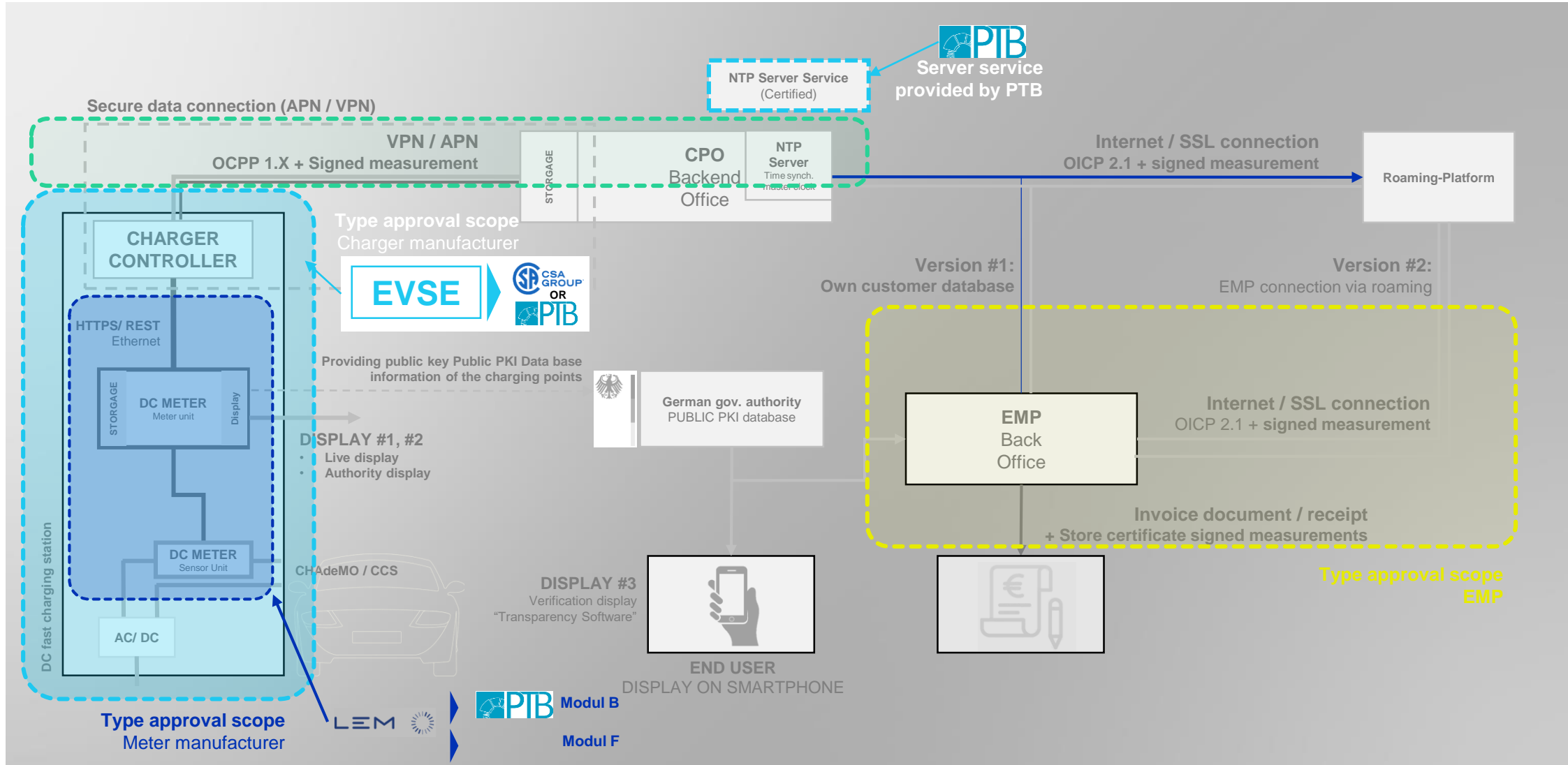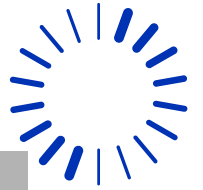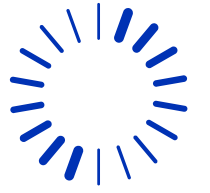## Global DC charger environment

DCBM
Certification level

Server service provided by PTB

NTP Server Service (Certified)

Secure data connection (APN / VPN)

VPN / APN
OCPP 1.X + Signed measurement

STORGAGE

CPO Backend Office

NTP Server
Time synch.
master clock

Internet / SSL connection
OICP 2.1 + signed measurement

Roaming-Platform

Type approval scope
Charger manufacturer

CHARGER CONTROLLER

EVSE ▶ CSA GROUP **OR** PTB

HTTPS/ REST
Ethernet

STORGAGE

DC METER
Meter unit

Display

Version #1:
Own customer database

Version #2:
EMP connection via roaming

Providing public key Public PKI Data base
information of the charging points

German gov. authority
PUBLIC PKI database

DISPLAY #1, #2
· Live display
· Authority display

EMP Back Office

Internet / SSL connection
OICP 2.1 + signed measurement

DC METER
Sensor Unit

CHAdeMO / CCS

AC/ DC

DISPLAY #3
Verification display
"Transparency Software"

END USER
DISPLAY ON SMARTPHONE

Invoice document / receipt
+ Store certificate signed measurements

Type approval scope
EMP

Type approval scope
Meter manufacturer

LEM

PTB **Modul B**

Modul F

DC fast charging station
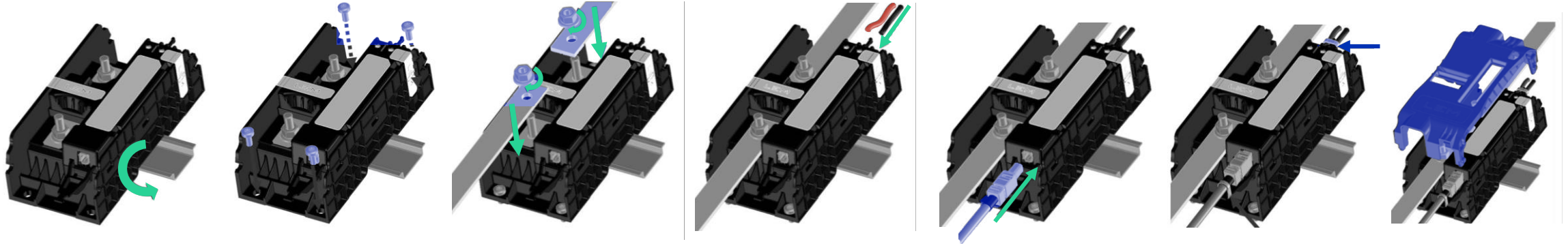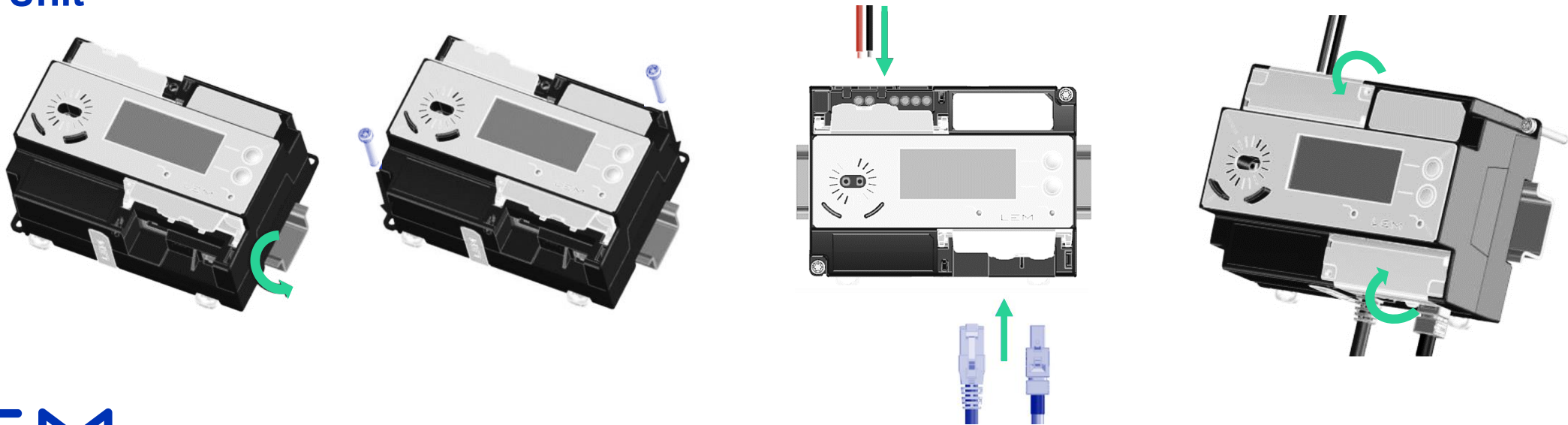
DCBM
Mechanical implementation & Sealing

Sensor Unit

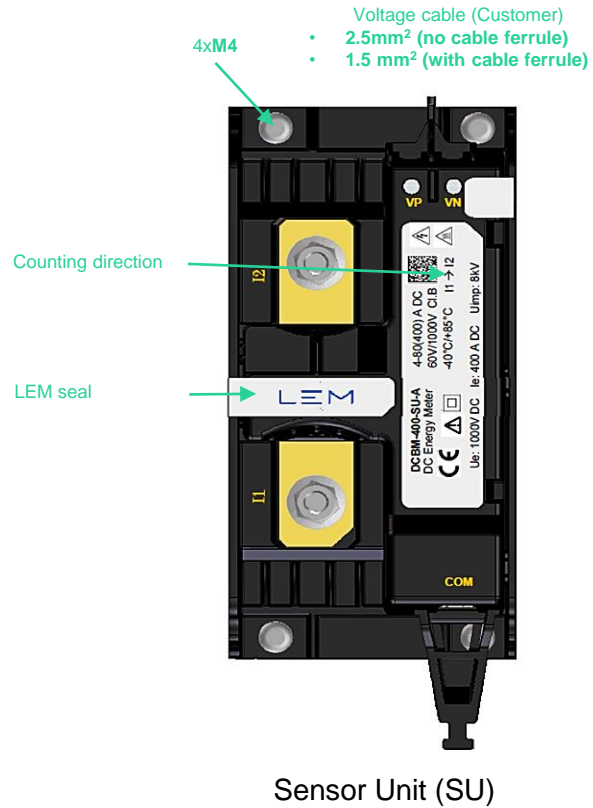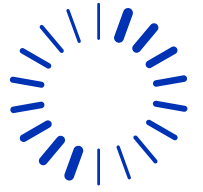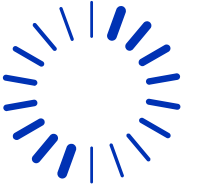**Meter Unit**

DCBM
Front face description

Sensor Unit (SU)

Sensor cover

Meter Unit (MU)

Sensor Unit (SU) labels:
- 4x **M4**
- Voltage cable (Customer)
  - **2.5mm² (no cable ferrule)**
  - **1.5 mm² (with cable ferrule)**
- Counting direction
- LEM seal

Meter Unit (MU) labels:
- Power Supply **12-24VDC**
- IR interface
- Customer sealing
- Legal information
  - **Public key**
  - **CE**
  - **Meter S/N**
  - **Year of production**
  - **Bi-directional meter**
- 2x push-button
- Calibration LED
- LCD (liquid crystal display)
- 2x **M4**
- Calibration sticker
- Customer sealing
- Ethernet (Customer)
- SU com. (LEM)

DCBM
Display integration

Advantages:

- DCBM display is certified and can do the role of

  - **Display #1:** Authority display, shows the correct operation of the meter to the government auditor

  - **Display #2:** Live display, show instantaneous data to the EV owner during the charge, like kWh, charging session duration…

- Legal and not legal relevant data are easily visible with two different backgrounds

- If you do not want to do an aperture to show LEM DC Meter display, DC charger HMI display must be certified by PTB to show legal relevant data.
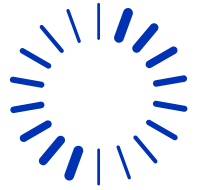
DCBM display

LEGAL RELEVANT DATA
WHITE BACKGROUND

NOT LEGAL RELEVANT DATA
BLACK BACKGROUND

Vision windows cutting recommendation
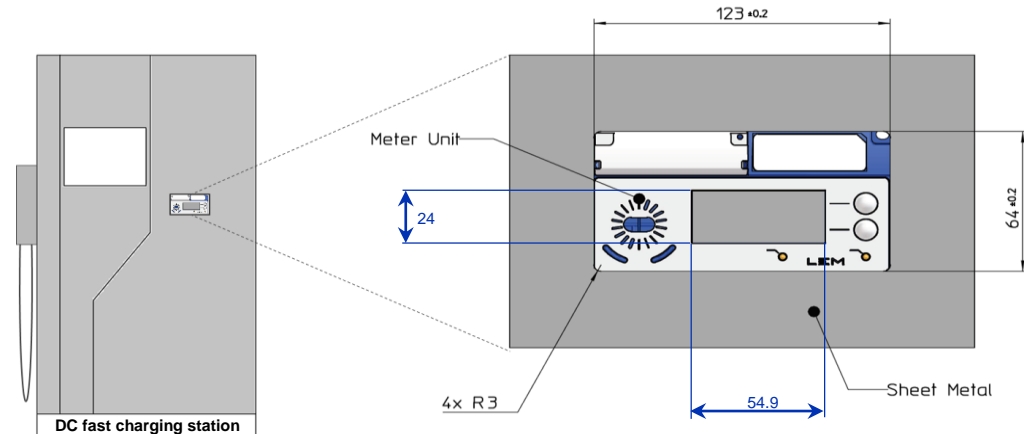
DCBM
Accuracy / Bidirectional meter

Advantages:

- DCBM has a Class Accuracy B (1%)

- PTB request a Minimum Class Accuracy A (2.5%)

PARAMETERS	DCBM 400	DCBM 600
I_{st} **(starting current)** Meter starts to count energy flow Accuracy not guaranteed by the meter	320mA	480mA
I_{min} **(minimum current)** Meter starts to guarantee the Class Accuracy B	4A	6A
I_{tr} **(transitional current)** value of current at and above which the smallest error of the meter starts	8A	12A
I_{max} Maximum current value of the meter with the Class Accuracy guarenteed	400A	600A
V_{min}	150V	150V
$V_{nominal}$	1000V	1000V
V_{max}	1150V	1150V
Accuracy	Class B	Class B

SU 400 Measured energy error

SU 600A Measured energy error
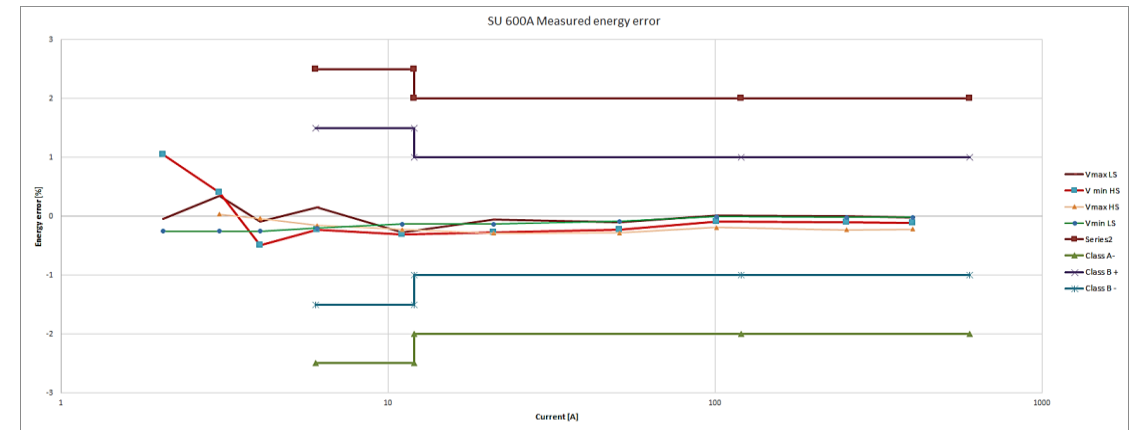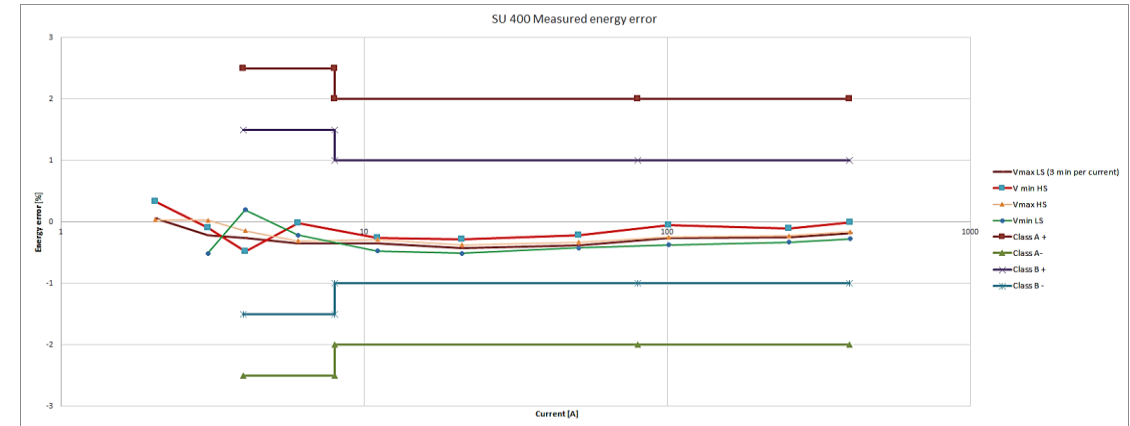
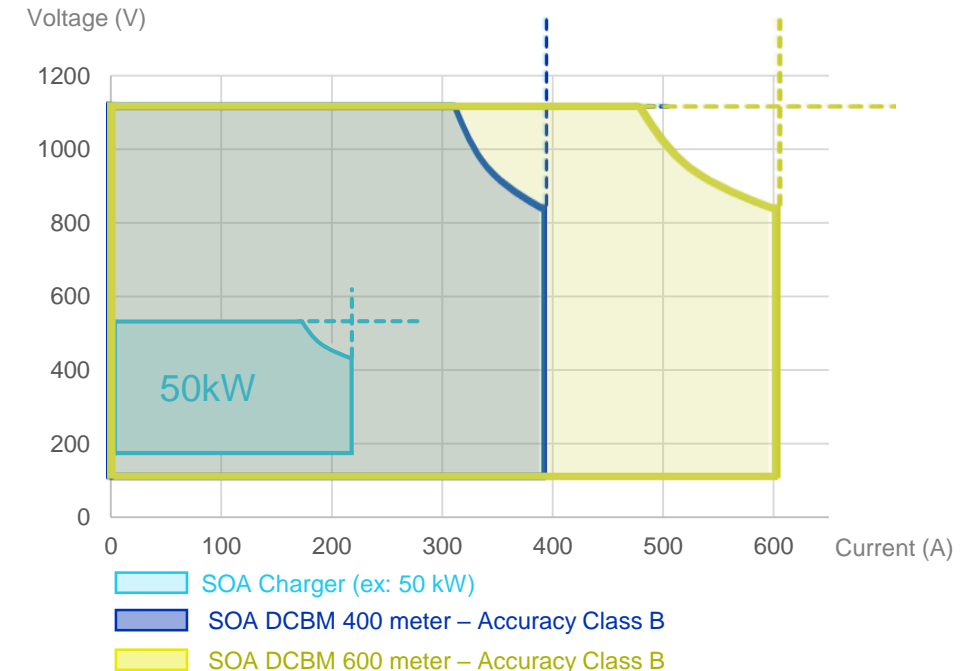# DCBM
DCBM compatibility table with charging power class
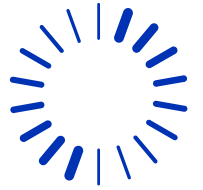
Power Class	Power range	Voltage range	Minimum current	DCBM Compatible
DC5	≥5kW	200V 500V	1A @ 500V	**DCBM 400**
DC10	≥10kW	200V 500V	1A @ 500V	**DCBM 400**
DC20	≥20kW	200V 500V	1A @ 500V	**DCBM 400**
DC50	≥50kW	200V 500V	1A @ 500V	**DCBM 400**
HPC150	≥150kW	200V 920V	5A @ 500V 5A @ 920V	**DCBM 400**
HPC250	≥250kW	200V 920V	5A @ 500V 5A @ 920V	**DCBM 600**
HPC350	≥350 kW	200V 920V	5A @ 500V 5A @ 920V	**DCBM600**

- SOA Charger (ex: 50 kW)
- SOA DCBM 400 meter – Accuracy Class B
- SOA DCBM 600 meter – Accuracy Class B

From definition, for PTB, it must be clear that the Shut-Off current of the charging station must be above I_{start} of the meter

DCBM
Interface
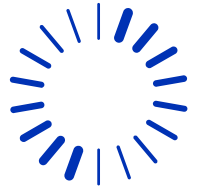
Prerequisite
- Set the UTC time at least once a day
- Time sync expire after **48h / Flag** is raised
- Transaction are refused if not done

Initialization
- IDs are sent to the Meter
- evseId, transactionId, clientId, tarrifId, cableId

Charging session
- To start a transaction a **run start.ps1** command is sent
- During a session instantaneous data are readable with each second (1Hz) with a **run read.ps1** command
- Current, Voltage, Energy (positive/negative), bus-bar temperature
- To stop a transaction a **run stop.ps1** command is sent
- Current, Voltage, Energy (positive/negative), bus-bar temperature
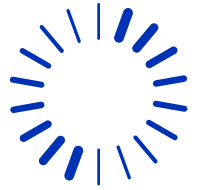
Billing data
After the stop command LEM meter send the billing with LEM legal format for transaction with
- Paginmation
- IDs
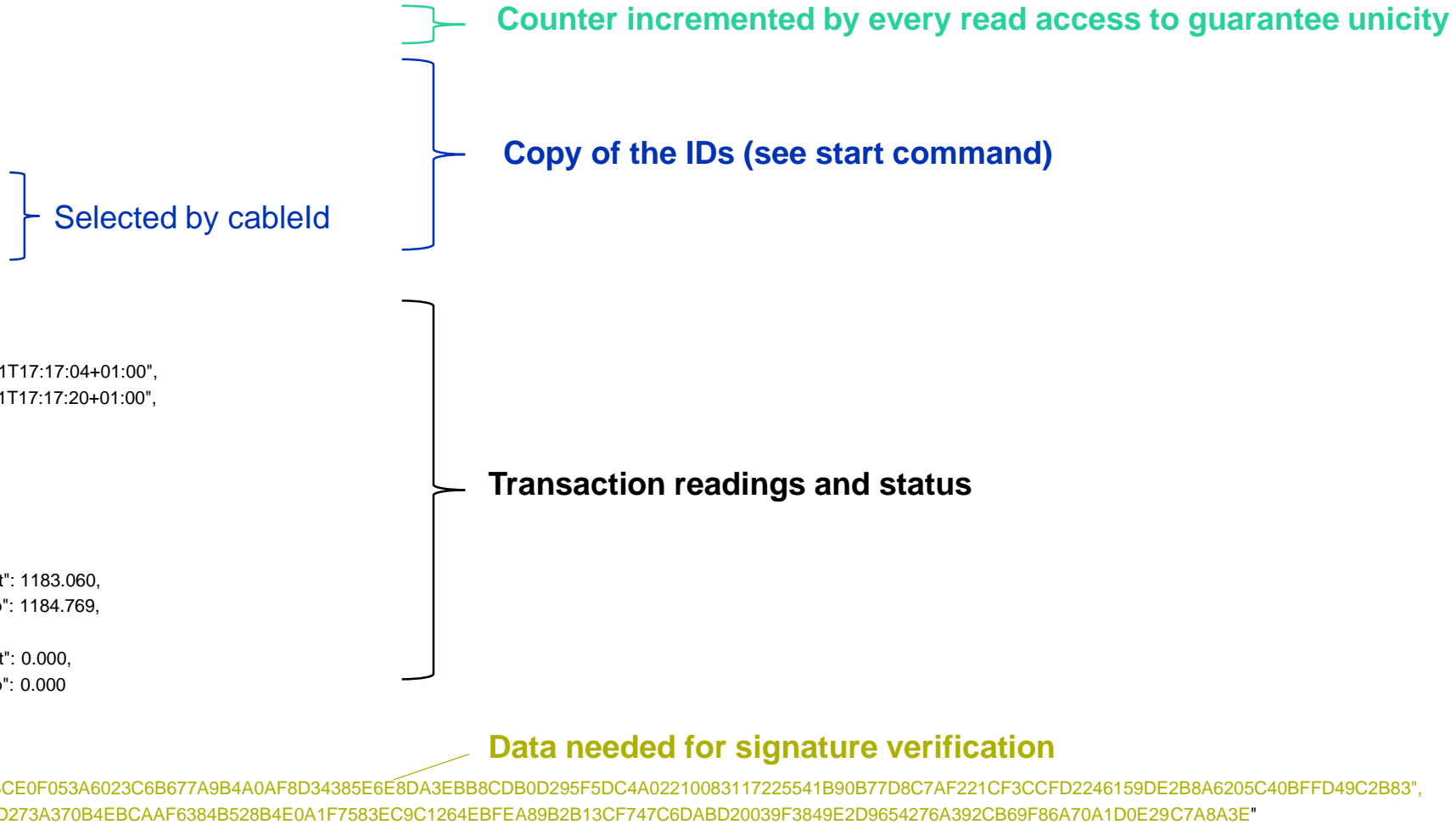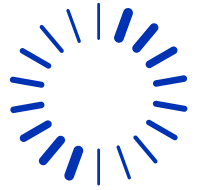- Transaction readings and status
- Signatures for verifiation
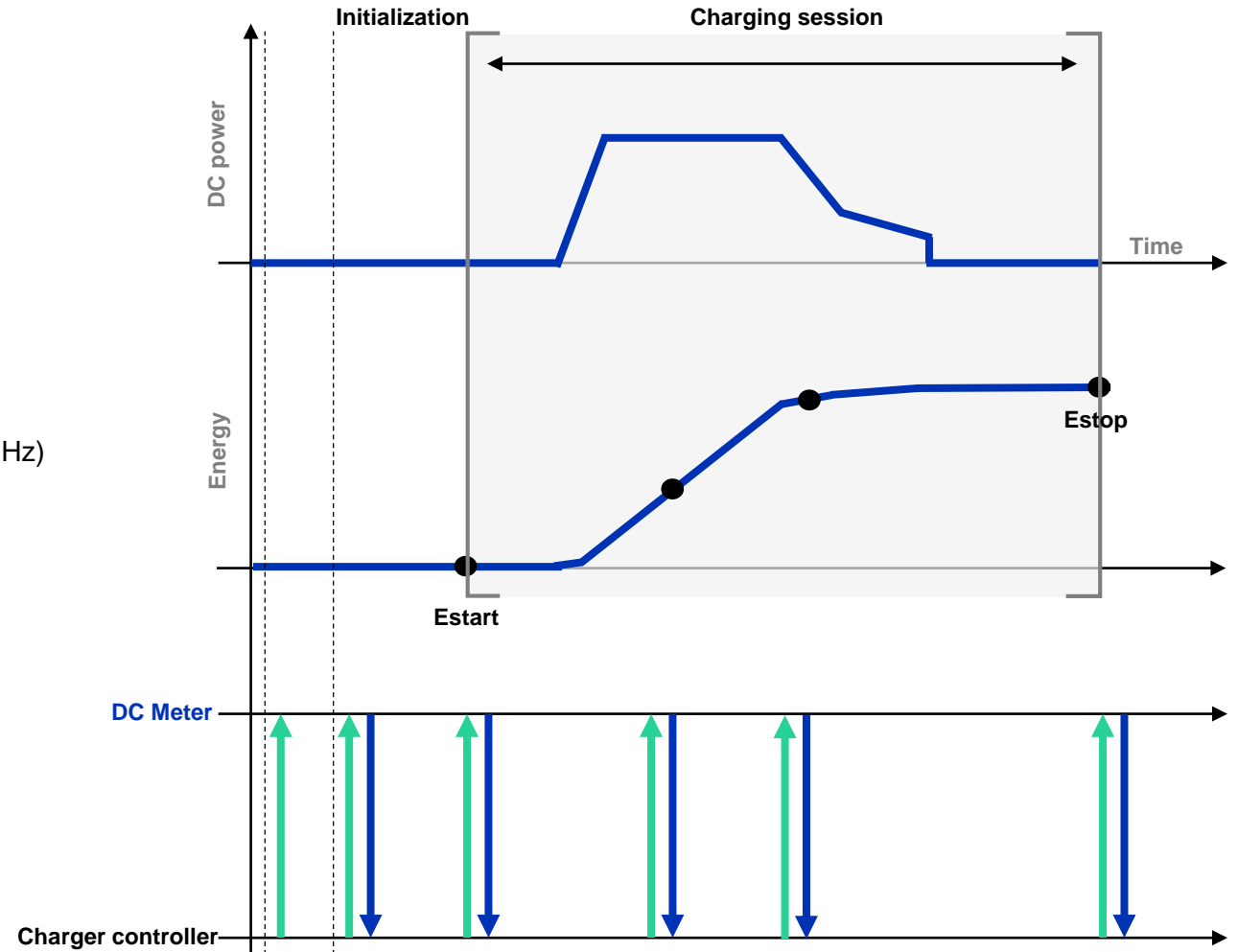
```
{
"paginationCounter": 2,
"transactionId": "demo1234",
"evseId": "+49*DEF*E123ABC",
"clientId": "12",
"tariffId": 0,
"cableSp": {
    "cableSpName": "0 mohm",
    "cableSpId": 0,
    "cableSpRes": 0
},
"userData": "",
"meterValue": {
    "timestampStart": "2019-12-11T17:17:04+01:00",
    "timestampStop": "2019-12-11T17:17:20+01:00",
    "transactionDuration": 16,
    "intermediateRead": false,
    "transactionStatus": 25,
    "sampleValue": {
        "energyUnit": "kWh",
        "energyImport": 1.709,
        "energyImportTotalStart": 1183.060,
        "energyImportTotalStop": 1184.769,
        "energyExport": 0.000,
        "energyExportTotalStart": 0.000,
        "energyExportTotalStop": 0.000
    }
},
"meterId": "MU_ID_123456",
"signature": "3046022100E829A3CE0F053A6023C6B677A9B4A0AF8D34385E6E8DA3EBB8CDB0D295F5DC4A02210083117225541B90B77D8C7AF221CF3CCFD2246159DE2B8A6205C40BFFD49C2B83",
"publicKey": "C47DDE84F44D86D273A370B4EBCAAF6384B528B4E0A1F7583EC9C1264EBFEA89B2B13CF747C6DABD20039F3849E2D9654276A392CB69F86A70A1D0E29C7A8A3E"
```

Counter incremented by every read access to guarantee unicity

Copy of the IDs (see start command)

Selected by cableId

Transaction readings and status

Data needed for signature verification

DCBM
Flag

Flags

Temperature detection on Sensor Unit

- Flag appears if the temperature is over **140°C**
- No associated action
- Reported in the transaction status

Time synchronization detection on Sensor Unit

- Time sync expire after **48h**
- Flag is raised
- Transaction are refused

Time synchronization detection on Sensor Unit

- We detect if **voltage probe are misconnected** ("reverse voltage")
- forbids a transaction start until the voltage connectors are reversed
- the meter shall be restarted

Memory

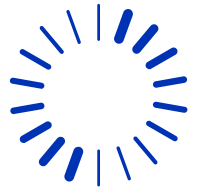#### Billing transaction, storage period

- **22'000 charging sessions** can be stored
- Storage period varies in function of number of transactions/day
- With assumption of **50 transactions/day**, **14 months** can be stored in meter unit.
- 50 transactions/day represent 1 session every 28 minutes round the clock

Logbook

- The logbook can contain up to **43'690** events
- 33 types of event can be recorded

Thank you

LEM