DC Energy and DC Power Quality Reference Systems

Guglielmo Frigo

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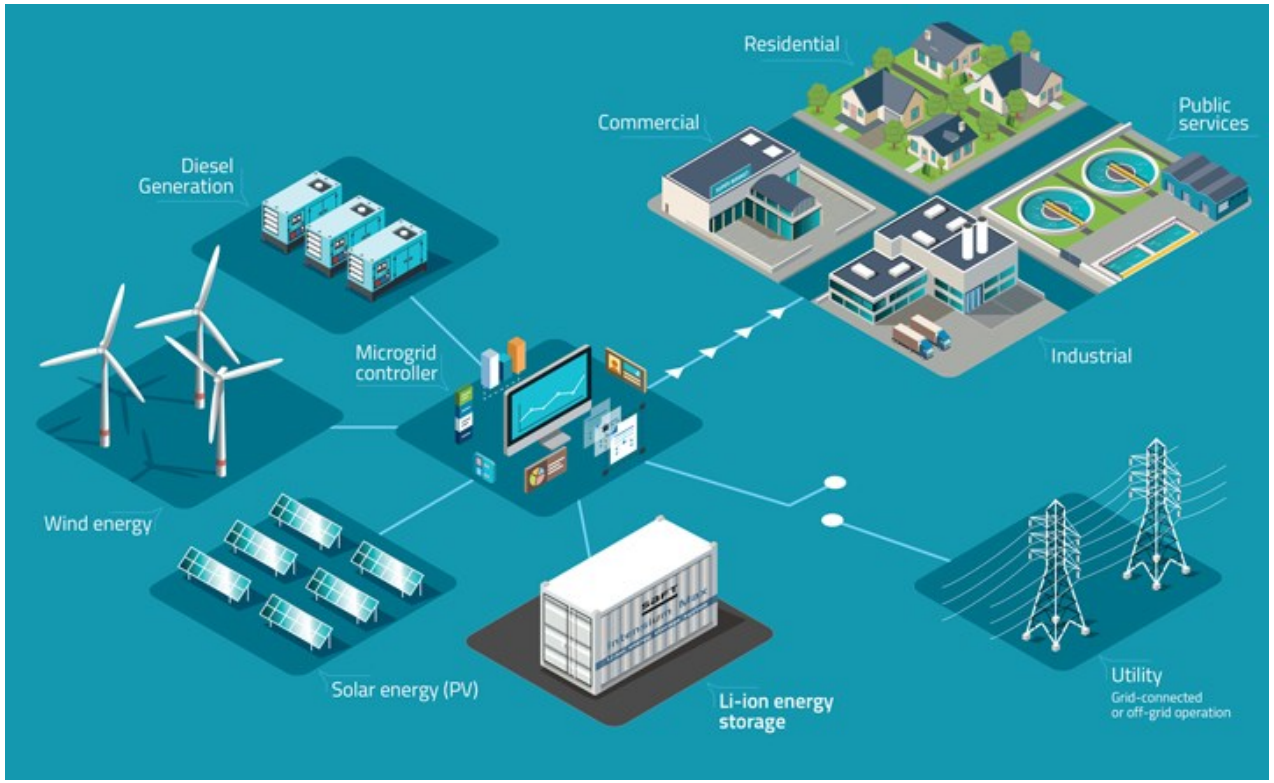
Content

1. DC Microgrids’ Scenario
2. Challenges in DC Metering
3. Coordinated Metrology Effort
4. Example of Reference System
5. Comparison and Validation
6. Conclusions and Next Steps

DC Microgrids

In recent years, DC microgrids are becoming more and more popular solutions for **energy communities** or smaller sites (e.g., airports, railway stations) where **load profiles** can be foreseen with sufficient accuracy.



source: https://www.aceongroup.com/

PROs

- Improved conversion efficiency
- Higher flexibility and reliability

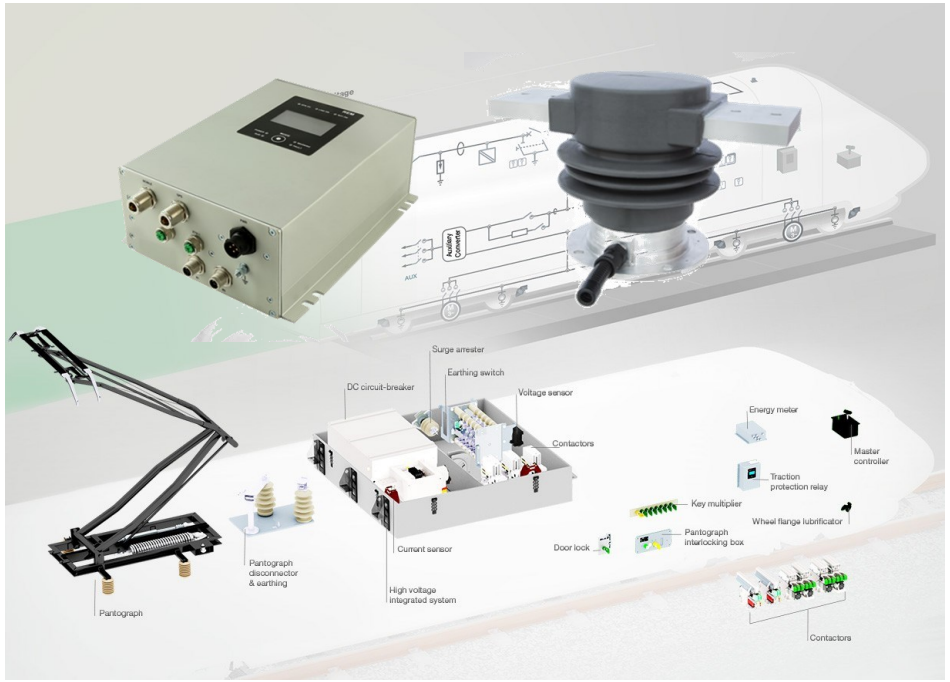
CONs

- Interference from (to) AC side
- Lack of metrology infrastructure

DC Revenue Metering

The measurement infrastructure is mainly related to **safety** or **revenue metering** applications.

source: https://eepower.com/



source: https://www.secheron.com/

Normative Open Issues

IEC 62052-11:2020

DC power is the product of DC voltage and current, in turn defined as the **average value** of voltage and current signals.

- *Which sampling rate?*
- *Which averaging interval?*
- *Which reporting / update rate?*
- *Which ADC front-end bandwidth?*

EN 50470-4:2023

Frequencies **up to 10 Hz** shall be considered part of the measurand and the averaging interval shall be **long enough** to minimize the effect of AC power components.

- *Is ripple noise or (active) power?*


IEC 62052-11

Edition 2.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONAL

Electricity metering equipment – General r
conditions –
Part 11: Metering equipment

Équipement de comptage de l'électricité –
conditions d'essai –
Partie 11: Équipement de comptage

EUROPEAN STANDARD EN 50470-4

NORME EUROPÉENNE

EUROPÄISCHE NORM August 2023

ICS 91.140.50

English Version

Electricity metering equipment - Part 4: Particular requirements - Static meters for DC active energy (class indexes A, B and C)

Équipement de comptage de l'électricité - Partie 4: Exigences particulières - Compteurs statiques d'énergie active en courant continu (indices de classe A, B et C)

Elektrizitätszähler - Teil 4: Besondere Anforderungen - Elektronische Wirkverbrauchszähler für Gleichstrom der Genauigkeitsklassen A, B und C

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DC grids – WP3

The project **DC grids** aims at setting up an **improved metrology infrastructure** for DC power & energy meters.

DC Power Reference System

Pure DC conditions
- DC Voltage: 0 → 1000 V
- DC Current: 0 → 800 A

Distorted DC conditions
- AC Magnitude: 0 → 10 %
- AC Frequency: 100 mHz → 150 kHz

Power quality disturbances
- Sinusoidal & triangular ripple
- (Voltage) dip and swells

1 METAS (CH)

2 INRiM (IT)

3 LNE (FR)

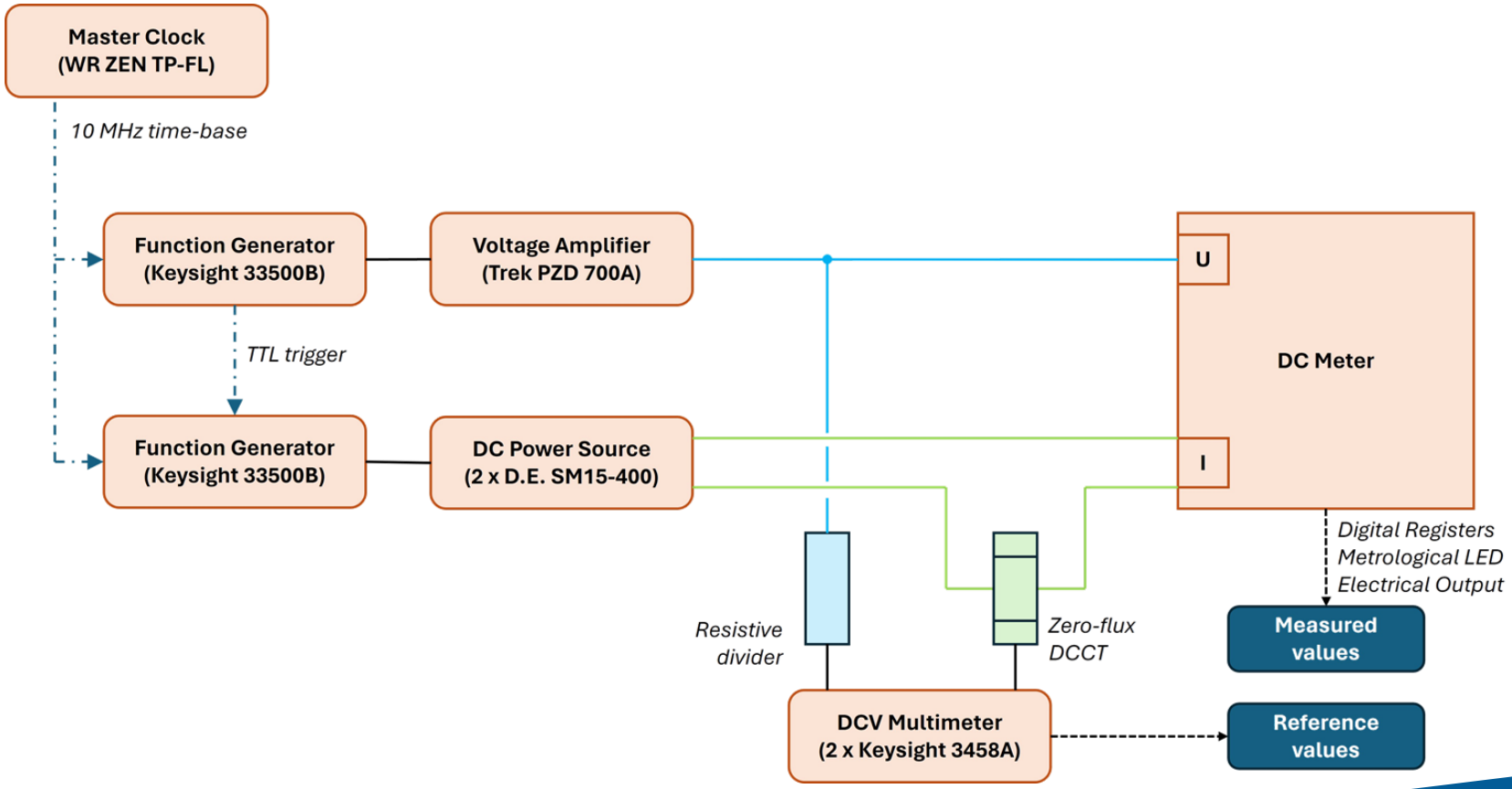
4 VSL (NL)

5 PTB (DE)

source: https://european-union.europa.eu/

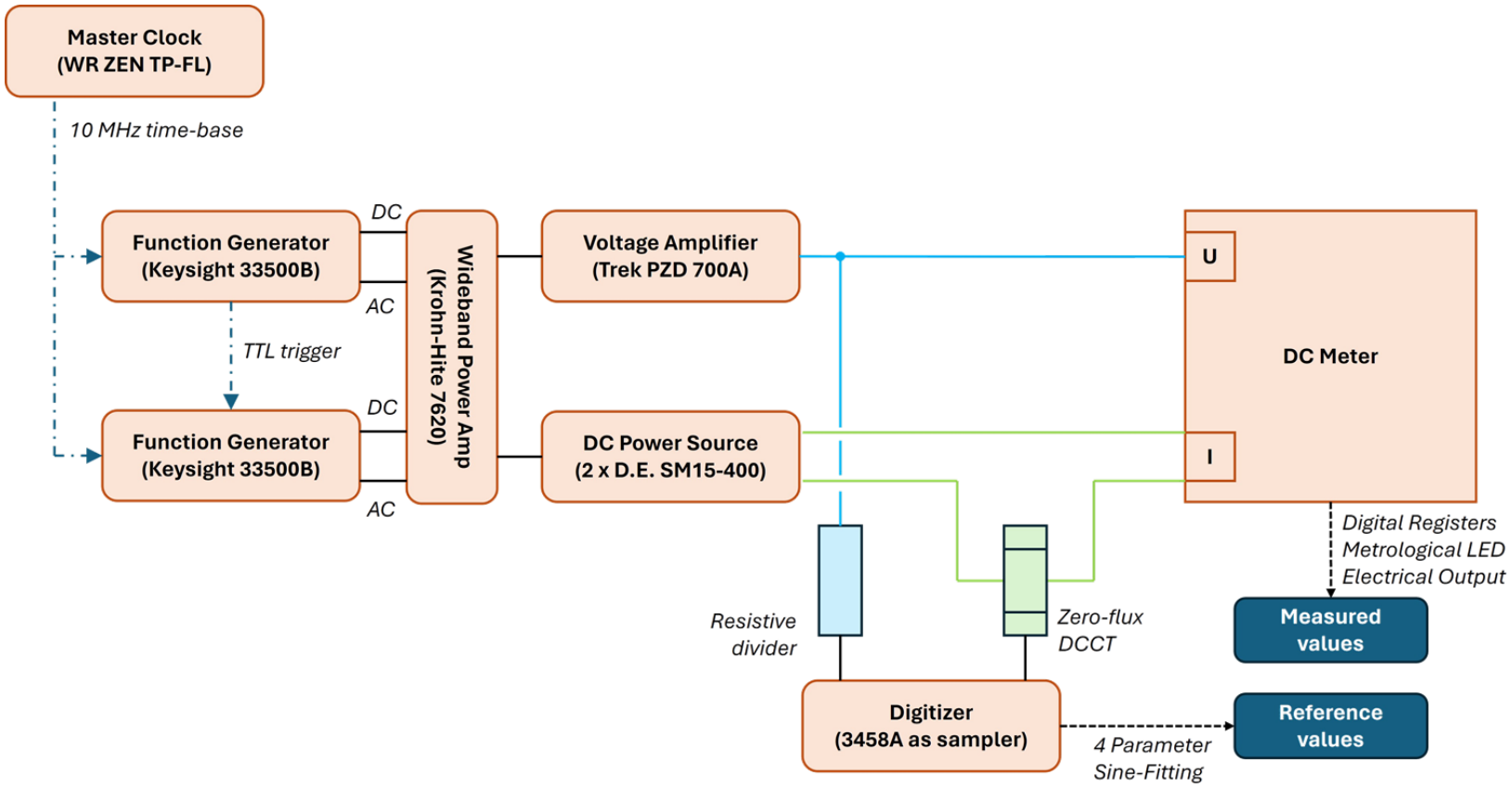
METAS Reference System

The measurement setup for meter testing in **pure DC conditions** (voltage up to 700 V, current up to 800 A).



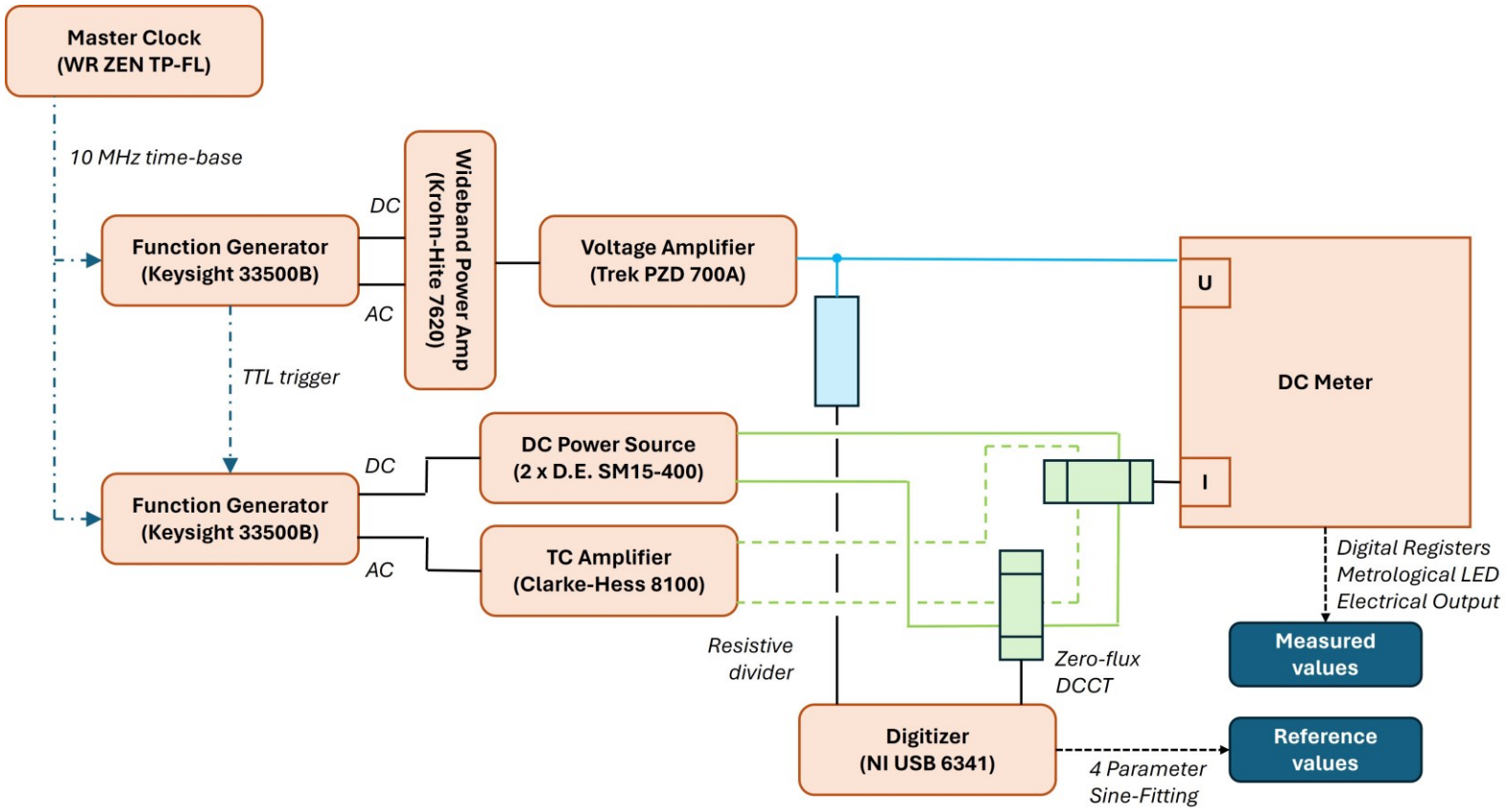
METAS Reference System

The measurement setup for meter testing in **LF distorted conditions** (magnitude & frequency up to 10% & 300 Hz).



METAS Reference System

The measurement setup for meter testing in **HF distorted conditions** (magnitude & frequency up to 10% & 150 kHz).



Inter-Lab Comparison

The validation of the reference systems has been carried out by means of an **inter-laboratory comparison** between METAS, INRiM and VSL.

NI cRIO 9068

source: https://www.ni.com/

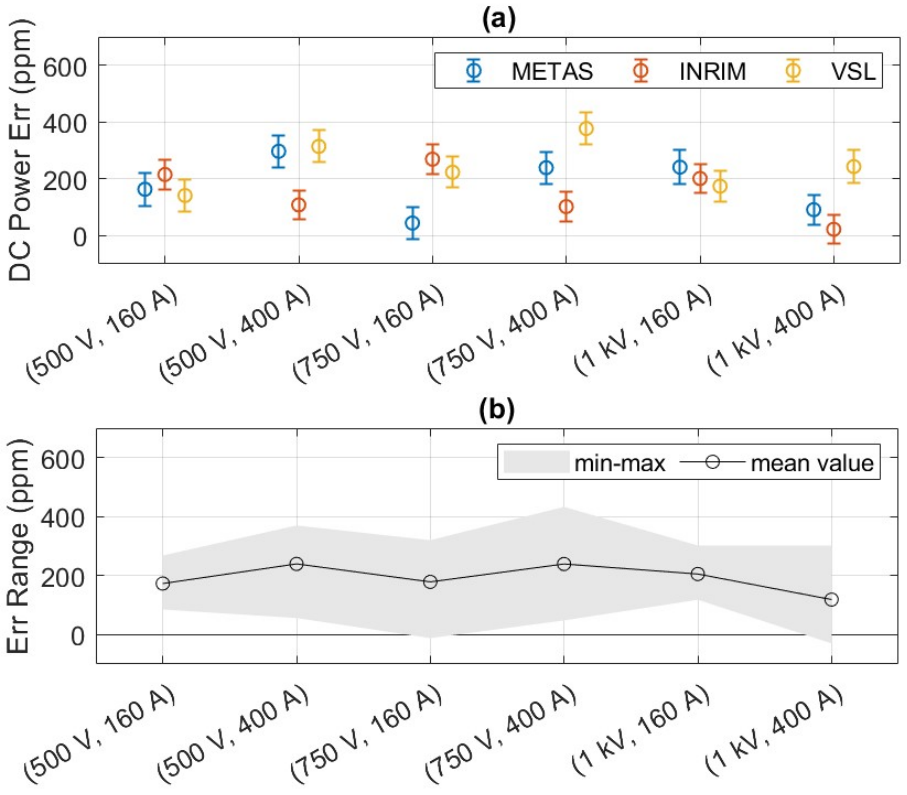
NI 9205

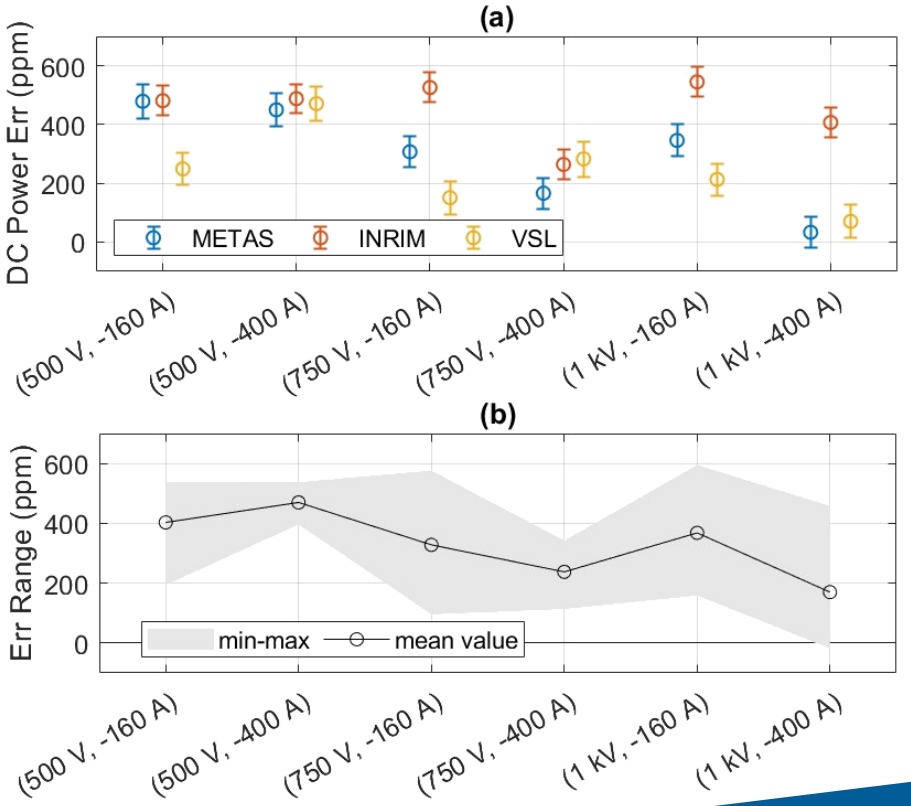
TRANSFER STANDARD

- FPGA controlled acquisition
- 100 kHz sampling rate
- Averaging interval 200 ms
- Adjustable rate (10, 5, 1, 0.2)
- 16-bit vertical resolution

Comparison Results – Pure DC

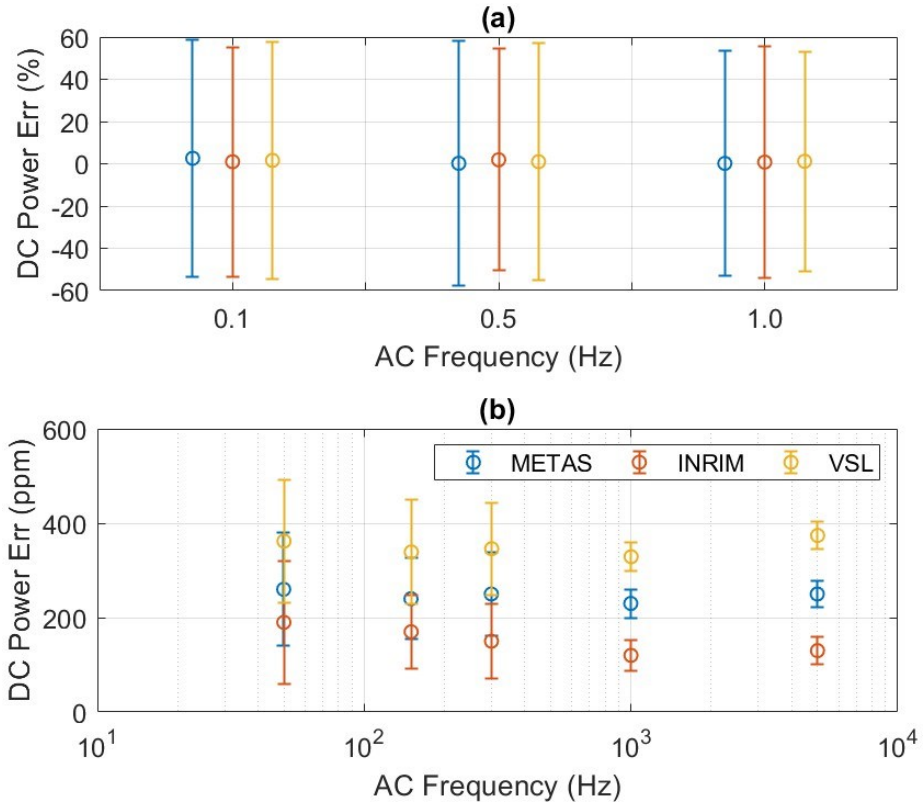
The comparison between the results in Pure DC tests shows an **excellent consistency**.





Comparison Results – Distorted DC

In the presence of AC distortions, it is evident the **discrepancy** between **lower (< 10 Hz) and higher AC frequencies**.

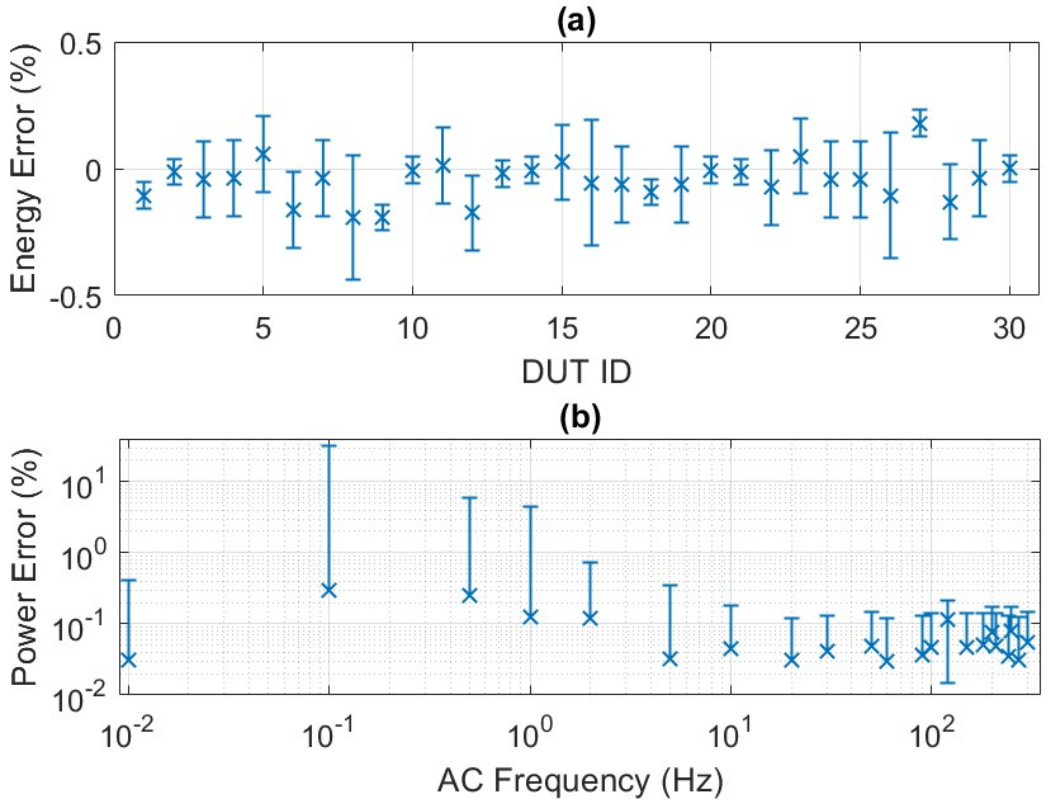


TEST CONFIGURATION

- DC Voltage: 750 V
- DC Current: 500 A
- AC Magnitude: 75 V
- AC Frequency: 0.1 – 5000 Hz
- Cos Phi: Random

Test on Commercial Device

Similar results have been obtained on a set of **30 commercial devices**, namely DZG GSH01 meters (class 1.0).



source: https://www.dzg.de/

Conclusions

- DC microgrids are **promising solution** for a more efficient integration of renewable energy sources.
- Injections of **AC components** and similar **PQ events** are not contemplated in current normative.
- There exist **metrology challenges** from both a technological and a methodological point of view.
- Development, characterization and validation of **reference systems** in several NMIs.
- Need for further analysis to set a well-acknowledged **definition of DC power** (energy).

Questions?

Guglielmo Frigo, PhD
Electrical Energy and Power Lab
Federal Institute of Metrology

guglielmo.frigo@metas.ch

guglielmo.frigo

METAS
Ihre Referenz.

Schweizerische Eidgenossenschaft
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Eidgenössisches Institut für Metrologie METAS