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astrolkwx
power electronics solutions

Unexpected power supply failures in complex electrical systems

Understanding the unkown, by visualizing the unseen

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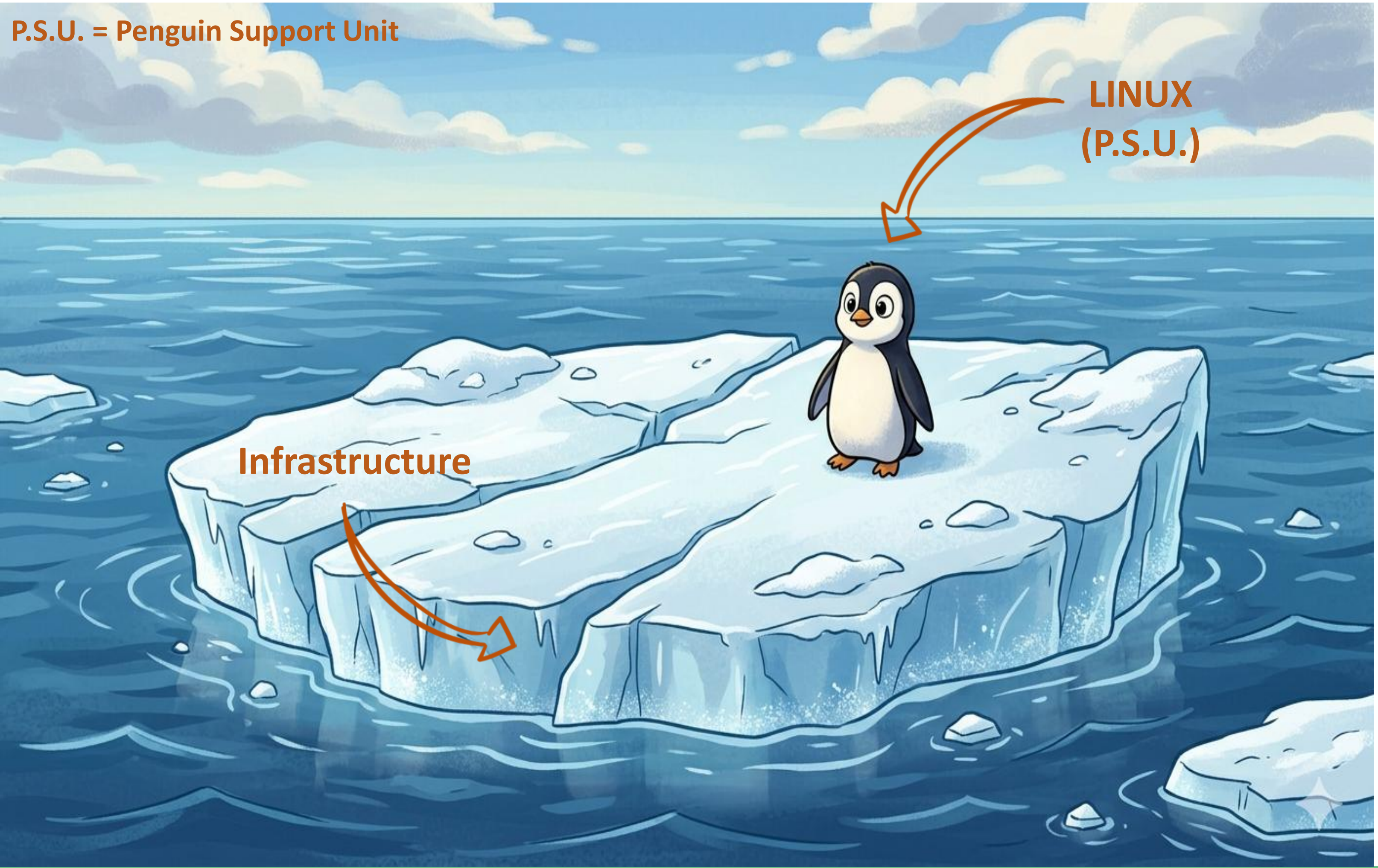
UNEXPECTED POWER SUPPLY FAILURES IN A NUTSHELL



Regulatory View:
- This is a certified penguin (standardized size and weight)

Technical View:
- The penguin introduces a load to the ice
- The ice can support the penguins weight
- The penguin has enough space on the ice

The Verdict:

✓ Regulatory, everything is fine

✓ Technically, everything is fine

UNEXPECTED POWER SUPPLY FAILURES IN A NUTSHELL

Regulatory View:
- Each individual penguin is certified (standardized size and weight)

Technical View:
- The ice can support the weight
- The ice can **not** support the size
- The penguins are harming each other

The Verdict:

✓ Regulatory, everything is fine
✗ Technically, there are some challenges

Conclusions that can be dawn:

✓ Weight-wise, the ice could support more
✗ Size-wise, the ice can **not** support more

UNEXPECTED POWER SUPPLY FAILURES IN A NUTSHELL

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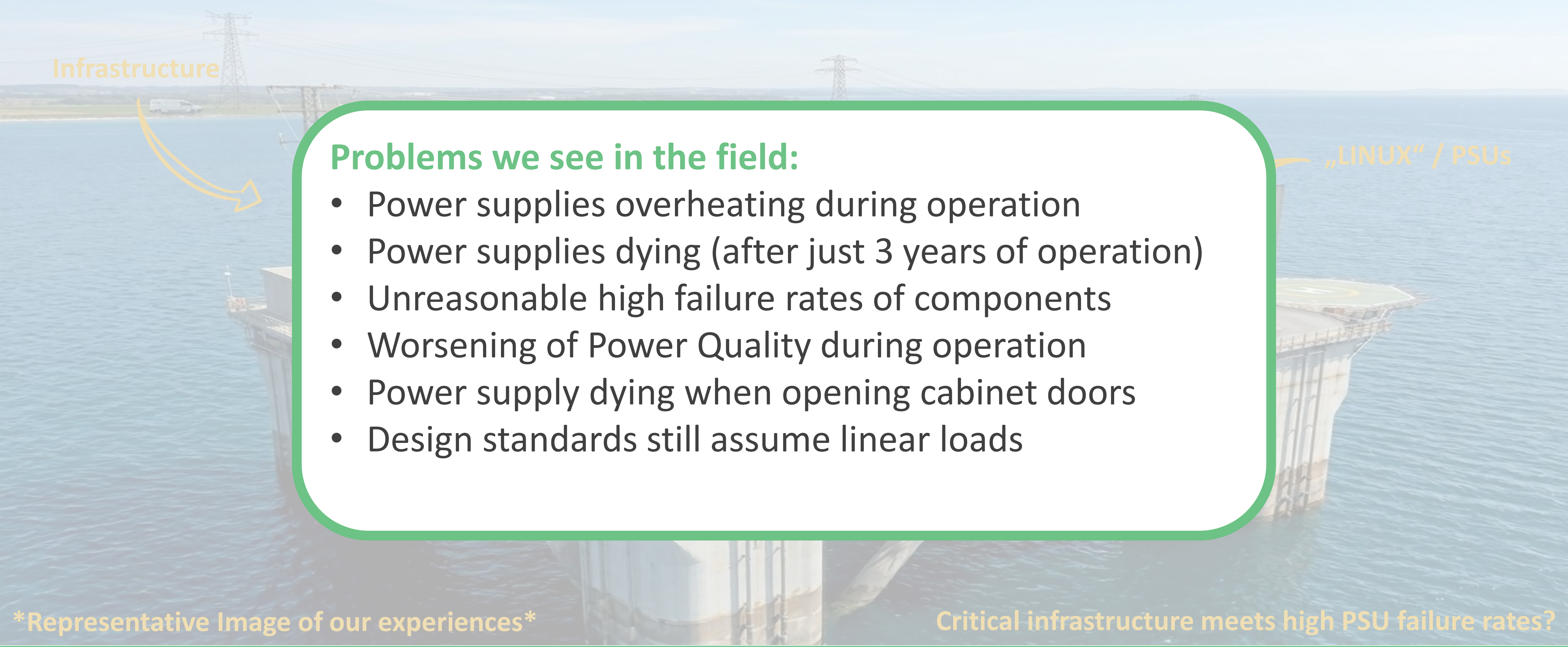


Problems we see in the field:

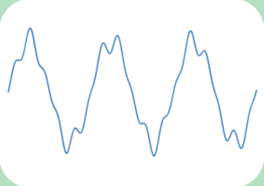
- Power supplies overheating during operation
- Power supplies dying (after just 3 years of operation)
- Unreasonable high failure rates of components
- Worsening of Power Quality during operation
- Power supply dying when opening cabinet doors
- Design standards still assume linear loads

Representative Image of our experiences

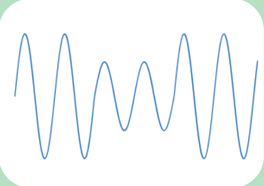
Critical infrastructure meets high PSU failure rates?

ASPECTS OF POWER QUALITY

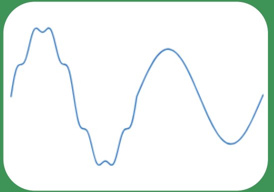
FLICKER



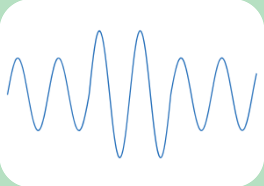
SAGS



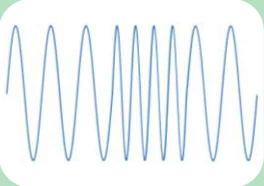
HARMONICS



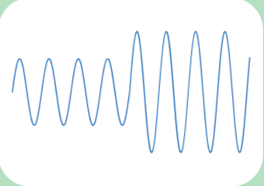
SWELLS



FREQUENCY DEVIATION

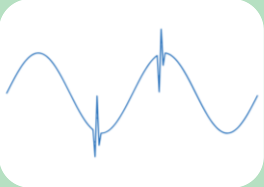


OVER/UNDERVOLTAGE

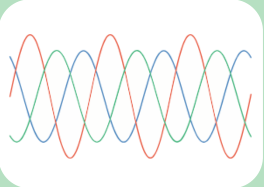


INTERRUPTIONS

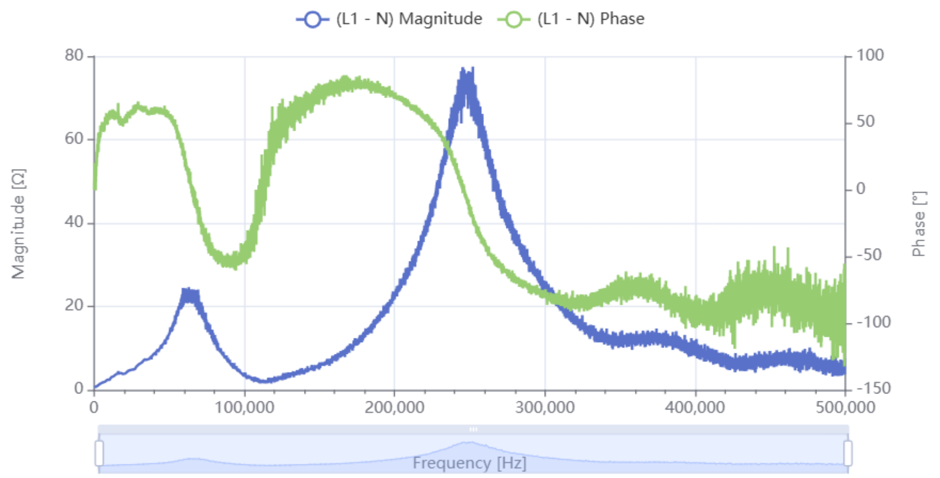
TRANSIENTS



UNBALANCE



SPECTRAL IMPEDANCE

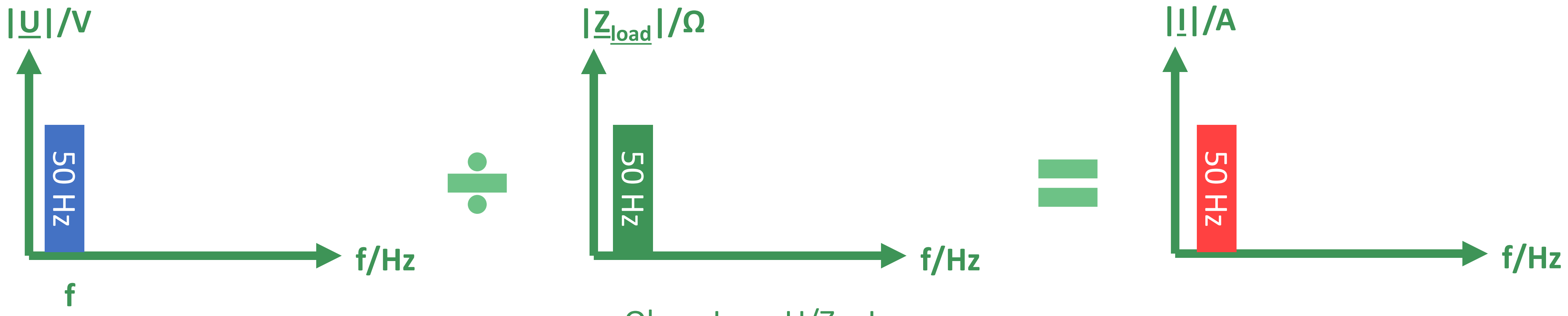


POWER QUALITY: CAUSE-AND-EFFECT CHAIN

$$\underline{Z}_{load} = R + jX = |\underline{Z}| \cdot \exp(j\varphi)$$

$$\underline{Z}_{load} = R$$

Linear networks do not change frequency

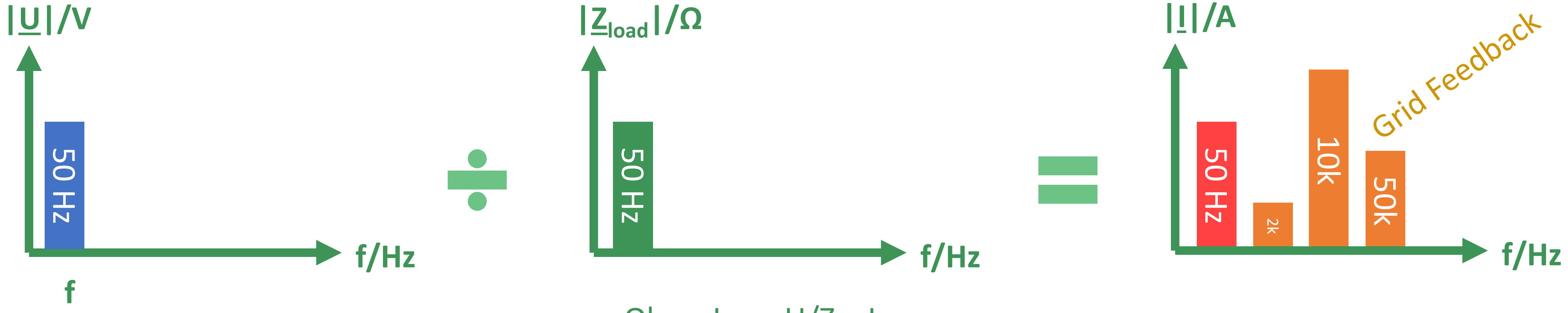


Ohms Law: U/Z = I

POWER QUALITY: CAUSE-AND-EFFECT CHAIN

Non-linear networks can change/add frequency

Inverters/SMPS are frequency converters: They convert 50 Hz grid voltage to broadband spectral current emission: „Grid Feedback"



Ohms Law: U/Z = I

POWER QUALITY: CAUSE-AND-EFFECT CHAIN

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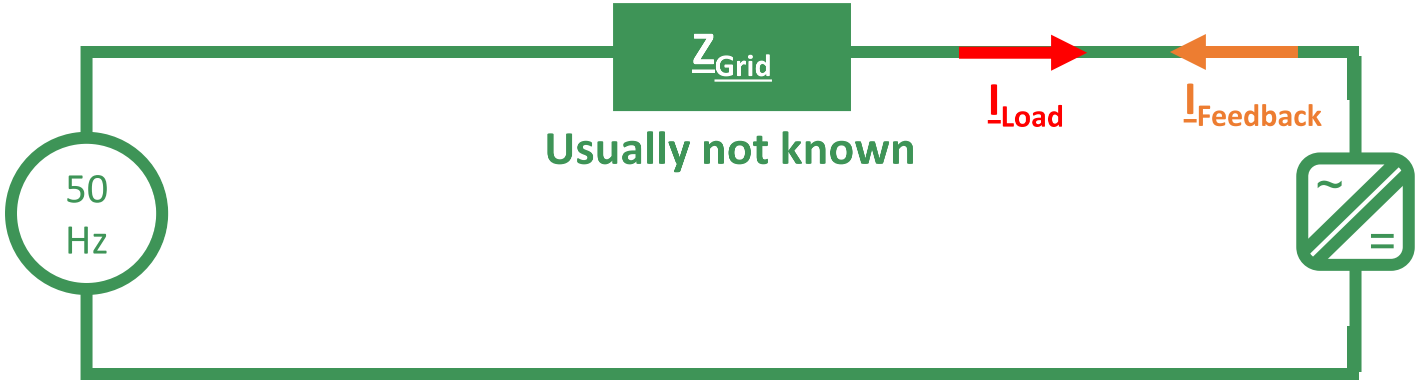
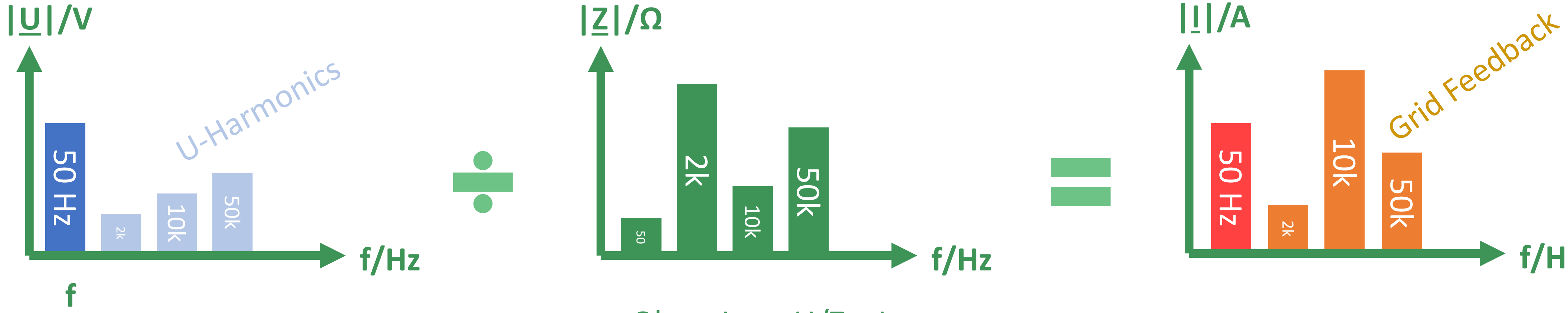


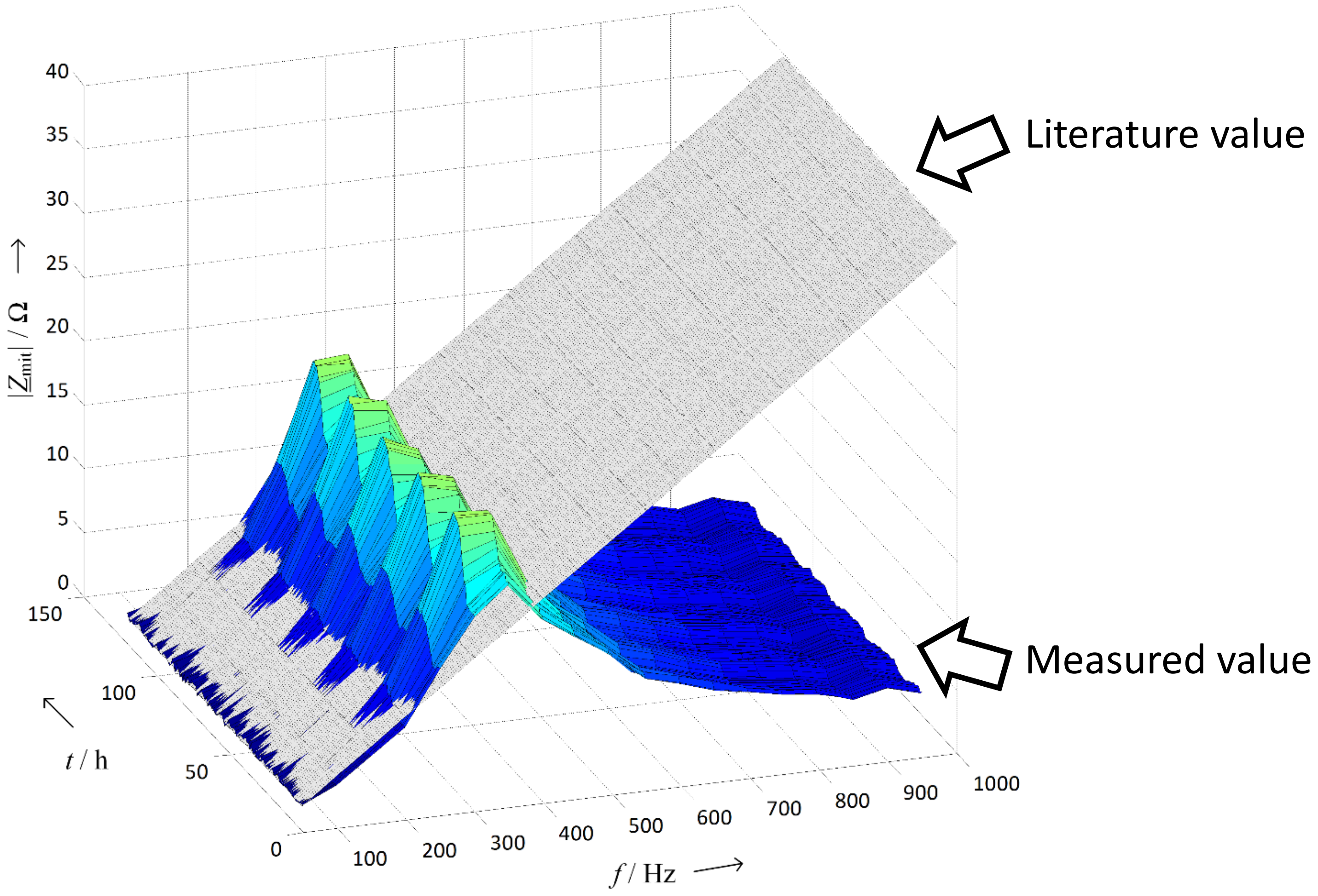
Voltage harmonics are created due to spectral current & impedance

Inverters/SMPS are frequency converters: They convert 50 Hz grid voltage to broadband spectral current emission: „Grid Feedback“



Ohms Law: U/Z = I

CHARACTERISTICS OF SPECTRAL GRID IMPEDANCE



The spectral grid impedance is:

- Location-dependent (wires & couplings)
- Time-dependent (topology & load)
- Difficult to simulate (unkown parameters)

COMPANY INTRODUCTION

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astrolKWX
power electronics solutions

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MORENERGY PRODUCT PORTFOLIO

- Online Network Impedance Spectrometer (ONIS)
- Power Quality analysis
- Voltage and Current spectrum analysis

ONISgo

400V, 50kHz
Spectral Grid Impedance

ONIS1000

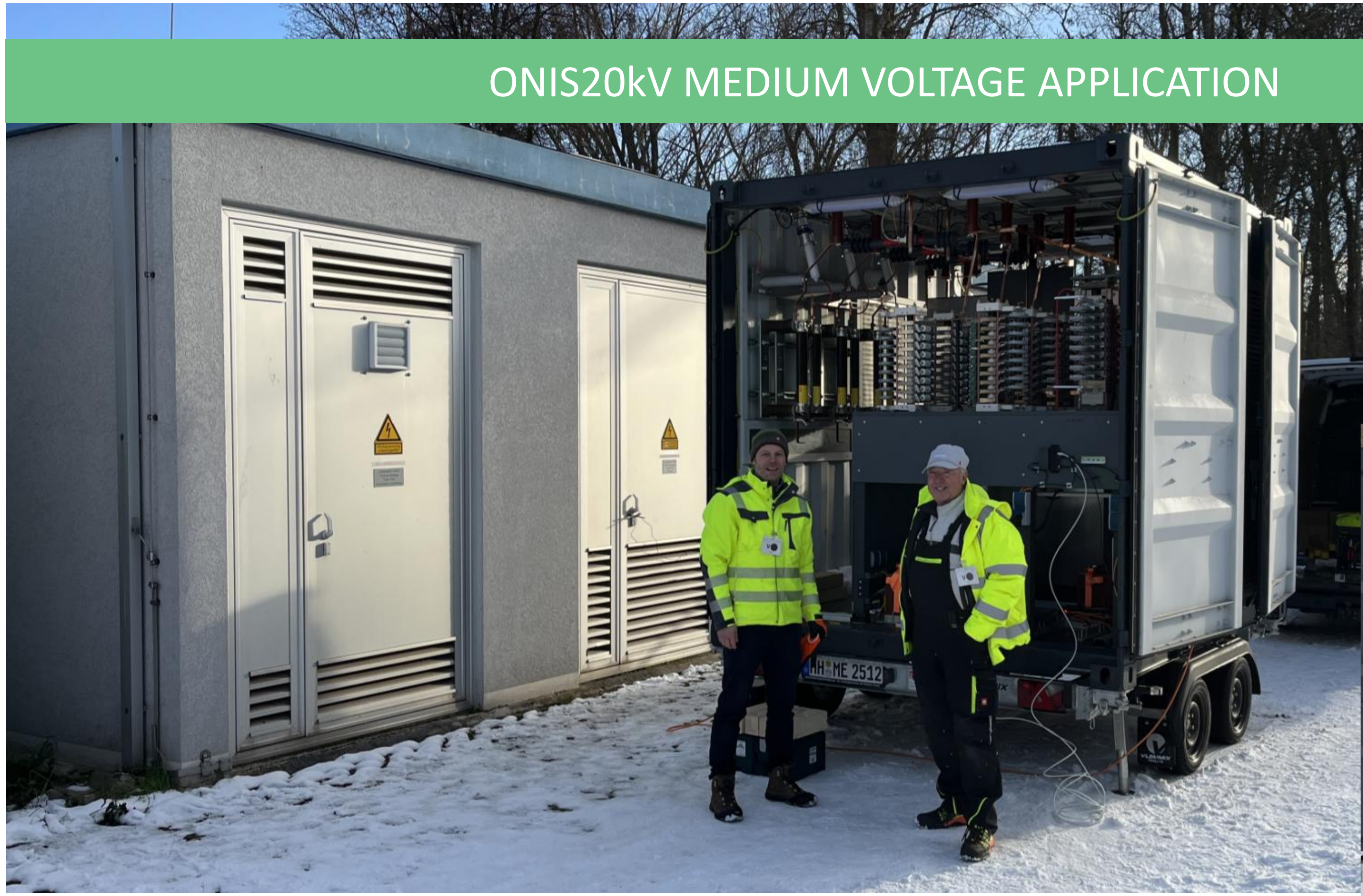
690 V, 500 kHz
Spectral Grid Impedance
Power Quality

ONIS20kV

20 kV, 150 kHz
Spectral Grid Impedance

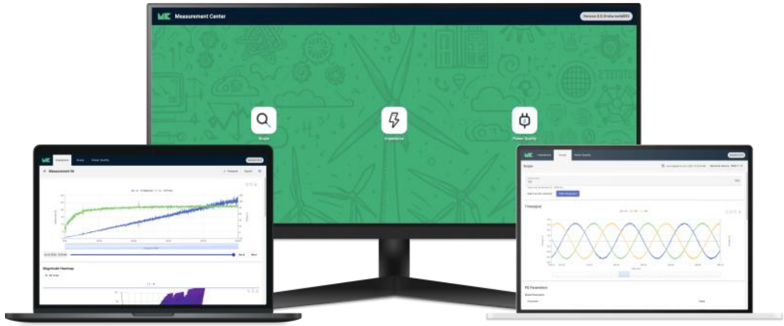
MORENERGY PRODUCT PORTFOLIO

ONIS20kV MEDIUM VOLTAGE APPLICATION



MORENERGY BUSINESS CLUSTERS

Hardware
Sales and Rental



gridDNA
Custom Solutions

ONIS SYSTEM

Online Network Impedance Spectrometer

PQ OR PQ+

Standard Power Quality or Power Quality Plus with up to 500 kHz U/I recording

GridDNA Digital Twin

- Generation of Digital Twins and Simulations
- Developing recommendations / action plans tailored to you business

RESULT

Custom software / hardware solution to problems you are facing in your grid or plant

Academy
Teaching and Training

BREAKING DOWN THE PROBLEM

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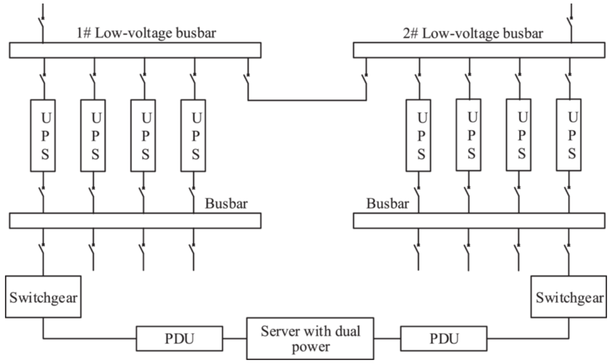
Device Impedance

Origin:
- Internal components (filter)
- Control algorithms

Effect:
- Harmonics absorption
- Harmonics amplification

Grid Impedance



Origin:
- Grid, wires and transformers
- Connected loads/generators

Effect:
- Distribution of spectral power
- Harmonic levels

Common-Mode Impedance

Origin:
- Symmetry-forcing processes
- Component/Isolation faults

Effect:
- Current flow in metal objects
- Unpredictable current paths

DIFFERENCE IN DEVICE IMPEDANCE: HEALTH MONITORING

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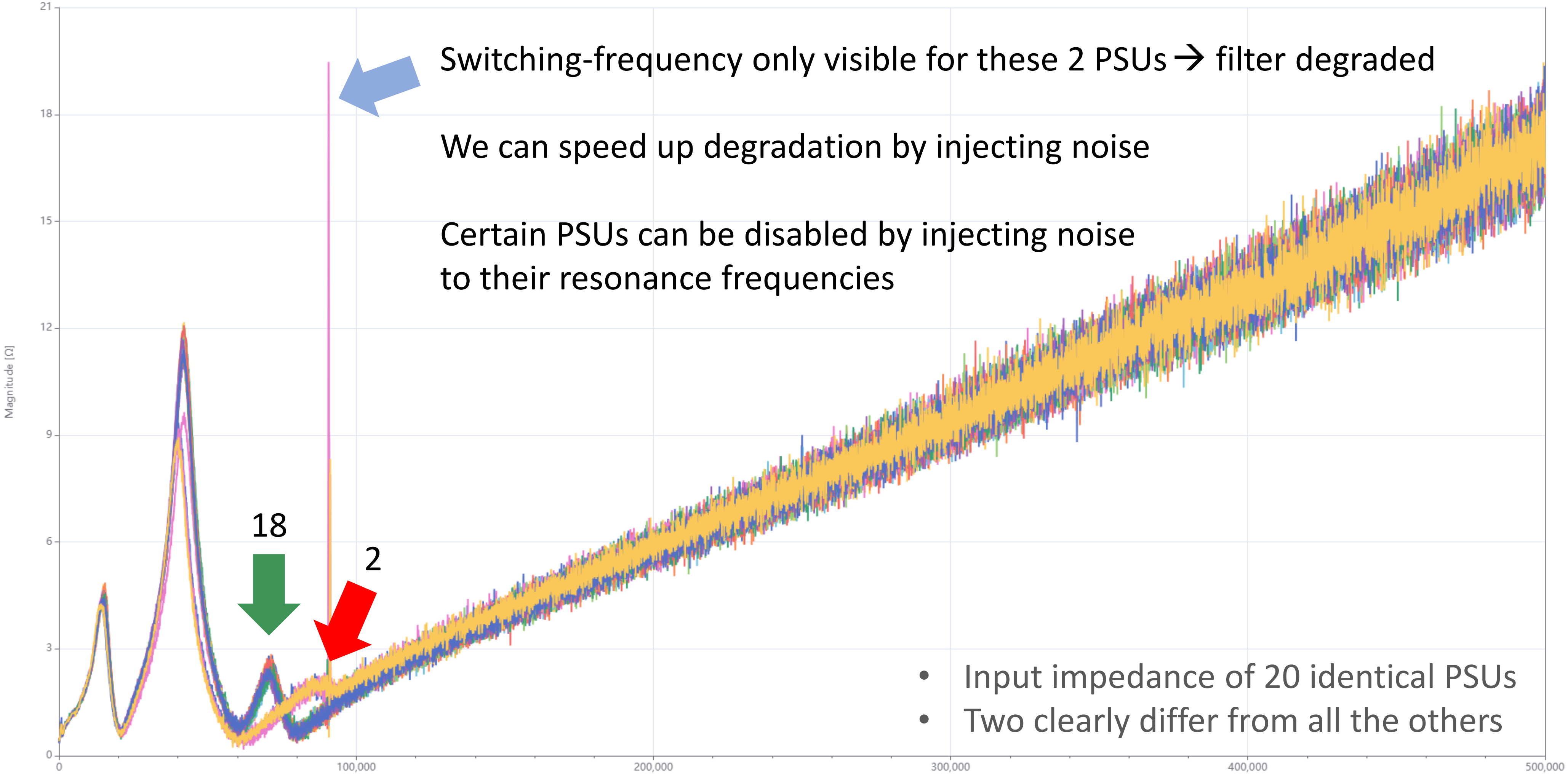
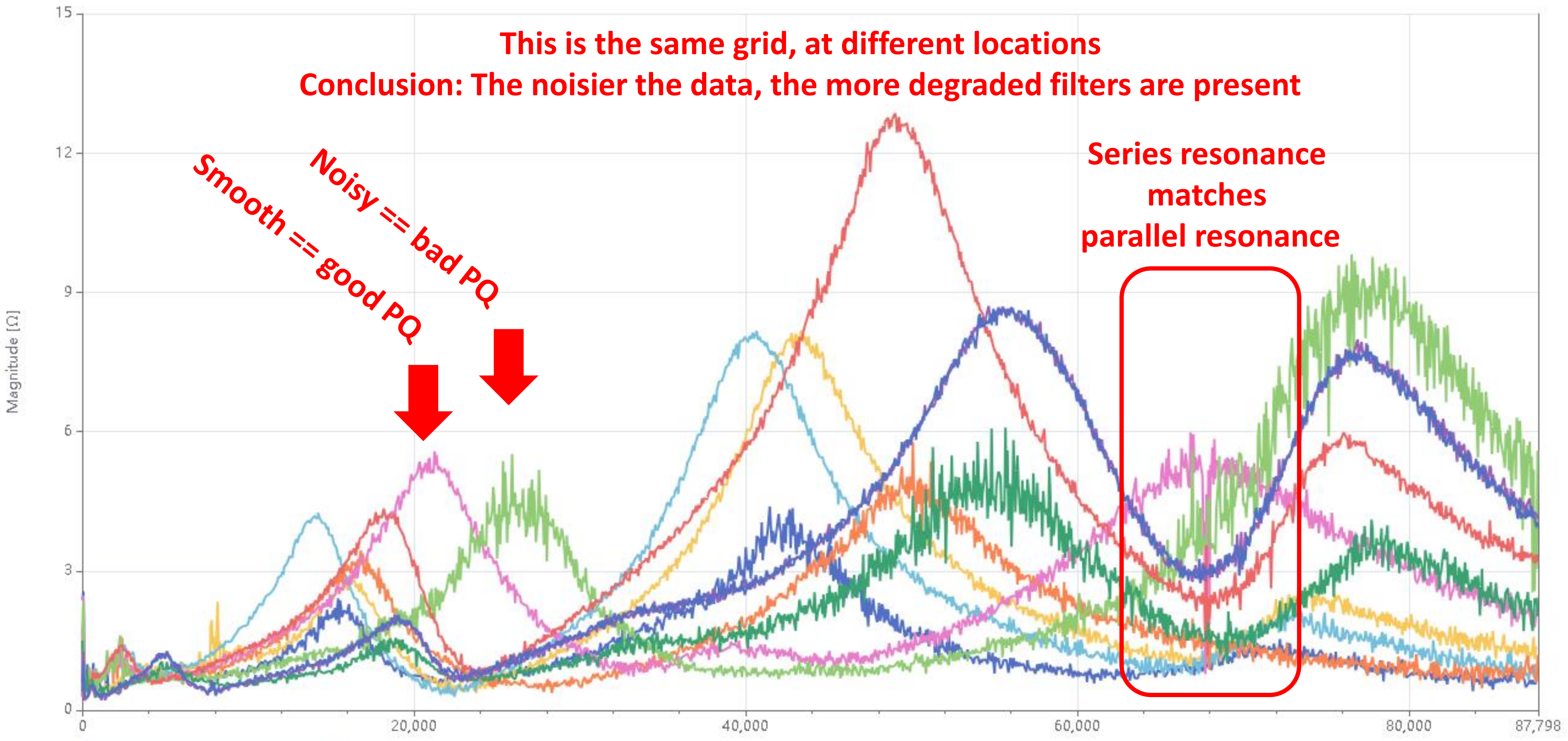


- Input impedance of 20 identical PSUs
- Two clearly differ from all the others

GRID IMPEDANCE: MONITORING THE GRID STATE



THE COMMON MODE PROBLEM

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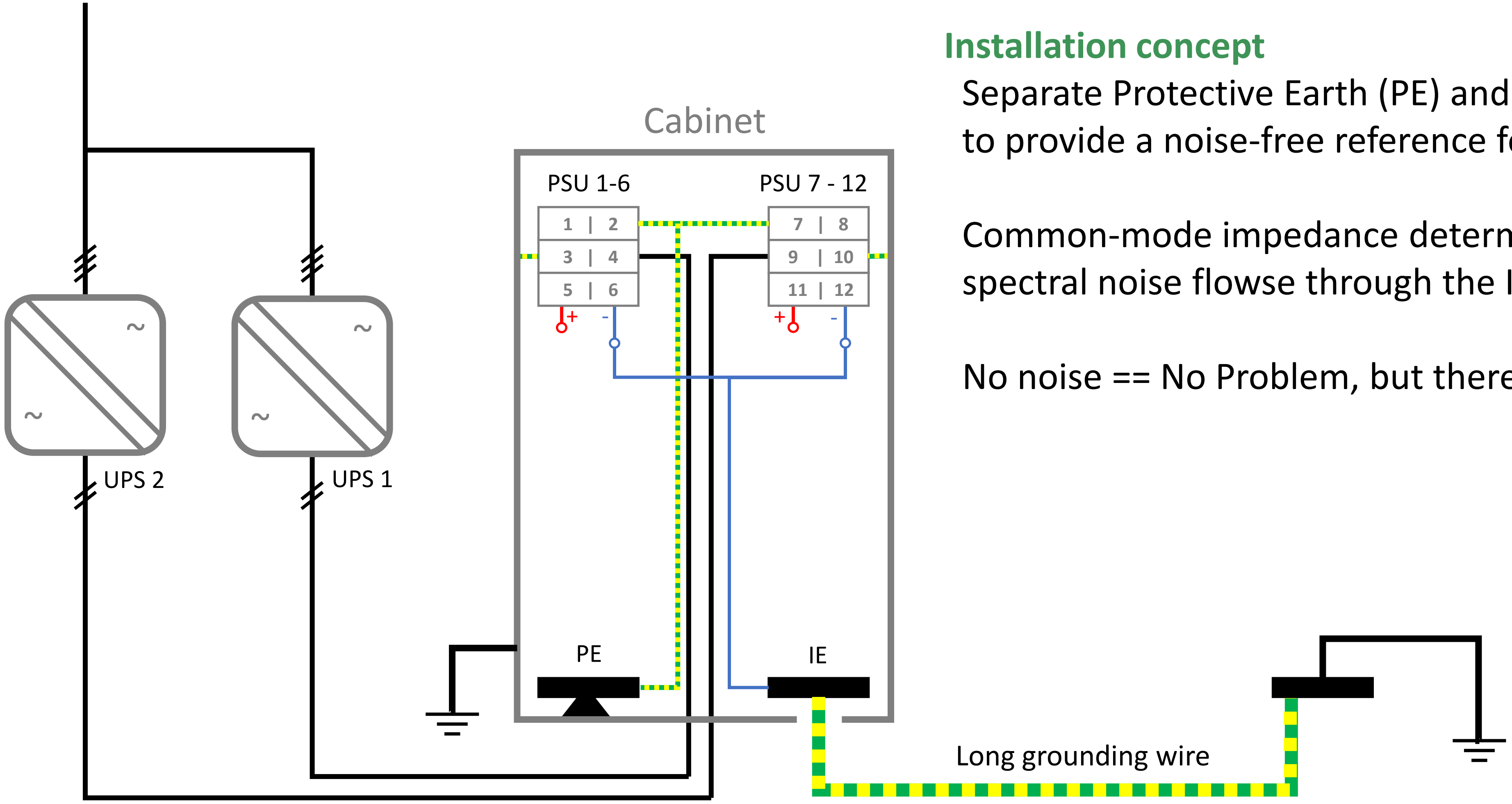


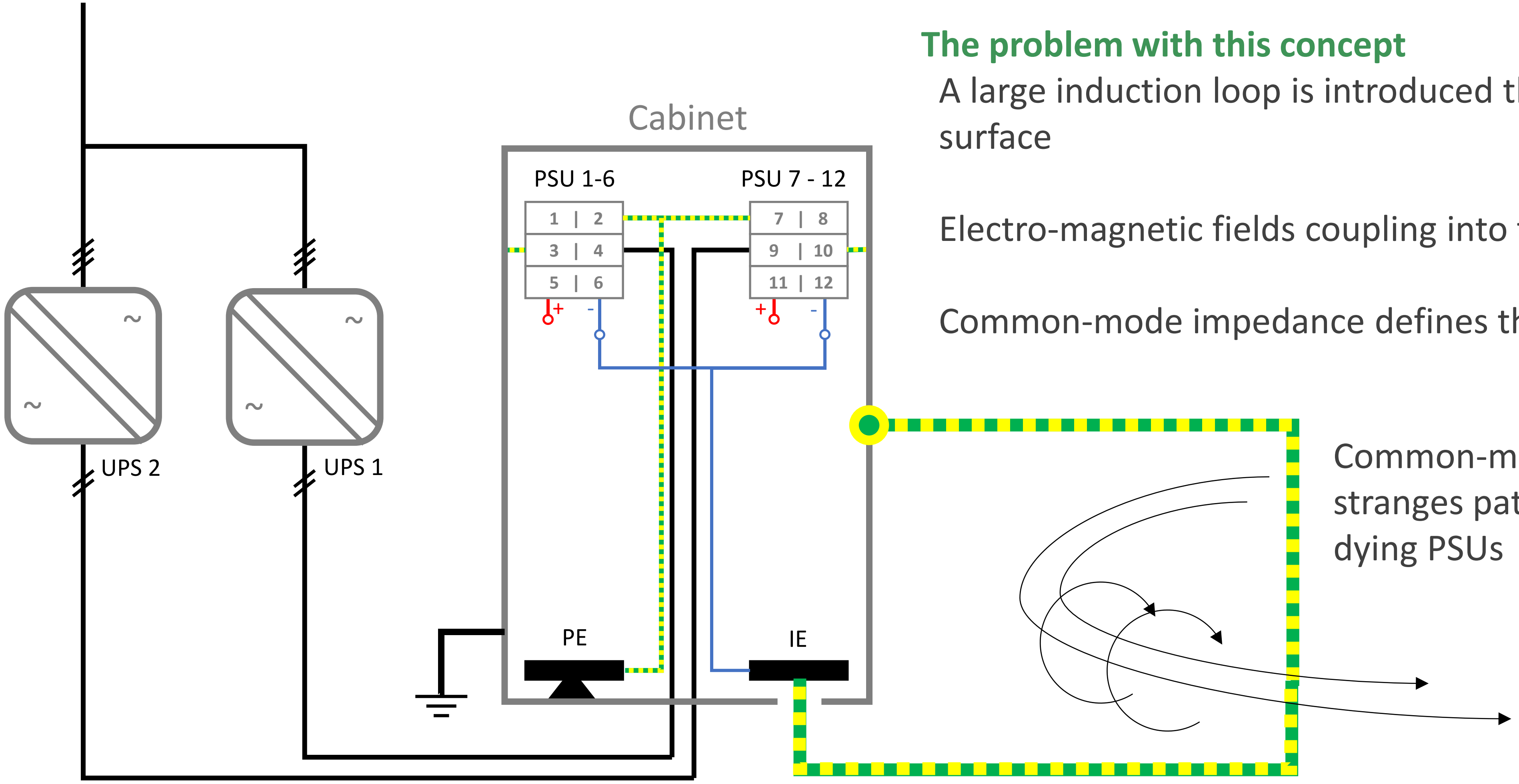
Installation concept

Separate Protective Earth (PE) and Instrumental Earth (IE) to provide a noise-free reference for the negative terminal

Common-mode impedance determines how much spectral noise flowse through the IE/PE connection

No noise == No Problem, but there is a catch (a loop)

THE COMMON MODE PROBLEM



The problem with this concept

A large induction loop is introduced throught the metal surface

Electro-magnetic fields coupling into the system

Common-mode impedance defines the current path

Common-modes flowing stranges paths, resulting in dying PSUs

CONCLUSION

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When facing high component failure rates

- Your system design according to regulations might not be suitable
- Focus on broadband Power Quality and Impedance analysis
- Be aware that common-mode phenomena might give you a bad time
- It is not a question about AC or DC systems

Impedance Measurement can do

- Device health monitoring for predictive maintenance
- Grid state monitoring to find potential problems
- Find the root-cause for poor Power Quality

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FOR LIVE DEMONSTRATION

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Thank you for your attention
and see you at booth #XY