

Power electronic event 2015

's Hertogenbosch 23 juni

Prof. dr. ir. J.F.G. Cobben

It is all about Smart!

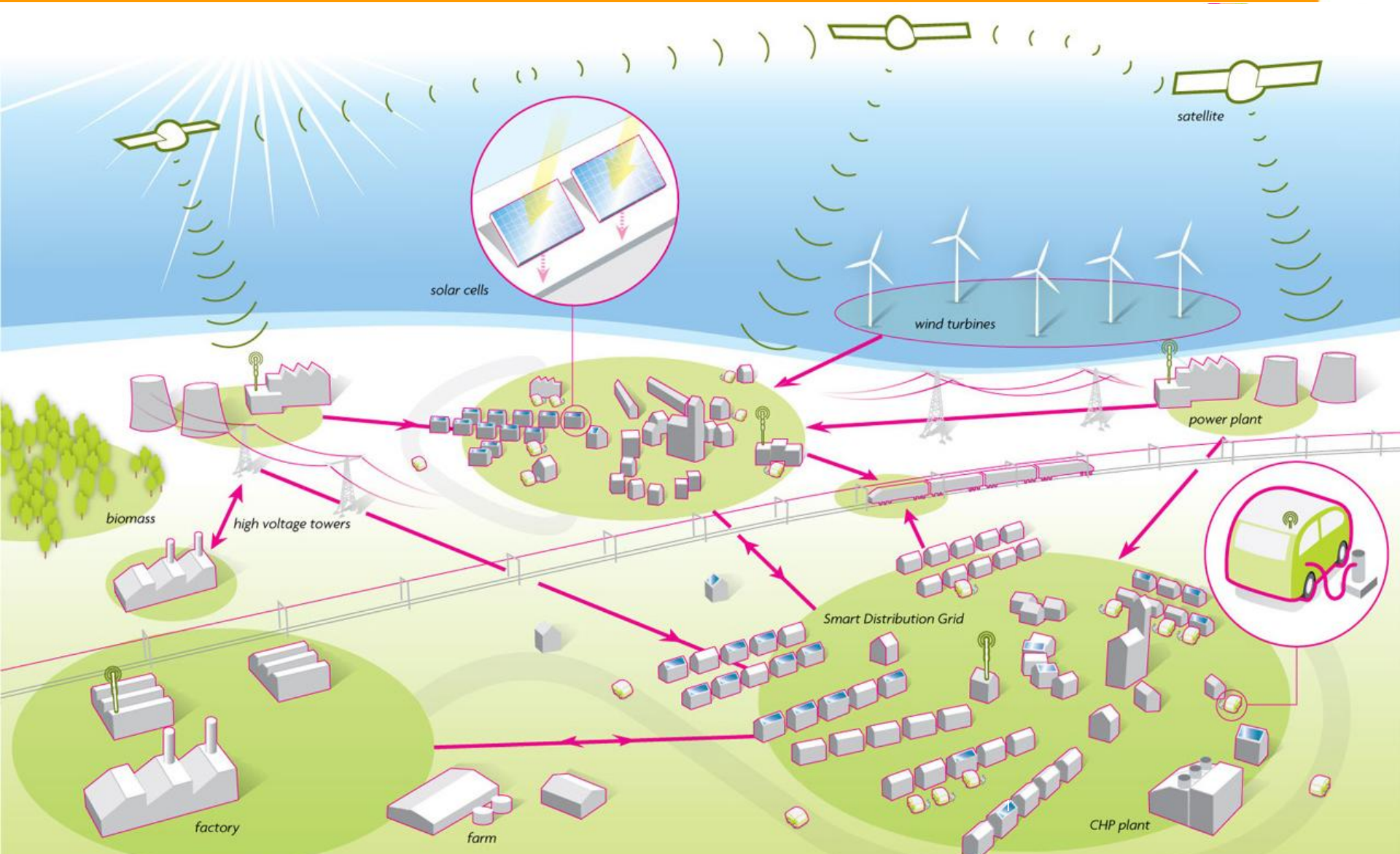


TU / **e**

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

The future electricity network!



From consumers to producers

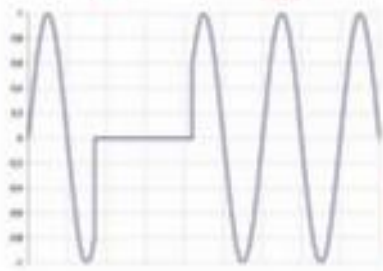


Not only generation but also additional load

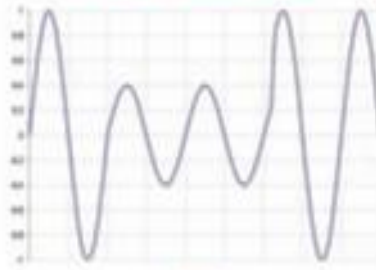


Even more important in a “smart grid”

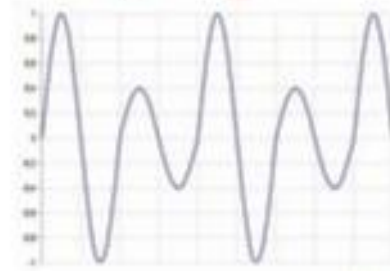
Voltage interruptions



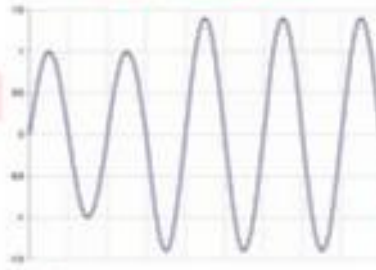
Voltage dips



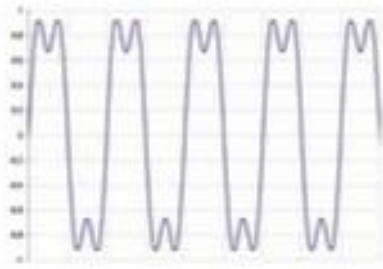
Voltage fluctuations



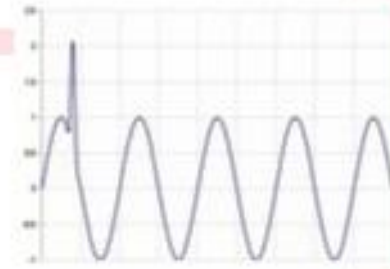
Overvoltages



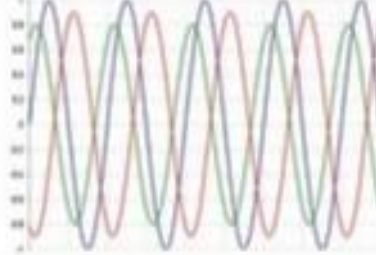
Voltage harmonics



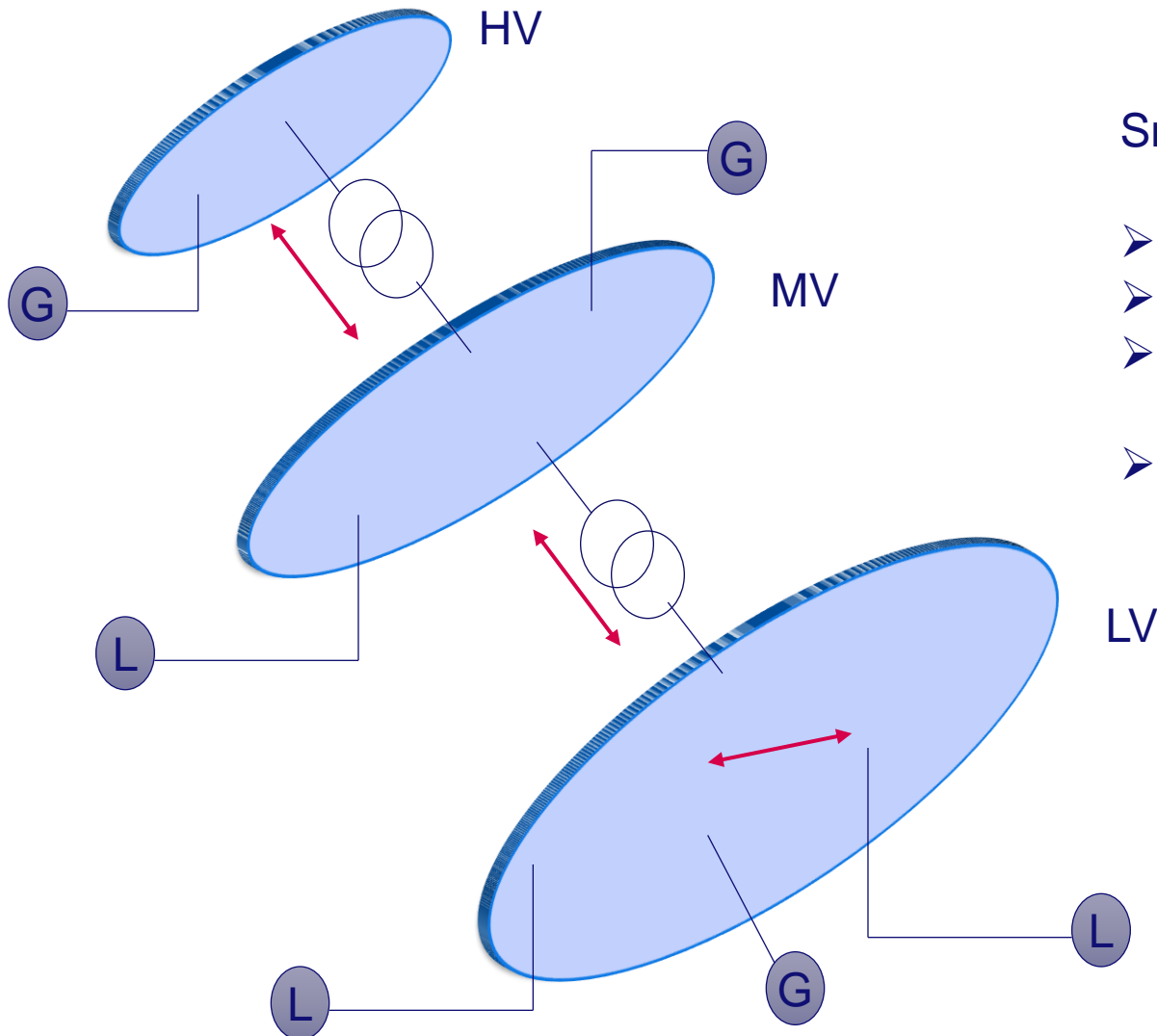
Transients



Voltage unbalance



PQ and “smart grids”



Smart grids:

- More information needed
- More control needed
- Propagation PQ
- “Predict and prevent”

MS-LiveLab Alliander

MS LiveLab

Intelligence



Interconnect



Assetmanagement



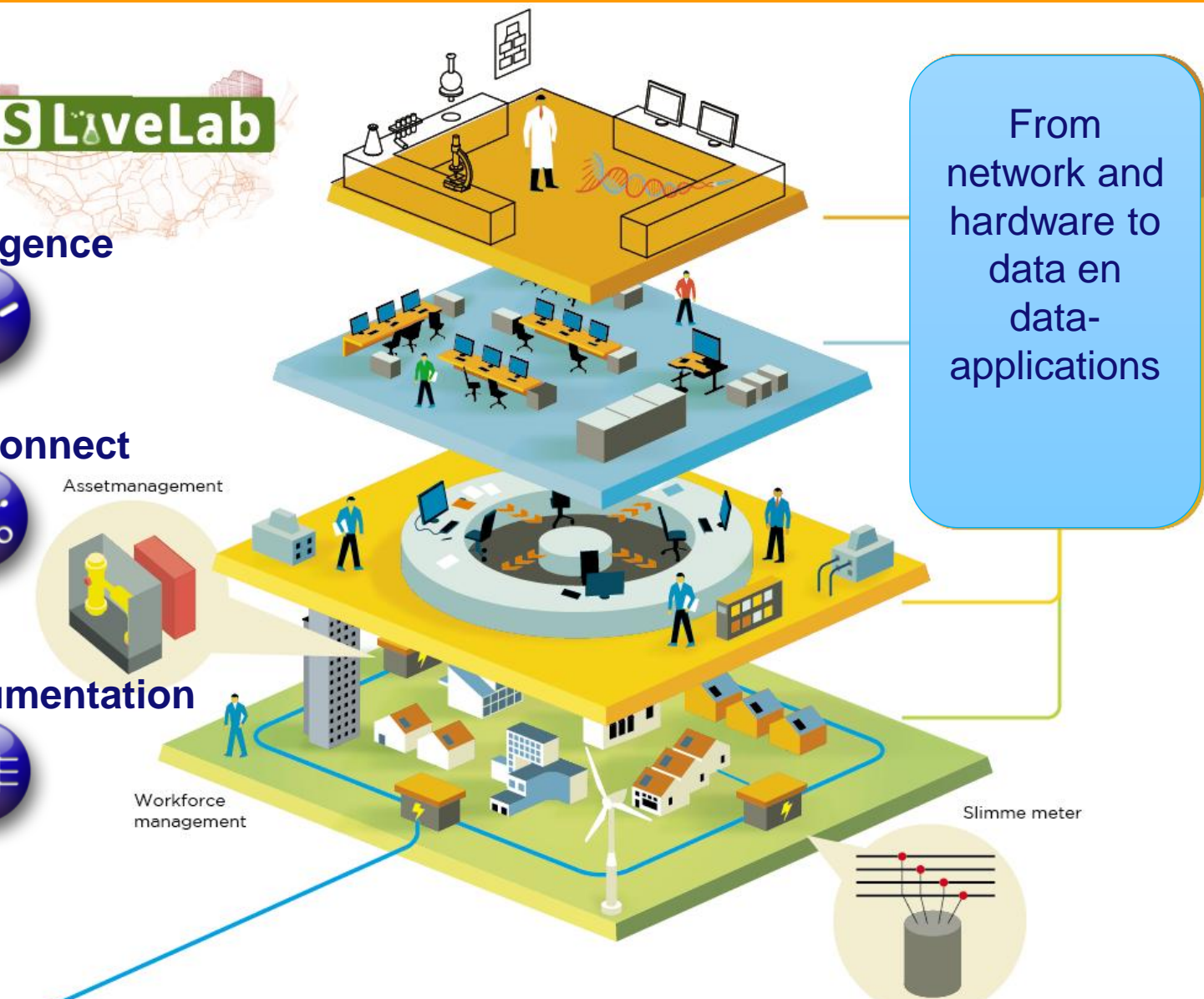
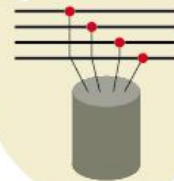
Instrumentation



Workforce management

From network and hardware to data en data-applications

Slimme meter



Sensors placed in the network

- Part of the MV-network
- Parts of LV-networks



Substation MV/LV



Substation MV/LV



Substation MV/LV



Functionalities Live lab

Optimalisation
Network
performance

Investments

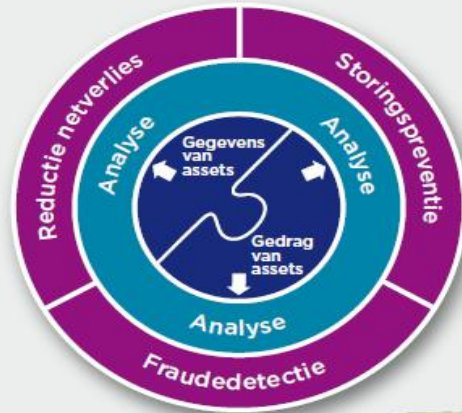
Losses

Fault prediction

Power Quality trend

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.....



Optimalisatie van
investeringen
en uitnutting
van assets



Measurement in LV-network

Is my smart meter spying on me?

by [Nikki Whiteman](#), Social Media Manager | [Energy & Home](#) | 9 March 2011 |  6 - 1 



We have to rely on the government to look after our personal data. But would we trust companies with it too? With the roll-out of smart meters we could be giving our utility companies some extremely sensitive data.



We may have mixed views on what we want to tell the government, but in general our views on private companies holding personal data are pretty clear: we don't like it.

And yet with the installation of millions of **smart meters** across the UK, we could be letting utility companies collect sensitive personal data on a half-hourly basis.

It is all about to make the system “smart”

From “blind and happy”

How to measure power of distorted waveforms precisely?

The next generation photovoltaic inverter

Flexible LV grid interface for controllable PV production and EV charging

Electric vehicle charging by PV

A DC socket outlet in your house?

Towards a DC distribution system – opportunities and challenges

Without electricity the world stops turning

The importancy of optimal quality of voltage and current

To “state estimation and alert”

DC – An interesting topic

From Wikipedia, the free encyclopedia

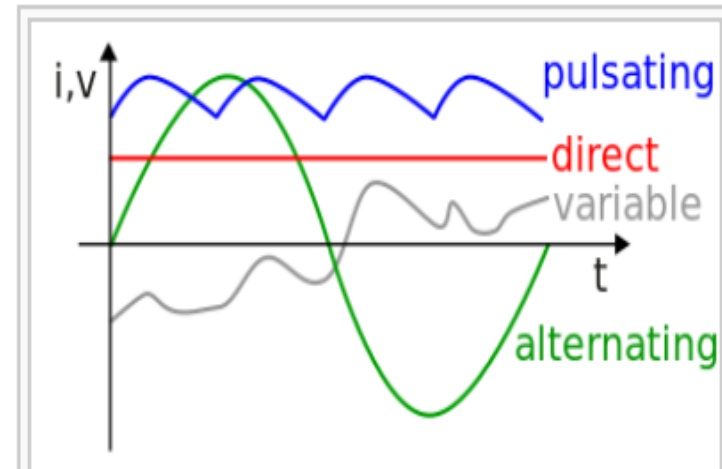
"LVDC" redirects here. For the computer, see *Saturn Launch Vehicle Digital Computer*.



This article **needs additional citations for verification**. Please help [improve this article](#) by [adding citations to reliable sources](#). Unsourced material may be challenged and removed. *(June 2009)*

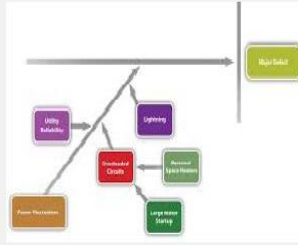
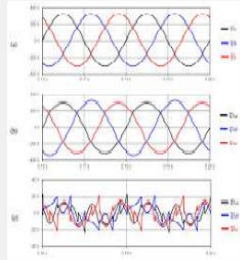
Direct current (DC) is the unidirectional flow of [electric charge](#).

Direct current is produced by sources such as [batteries](#), [thermocouples](#), [solar cells](#), and commutator-type electric machines of the [dynamo](#) type. Direct current may flow in a [conductor](#) such as a wire, but can also flow through [semiconductors](#), [insulators](#), or even through a [vacuum](#) as in [electron or ion beams](#). The electric current flows in a constant direction, distinguishing it from [alternating current \(AC\)](#). A [term formerly used](#) for this type of current was [galvanic current](#).^[1]

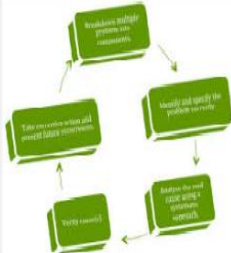
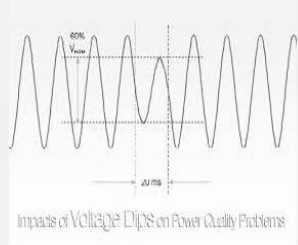
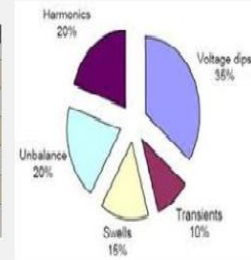


Direct Current (red curve). The horizontal axis measures time; the vertical, current or voltage.

Power Quality problems



Parameter	Tolerance
Steady state voltage	+/- 10% of nominal voltage
Line voltage swell	RMS amplitude of 120% of nominal voltage of up to 0.5 seconds
Low frequency decaying ring wave	Sliding scale from 140% at 200 Hz to 200% at 2,000 Hz
High-frequency impulse and ring wave	BSI minimum transient immunity
Voltage sag	50% of nominal voltage for up to 10 seconds, 70% of normal for 0.5 seconds
Dropout	Complete loss of voltage for up to 20 msec (3-25 cycles at 60 Hz)



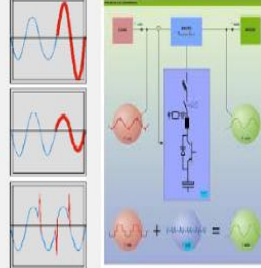
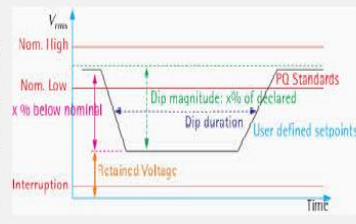
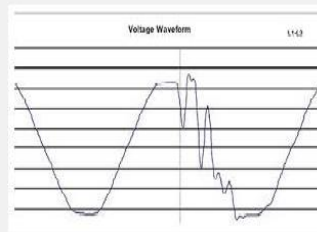
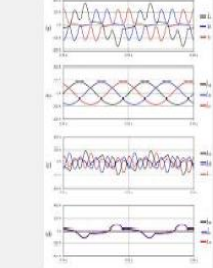
Hidden Power Quality Problems
 Many power quality problems are hidden and go undetected until they cause a problem. This is because many power quality problems are intermittent and occur only during certain times of the day or week. This makes it difficult to detect and solve these problems.

- Top problem areas on 2013 new models**
1. Built-in voice recognition frequently doesn't recognize or misinterprets commands
 2. Built-in Bluetooth mobile phone/devices frequent pairing/connectivity issues
 3. Excessive wind noise
 4. Materials scuff and/or soil easily
 5. Navigation system is difficult to use or poorly located



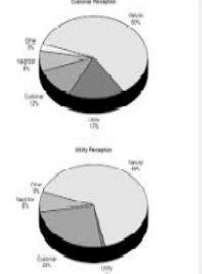
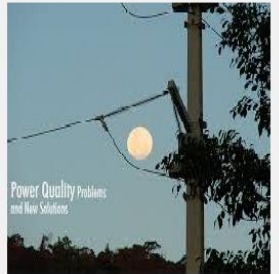
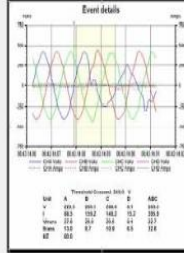
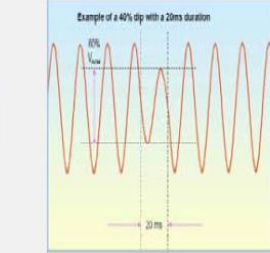
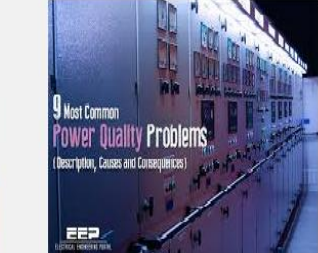
POWER QUALITY PROBLEMS:
 Power Quality problems can be broadly classified into following categories:

- Voltage sag
- Misses/interruptions
- Long interruptions
- Voltage spikes
- Voltage swells
- Harmonic distortion

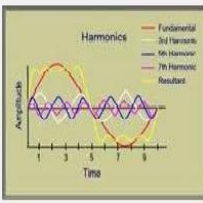
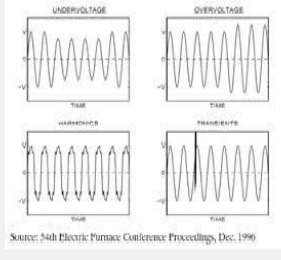


Top Three Models per Segment
 Truck-Mounted Attenuator (TMA) Segment

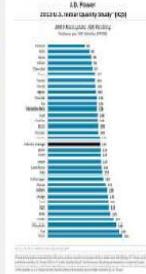
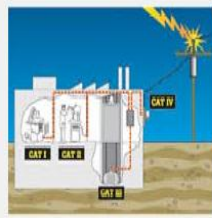
Segment	Model	Manufacturer
High-voltage Transformer (HV) Segment	High-voltage Transformer (HV) Segment	ABB
High-voltage Transformer (HV) Segment	High-voltage Transformer (HV) Segment	ABB
High-voltage Transformer (HV) Segment	High-voltage Transformer (HV) Segment	ABB



Power Quality Problems and New Solutions
 This document discusses the various power quality problems that can occur in a power system and the new solutions that are available to solve these problems.



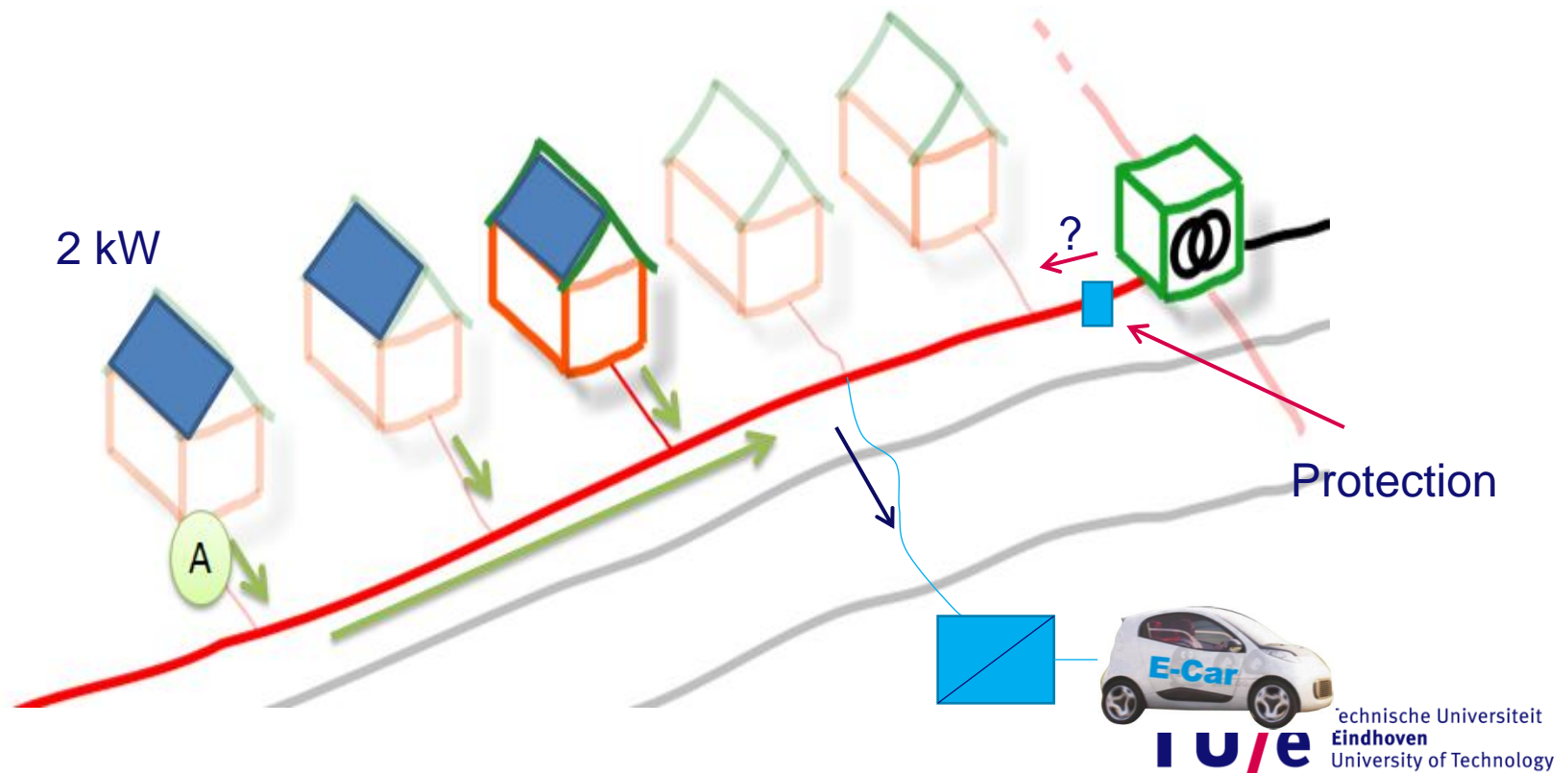
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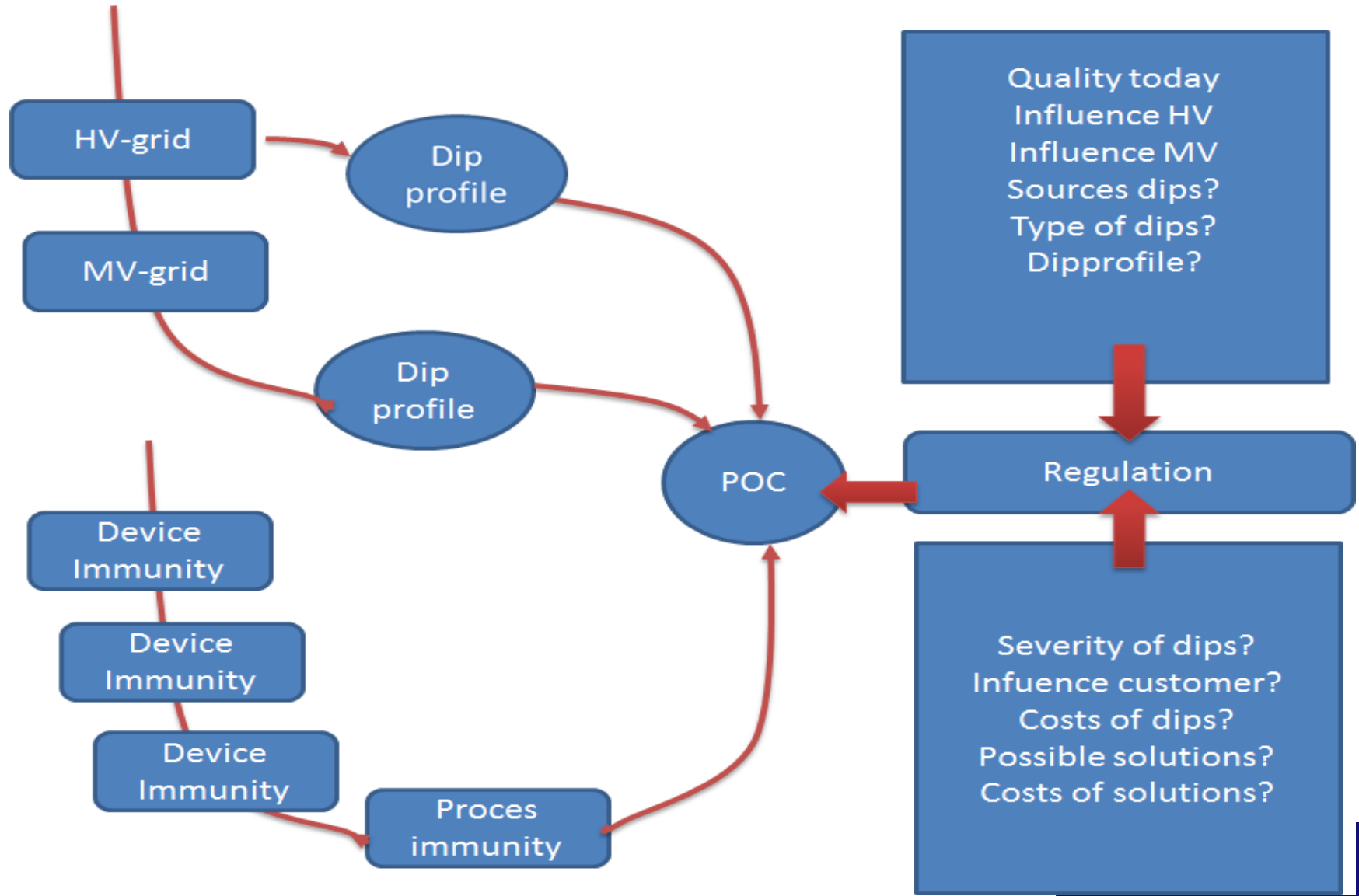
Source: 54th Electric Power Conference Proceedings, Dec. 1996

Problems related to PV-systems

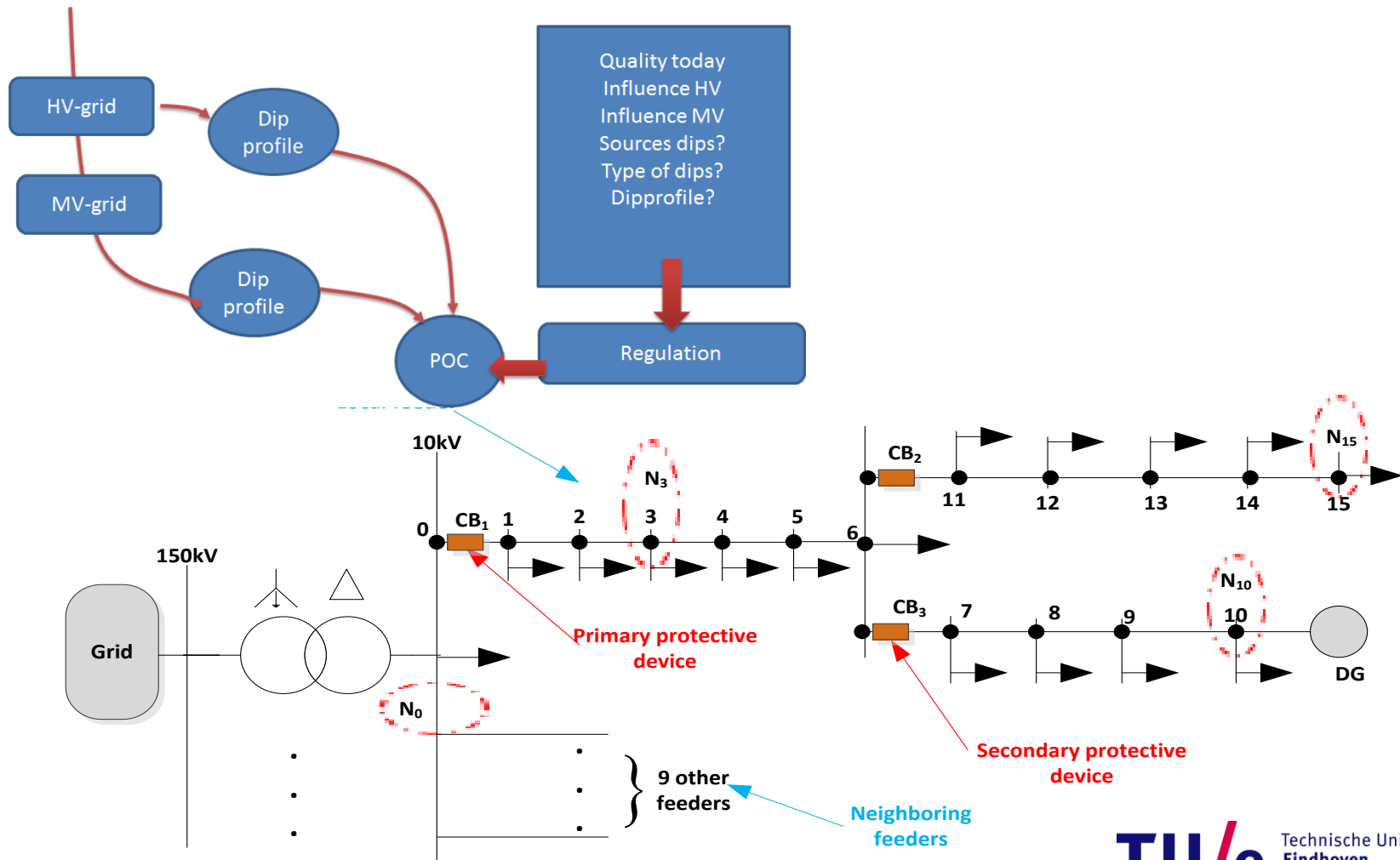
- **Overloading of transformer and overvoltages!**



Voltage dip



Research related to voltage dips



Research related to voltage dips

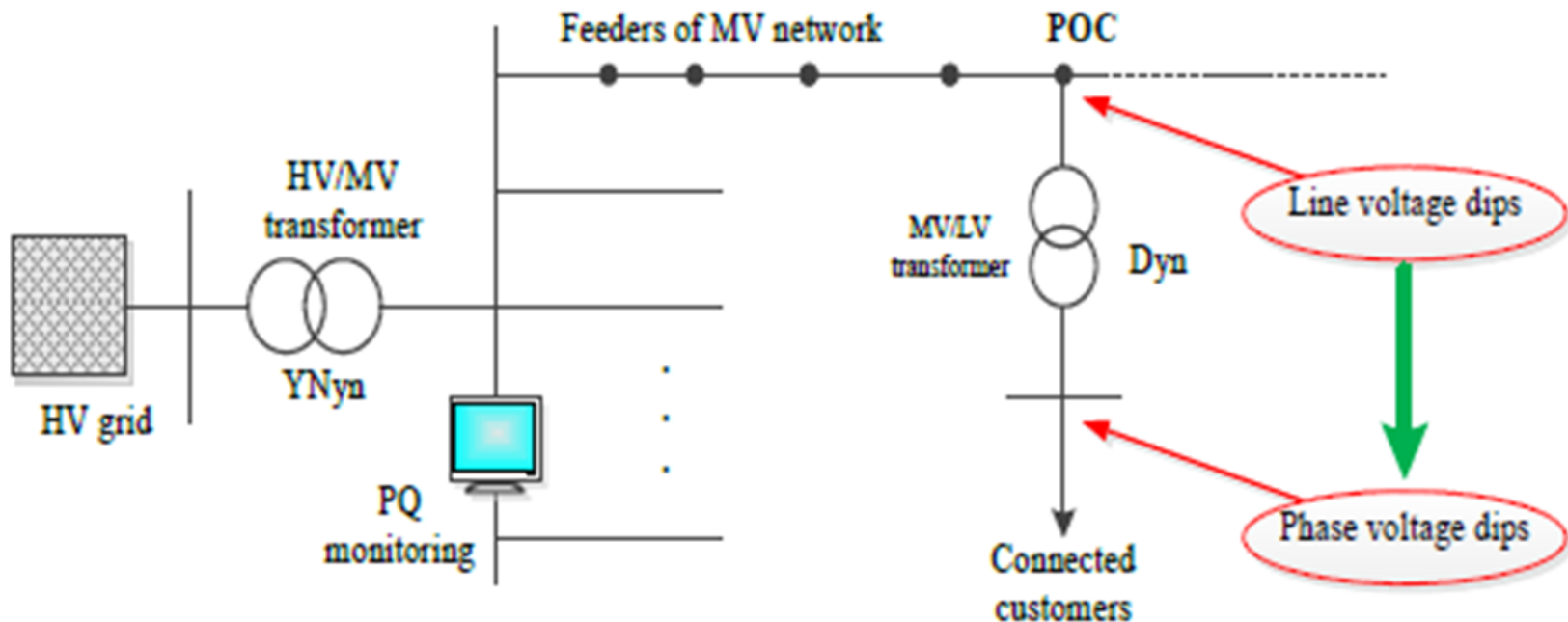
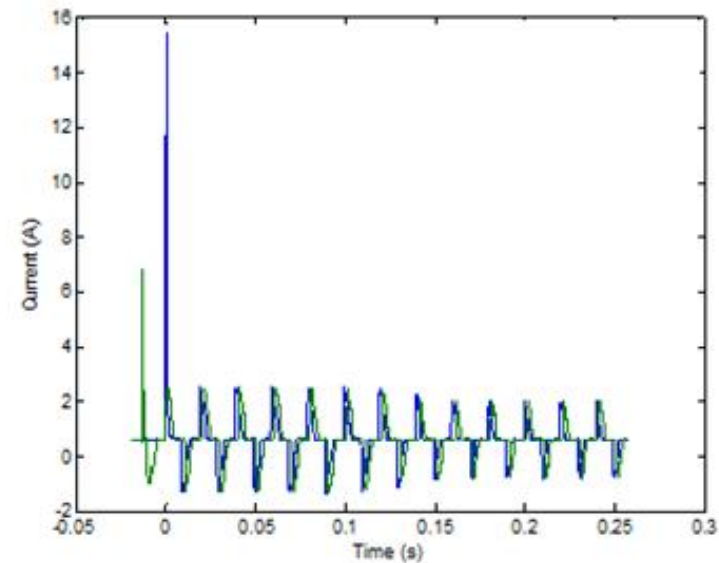
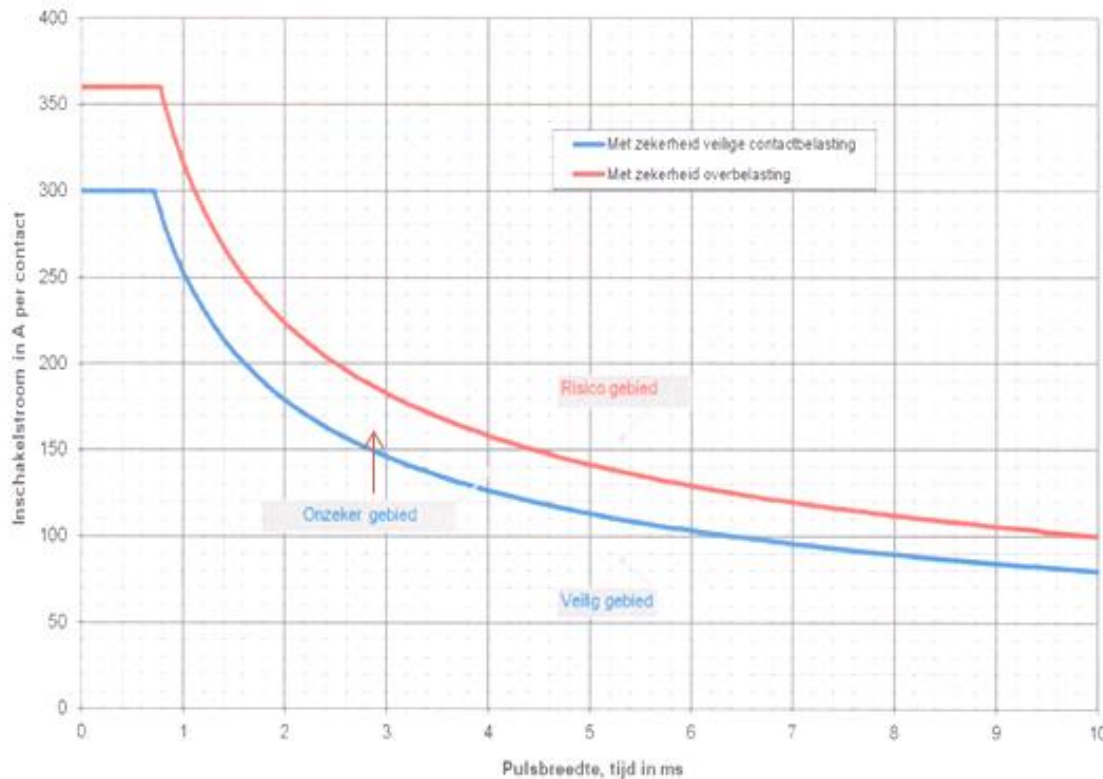


Figure 2: Simplified schematic for a 10kV (Nijkerk) network

Inrush currents (contactors/circuit breakers)



The capacitor has the capacity to create problems in the network

Harmonics and monitoring

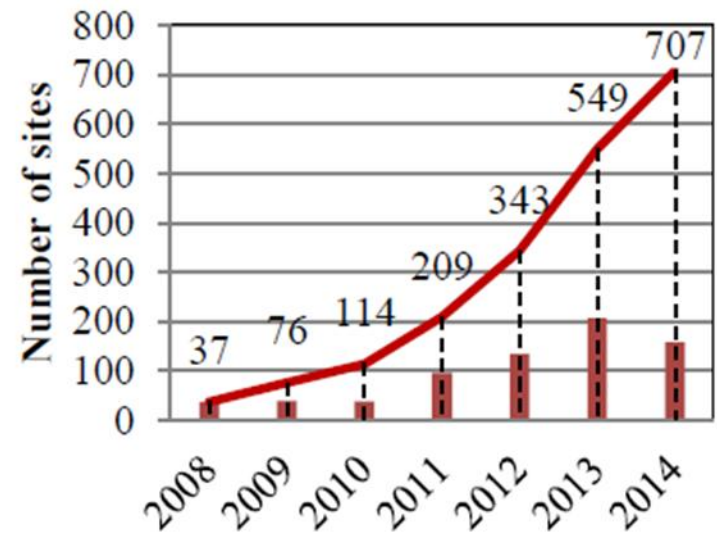
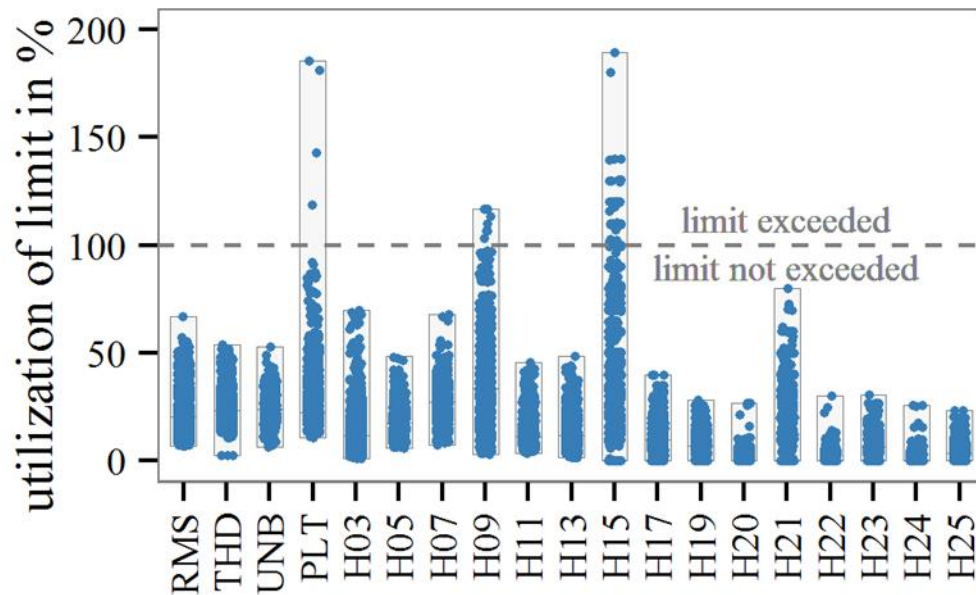
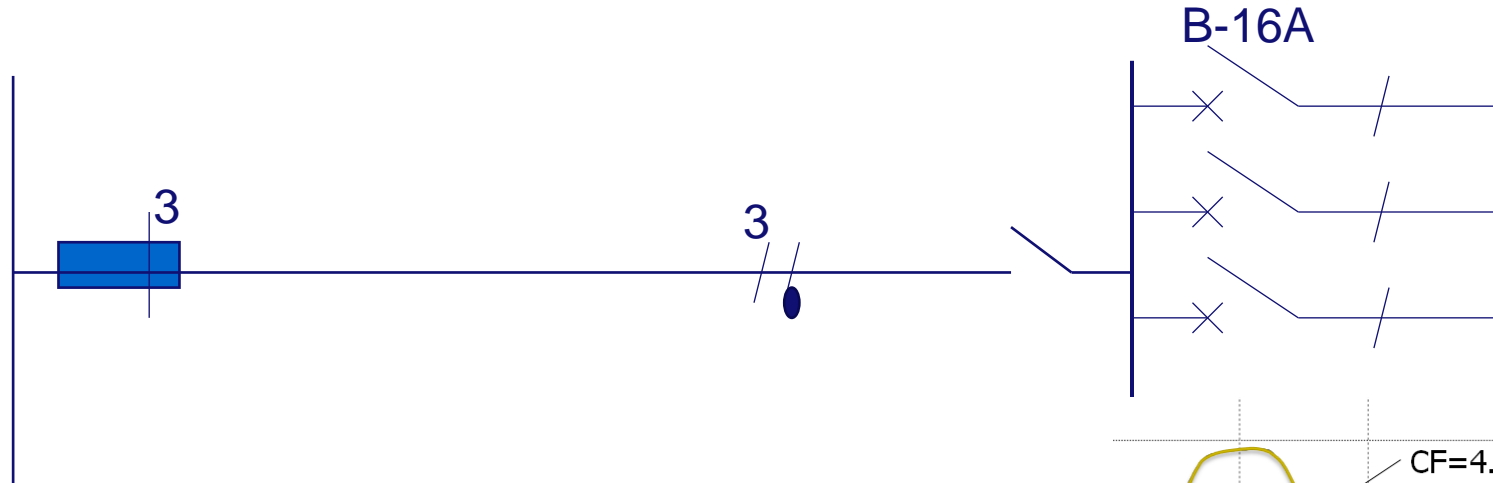


Figure 4 Annual growth of measured sites

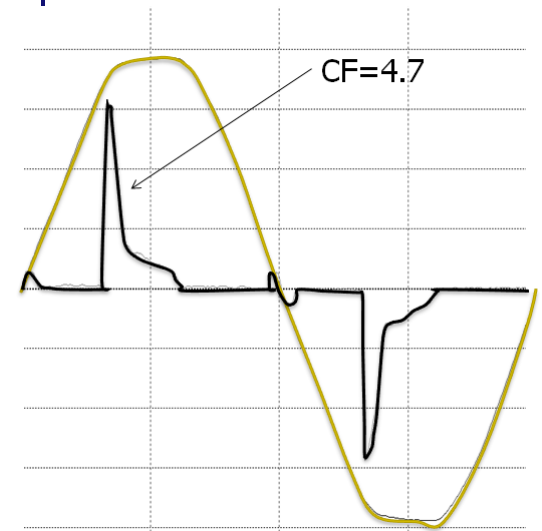
15th harmonic voltage problem has to be solved!

Cable cross section

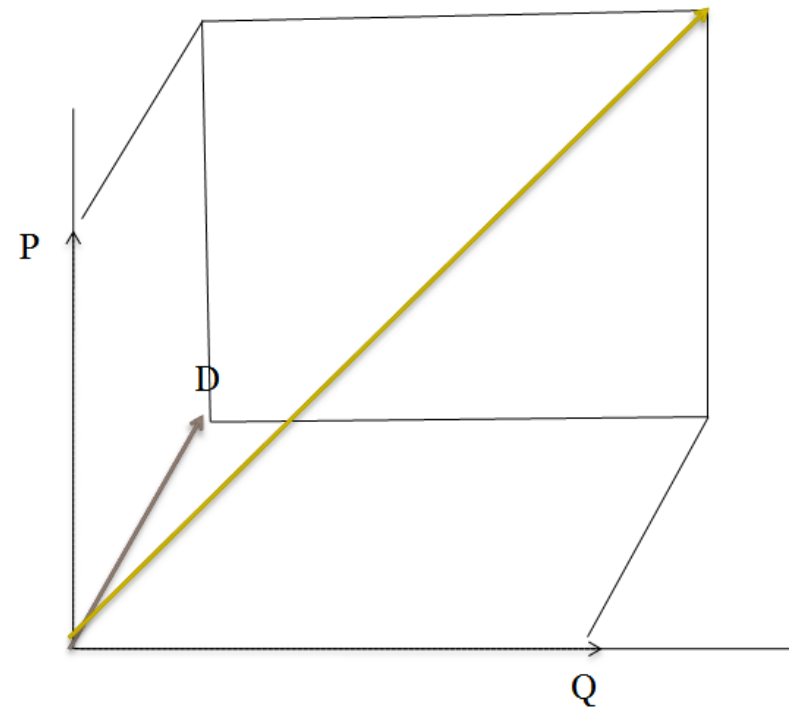
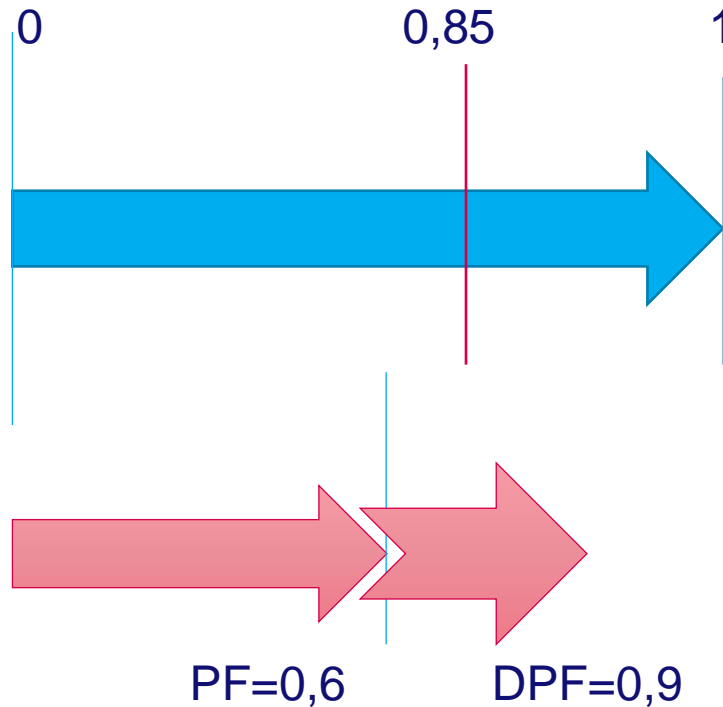
- **With high harmonic distortion**



- Without harmonics: 16 mm²
- With 3rd harmonic: 25 mm²
- With all harmonics: 35 mm²

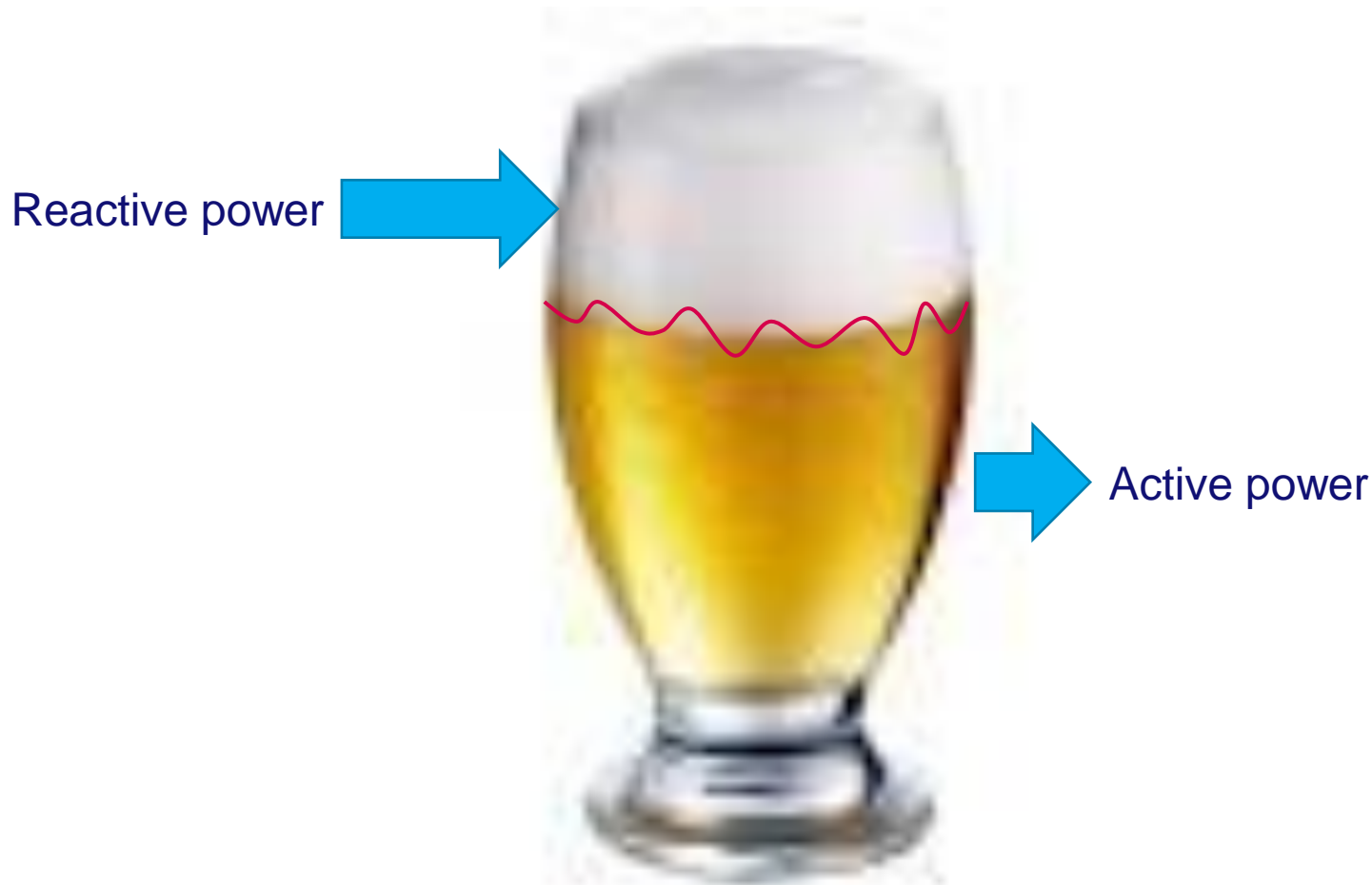


PF and the need for compensation



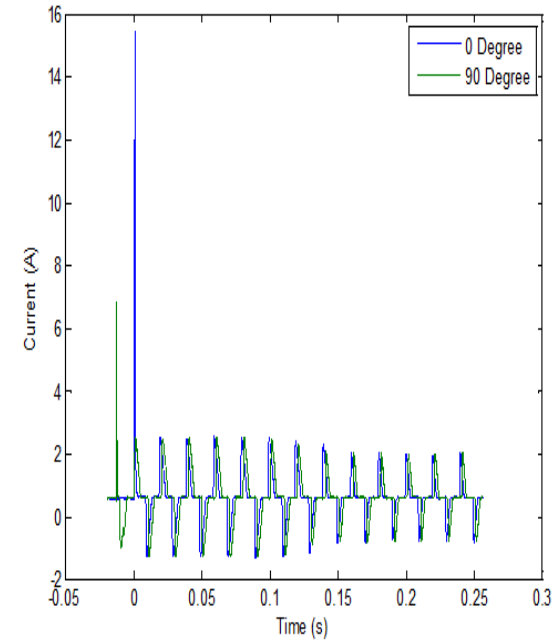
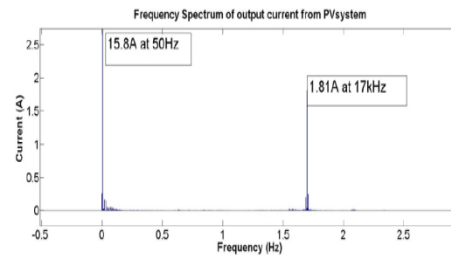
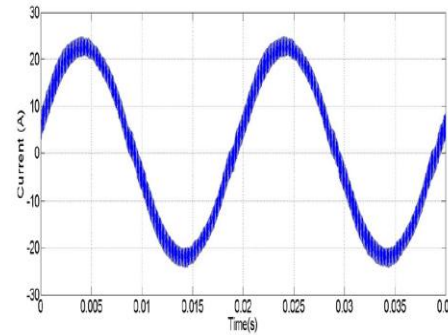
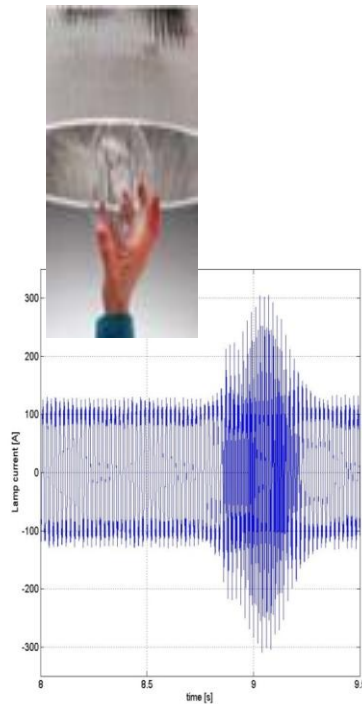
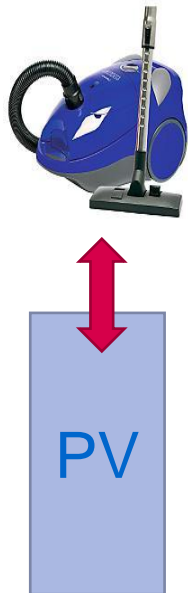
$$S = \sqrt{P^2 + Q^2 + D^2}$$

How to define the content of the glass?



Harmonic distortion makes it difficult to define the quality of the beer!

Examples of non-compatibility



Knowledge and education: Key to smart!

