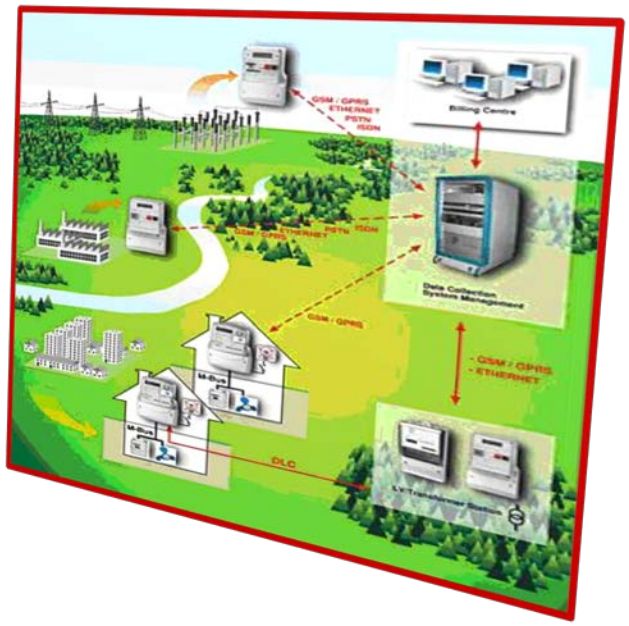
Smart Metering for renewable energies – 1) requirements, 2) capabilities 3) and correct use



Netzah Calamaro– IEC

Prof. Doron Shmilovitz – TAU

Renewable energy panel

The objective of this presentation:

- ✓To show modern grid capabilities especially renewable

- ✓To show the smart meter capabilities

The objective of this presentation:

- ✓To show the grid requirements from metering systems
- ✓To map renewable requirement to meter capability

- ✓To explain the new measurement problems of these new requirements and provide a simple solution

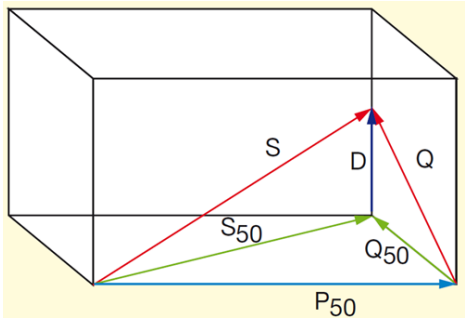
The objective of this presentation :

- ✓ To demonstrate to renewable engineers what can smart metering provide them and how can it save you money and increase their profits

The objective of this presentation :

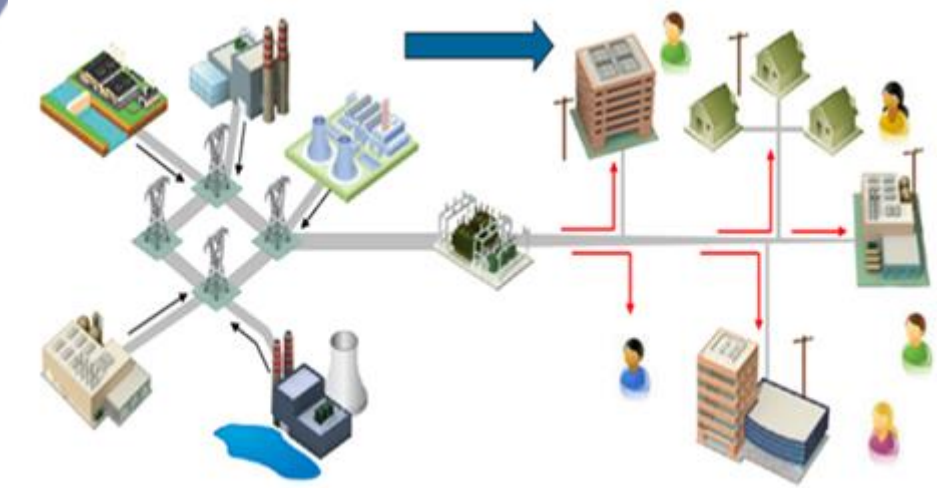
- ✓To explain how common metrology standards do not cover the new requirements and introduce new standards that does, and new verification that does cover them

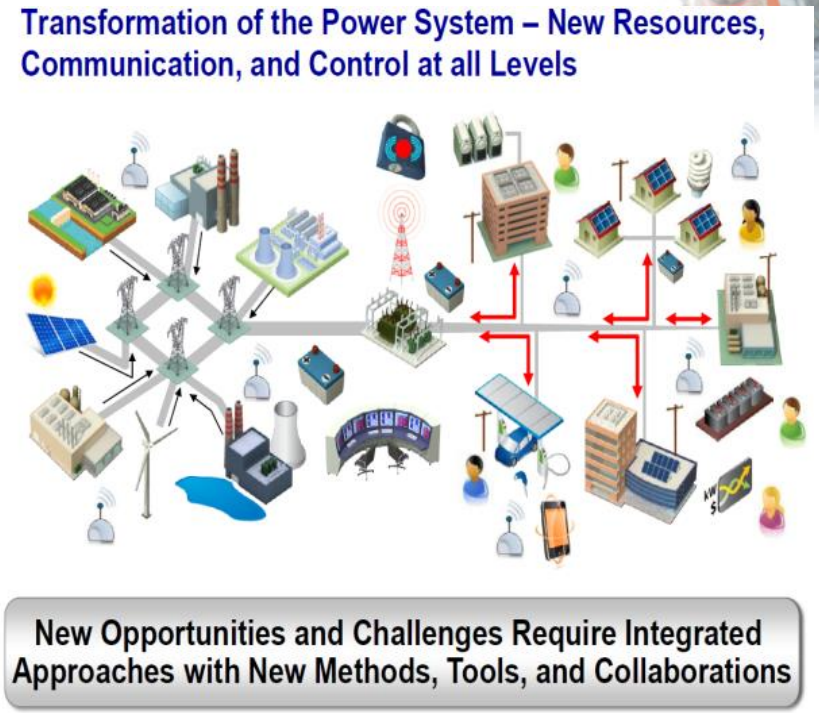
IEEE 1495



- ✓To explain some methods of correct field energy and power quality measurement

The grid is changing – how?



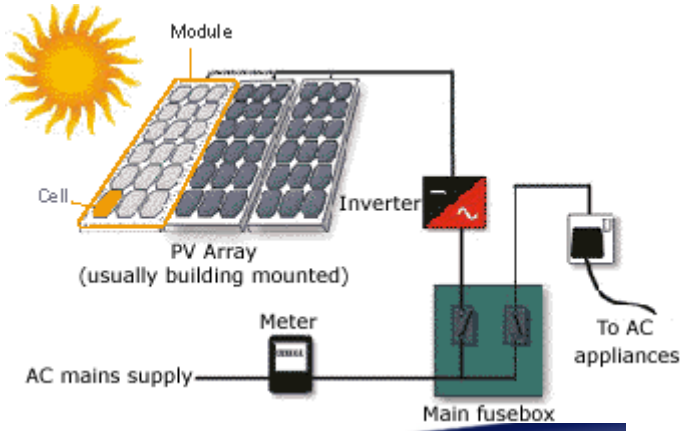


- ✓ **Bi-directional energy flow:** consumers are also producers – renewable energy generation

- ✓ **Remote** meter reading, **smart** meter

The grid is changing – how?

- ✓ **Distributed** energy generation
- ✓ **Renewable** energy



What can smart metering provide renewables #1st solution

- **Load and price forecasting 30 days ahead**

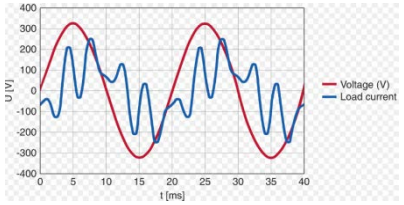
IEC application

The grid is changing – how?

The meter has changed: a smart meter

Smart meter capabilities:

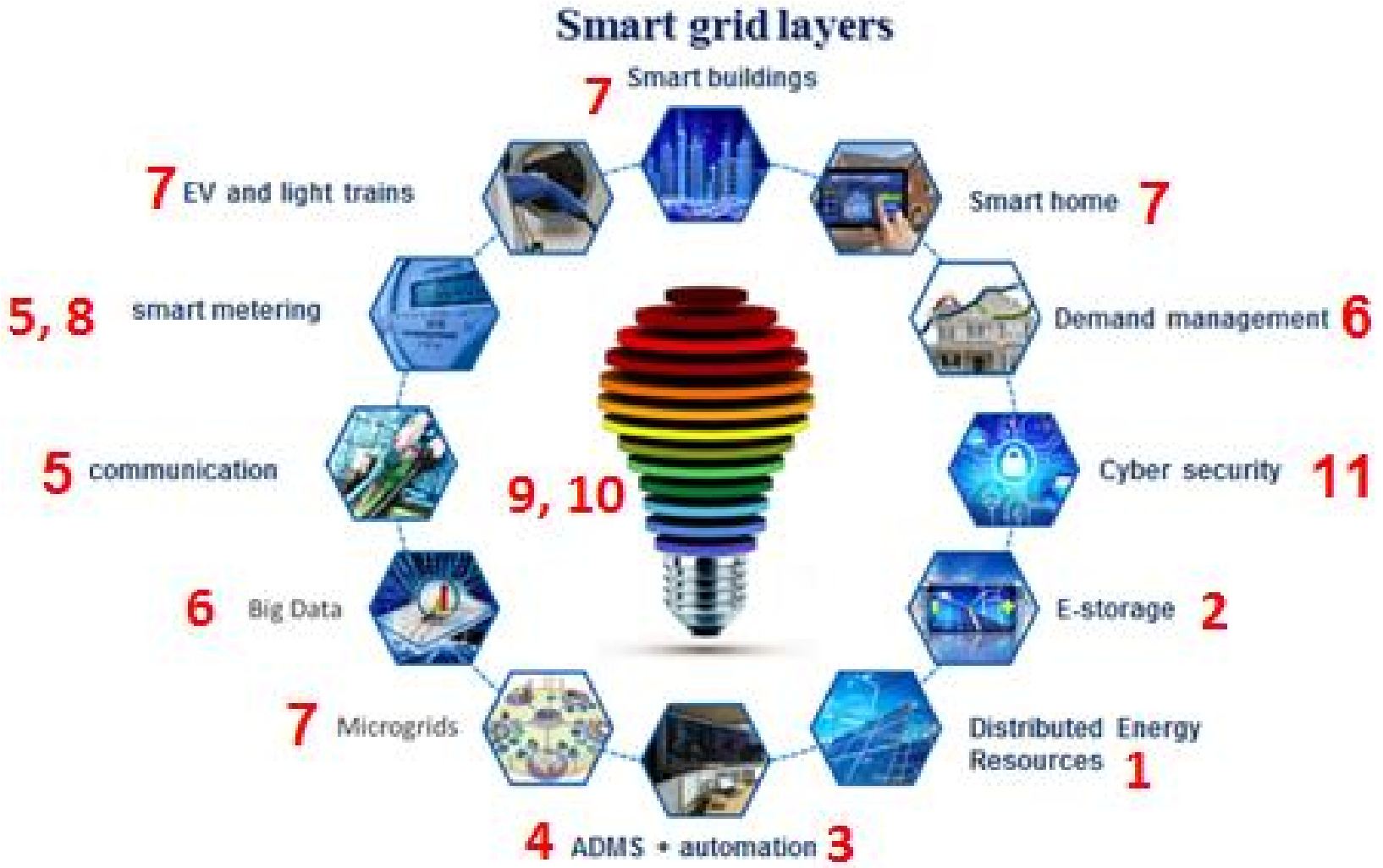
- ✓ **Remote meter reading**
- ✓ **15min load profile – periodic energy consumption**



- ✓ **Electricity events logging**
- ✓ **Power quality logging according to standard (EN 50160)**

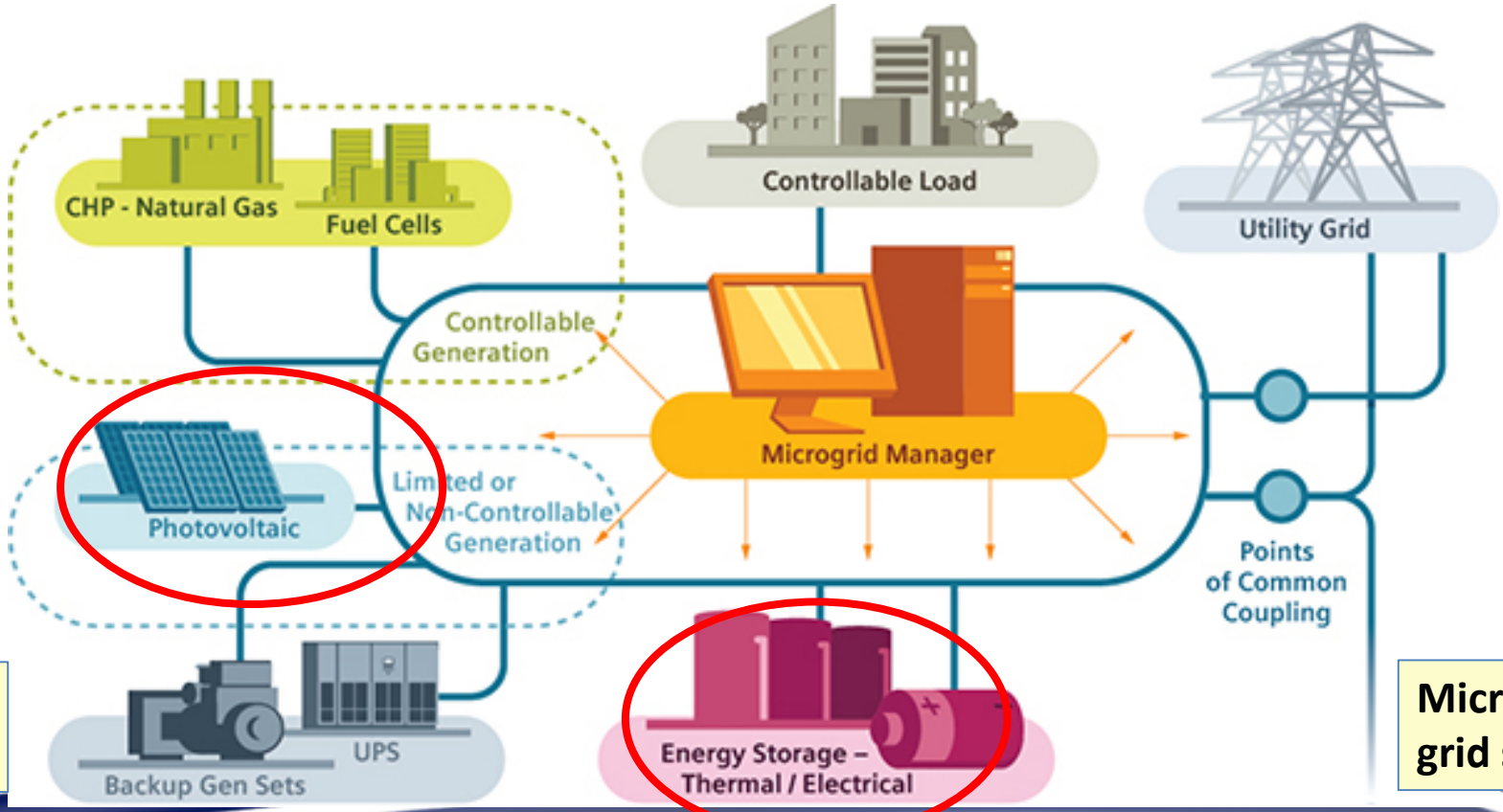
The grid is changing – how?

- ✓ **New modules enter the grid**



The grid is changing –how?

- ✓ New renewable modules enter the grid
- ✓ By 2050 technology will enable >80% renewables
- ✓ Renewables enable a Micro-grid: an autonomous grid



Micro grid l

Micro grid s

The grid is changing – how?

✓ **Smart metering offers a lot of operational benefits for renewables.** **Benefits =cost saving**

Operational efficiency and grid optimization

Reduction of grid energy losses: technical, non-technical
Volt/ VAR control (voltage regulation, reactive energy compensation)
Monitoring, control, and cyber grid security
(logistic and human) asset management

Minimization of ecological fingerprint

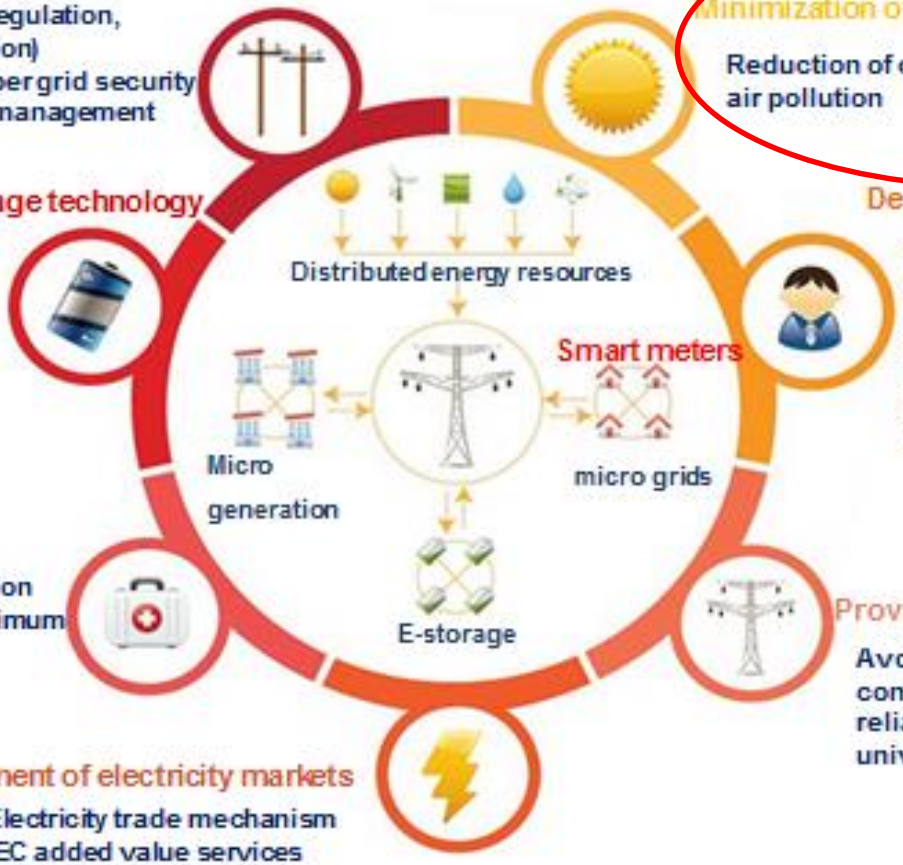
Reduction of carbon dioxide and air pollution

Merging generation and E-storage technology

Combine all generation technologies
Assist reduction of Generation
E-storage
EV

Demand management

Peak load flattening
Avoid/postpone generation investments Avoid expensive fuel usage
System survivability
Customer collaboration into the electric grid



Self-healing capability

Fast failure location and isolation
Return from power time at minimum duration
Micro grids

Provision quality and reliability

Avoid losses for IEC and consumers Improvement of reliability indicators Withstand universal regulation

Development of electricity markets

Develop Electricity trade mechanism
Develop IEC added value services

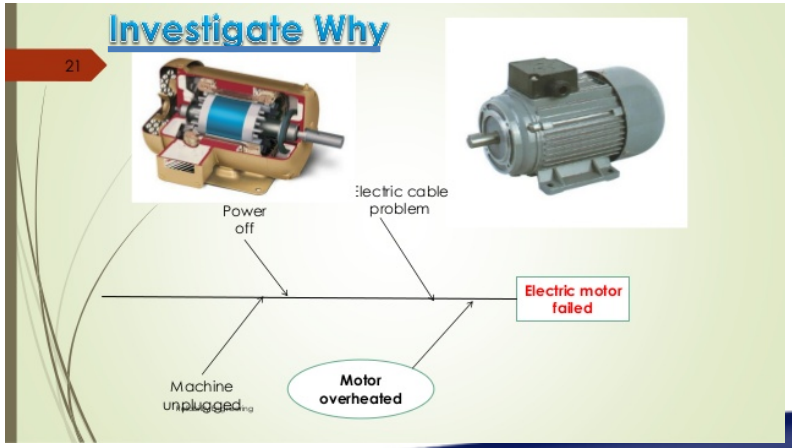
What can smart metering provide renewables #2nd solution

- **if you are worried about and not from:**

Fraud detection, and technical/non-technical loss detection

- **Diagnosis and Early detection of electric devices failures**

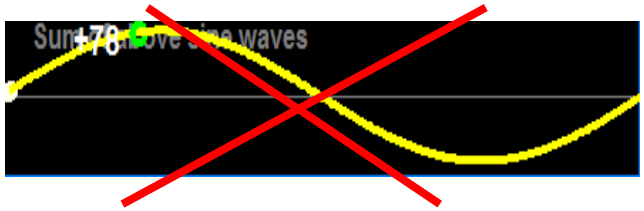
From outside the farm and in advance

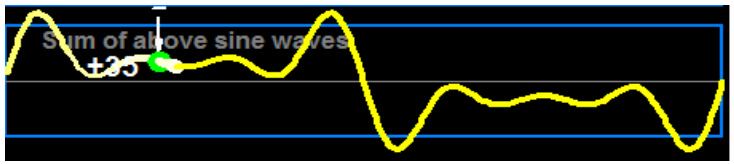


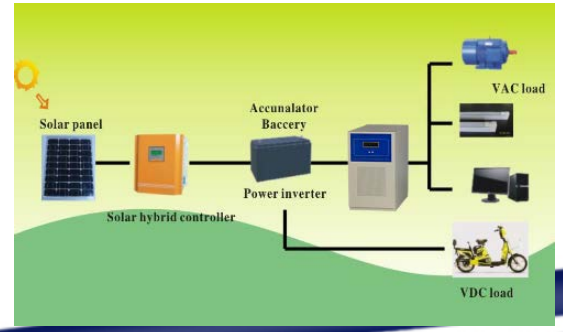
IEC application
Behind the scenes

The grid is changing: harmonics

- ✓ Renewables insert converters. Converters are Harmonic Generating Loads (HGL-s)
- ✓ HGL-s may cause large inaccuracy at energy metering
  This should be properly designed and validated
- ✓ Conventional metrology standards does not sufficiently validate this phenomena – written for conventional meter

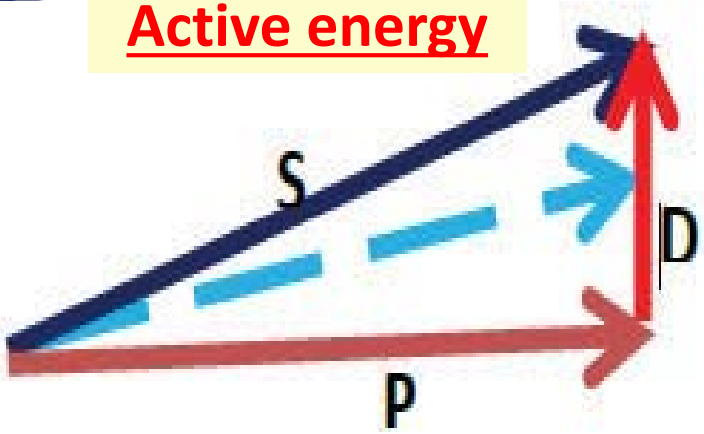






Problem of accurate energy measurement with harmonics

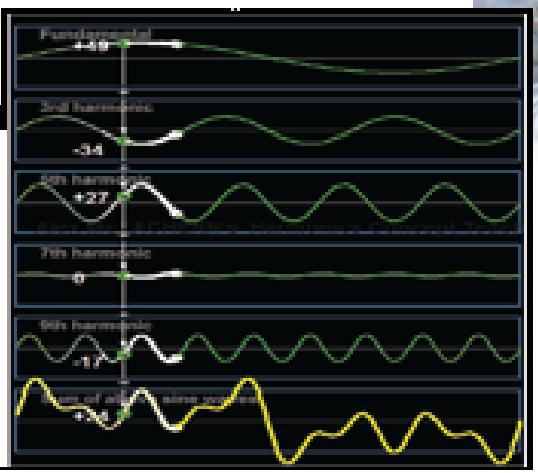
Active energy



Reactive energy

$$Q = \sum_{n=1}^{N} V_n I_n \sin(\varphi_n)$$

$$Q = \int_0^T v(t) i(t - T/4) dt$$



Simple solution:

- ✓ Use meter designed according to **IEEE 1459, or DIN 40110-1,3**
- ✓

Or:

- ✓ validated at lab according to the standard

Israel Electric
National meters lab

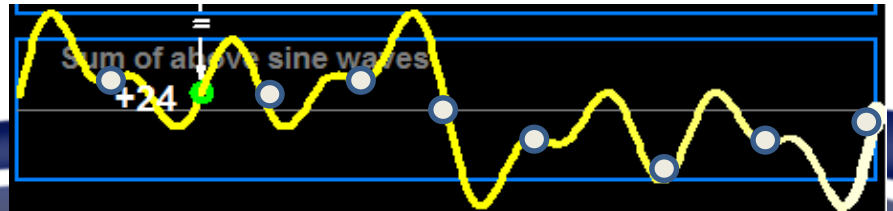
New requirements from metering systems that did not exist before

Measurement challenge due to entry of prosumer:

- ✓ **Dynamic measurement range enlargement:** Generation energy level (1-500MWatt) is much higher than consumption (100kWatt)

- ✓ Sensitivity to ultra low power gives rise to measurement **quantum effects** that disrupts energy metering

- ✓ **2nd harmonic problem:** Renewable energy insert harmonics: conventional digital meters are **not always sensitive** to harmonics.



Solution:

- ✓ Good quality meters are sensitive to larger dynamic range **1kWatt-500MWatt**

- ✓ Good quality meters + designed according to **IEEE 1459 or DIN 40110-1,3**

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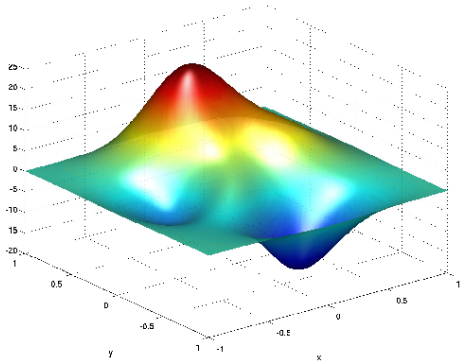
National meters lab

Optimize your Renewable cost-benefit

#3rd + 4th benefits: optimization



you may receive as a result of metering:

- ✓ Load and price forecasting 30 days ahead

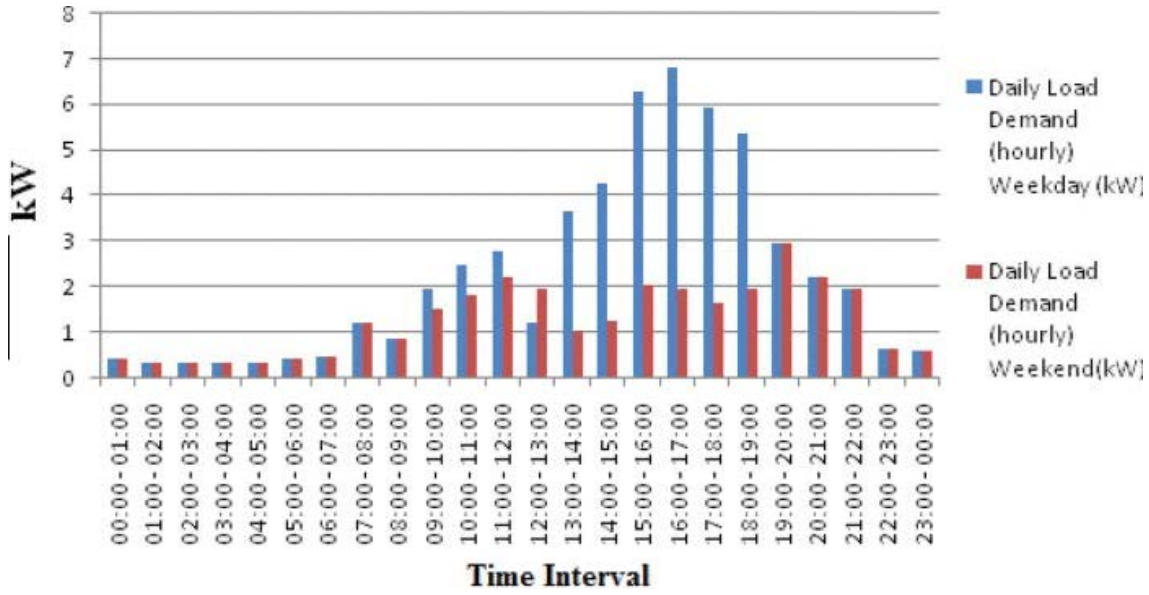
- ✓ Extending battery life – a key technology to E-storage and enabling micro-grid

Optimizing correctly

- ✓ Liberalized market: Optimization of selling electricity to the provider

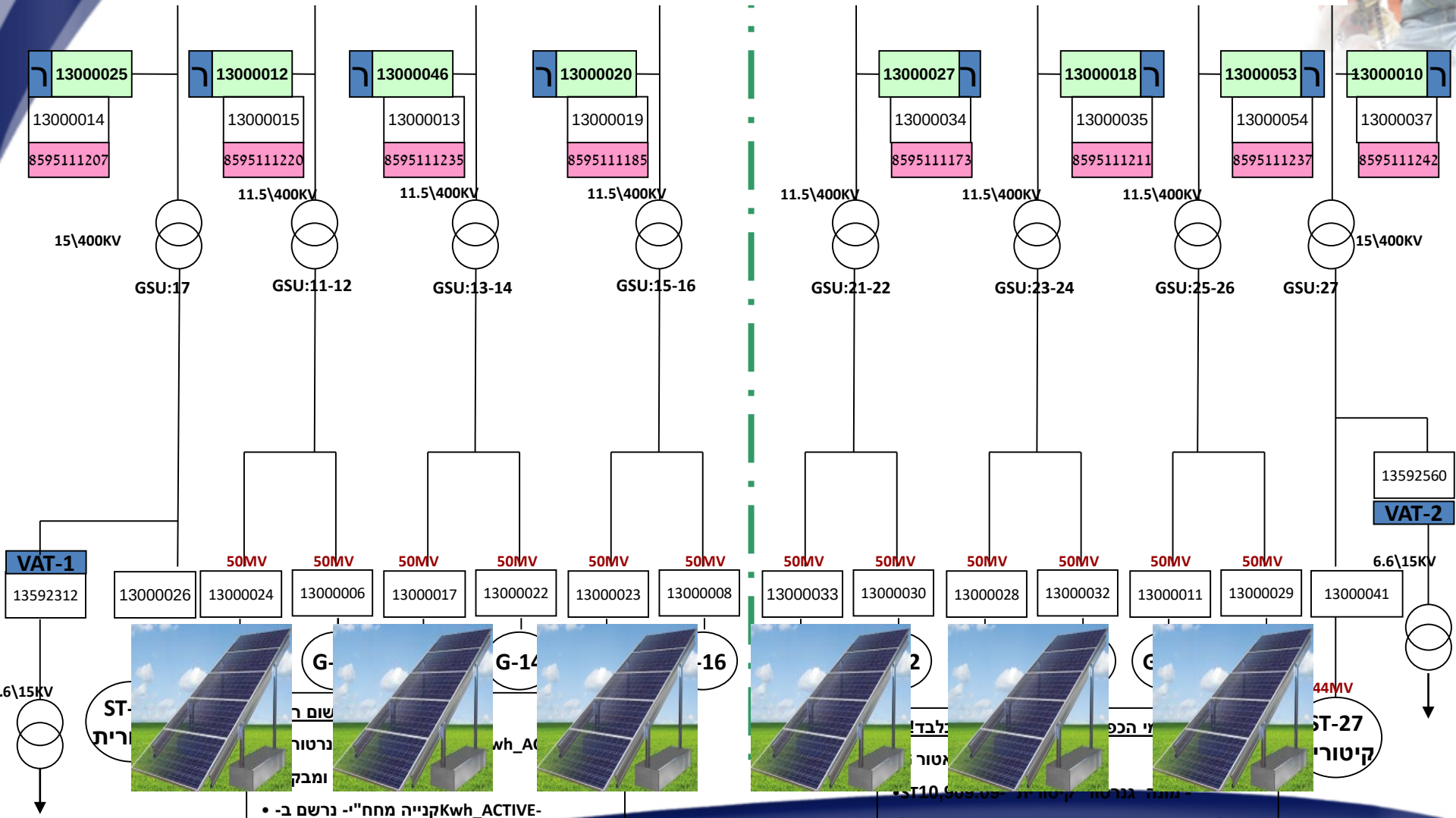
New requirements from metering systems that did not exist before

- ✓ **Load profile - a new feature:** accurate energy **quarterly hourly** measurement from prosumers



- ✓ **Problem:** meterology **standards** handle only bi-monthly billing registers
- ✓ How to guarantee accurate measurement?

New requirements from metering systems that did not exist before – energy balance



New requirements from metering systems that did not exist before energy balance

Large solar arrays. We want to perform both (1) quarter-hourly billing (2) an energy balance of separate fields/farms to the grid collected energy

How do we make sure that all meters are measuring

1) simultaneously

2) and accurately

Problem of energy balance using array of meters

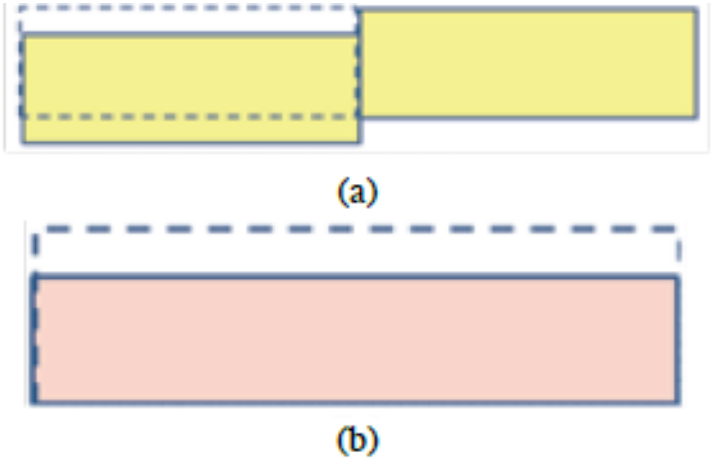


Fig. 3. (a) relative view of two periods of two slightly miss-synchronized meters. Yellow rectangles represent actual time of two meters on simultaneous time. The dotted line represents a hidden assumption that both times are simultaneous. (b) A partially filled minimal quanta registered by meter.

Solution:

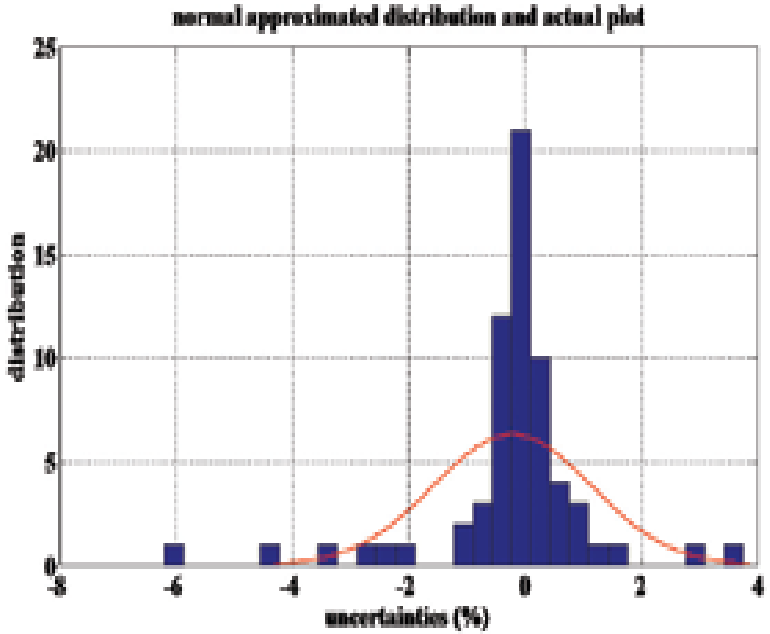
✓ synchronize all meters to a single source

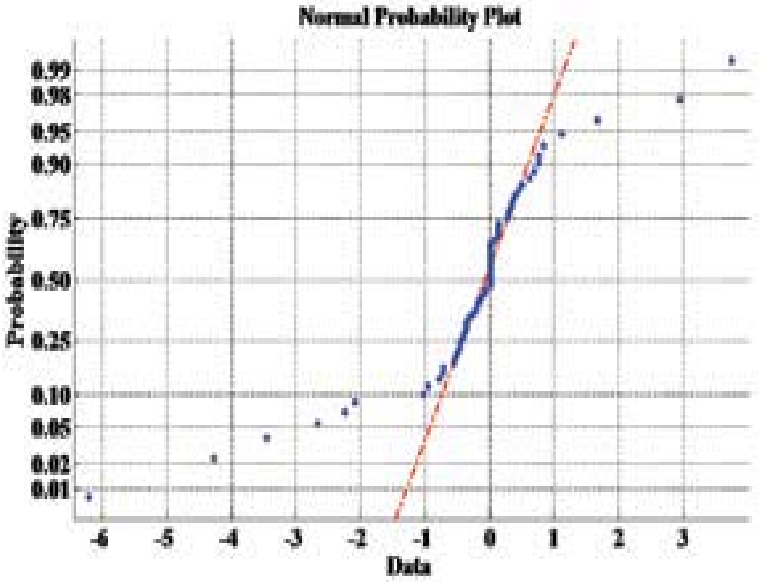
SNTP – Server Network Time Protocol

Either:

PC simple computer or accurate clock server

Accurate synchronization of meters



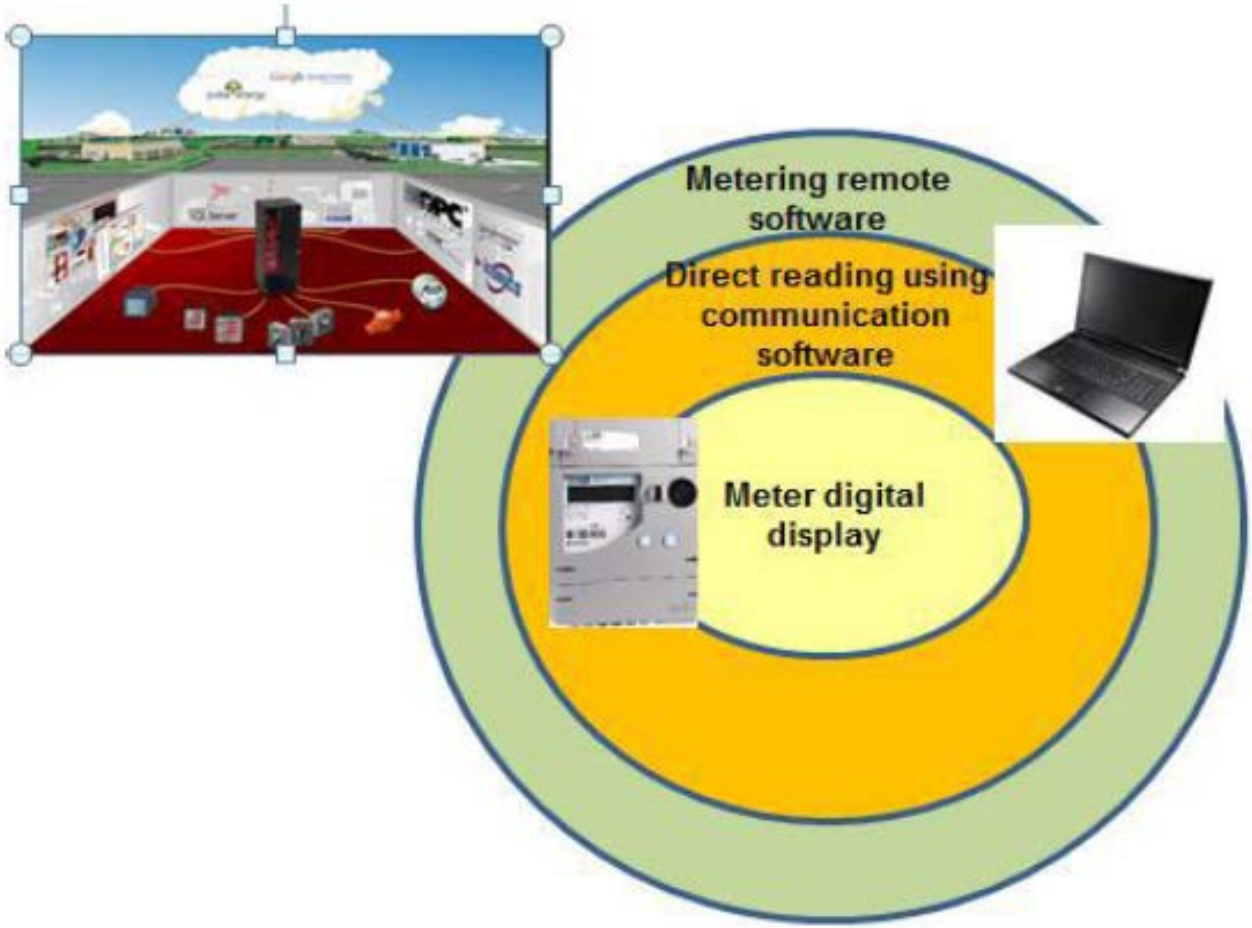


New requirements from metering systems that did not exist before – correct functionality

- ✓ Besides accuracy there is issue of **measurement correction:** measurement that is suitable to a prosumer – producer/ consumer situation:
- ✓ Separation of **active import/export energy consumption:** Arithmetic measurement and not the traditional vector measurement
- ✓ Correct **tariff** measurement
- ✓ Electricity **events logging**
- ✓ ::

New requirements from metering systems that did not exist before

- ✓ Metering scope is much wider



Recommended Solution to all these problems is simple

Accuracy of measurement:

Paper on issue

- ✓ Use a meter that is designed in accordance with standard IEEE 1459, or DIN 40110-1, 3
- ✓ Or: validated at lab in accordance with these standards

Correction of measurement:

Paper on issue

- ✓ Use a meter that is certified logo according to standard DLMS/COSEM (IEC 62056)

Or:

PLC meters: prime+T5 or IDIS or G3 logos

- ✓ Or go to a meters **functional validation** lab Specializing at these standards

Israel Electric
National meters lab

Summary of benefits:

- ✓ 1st benefit: load and price hourly forecasting 30 days ahead
- ✓ 2nd benefit: technical/non technical loss detection
- ✓ 3rd benefit: optimization of E-storage lifespan and of selling renewable energy

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Thank you