Systems Work

Addressing complexity

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A **system** is a set of interacting or interdependent components forming an integrated whole.[1]

Systems work
Addressing complexity

The multiplicity of technologies and their convergence in many new and emerging markets, particularly those involving large scale infrastructure now demand a top down approach to standardization, starting at the system or system architecture rather than at the product level.

System standards are increasingly required in sectors such as environment, safety and health.

To prevent conflicting standards (and regulations), it will be necessary to take account of the implied need for increased co-operation with many other standards-developing organizations, as well as with relevant non-standards bodies in the international arena.

There will also be implications for the IEC's conformity assessment systems and processes.

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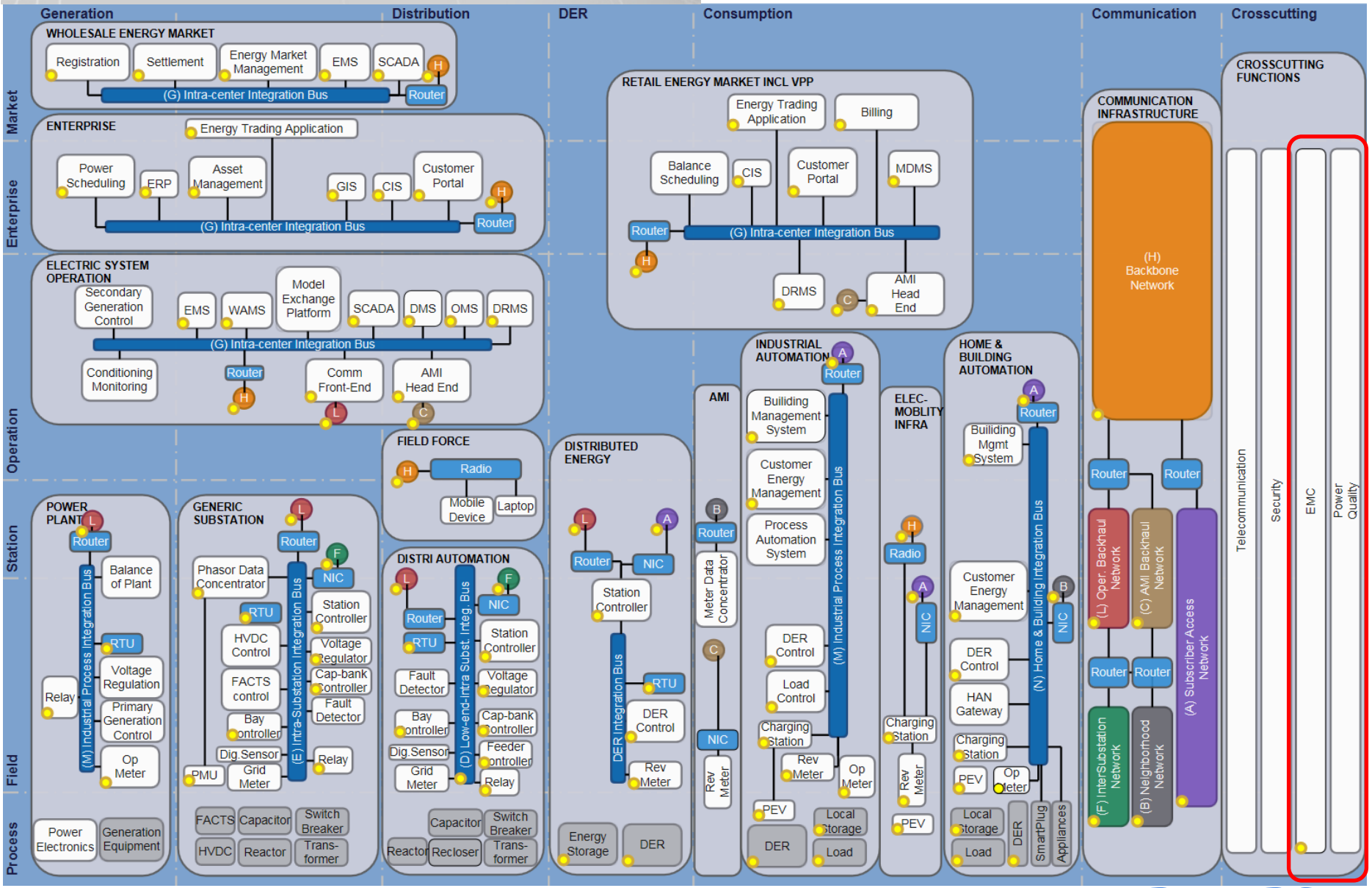
SMART GRID STANDARDS MAP
INTERNATIONAL ELECTROTECHNICAL COMMISSION



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Power factor in single phase systems

An example of System Work

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The power, transport & distribution companies and installers have a concern about the power factor since it impacts the quality and efficiency of the grid.

Generation

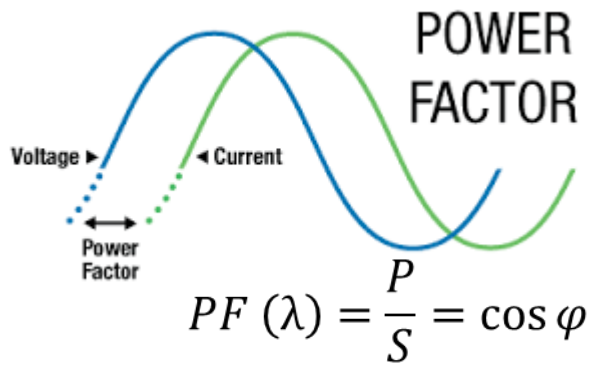
Transport & Distribution

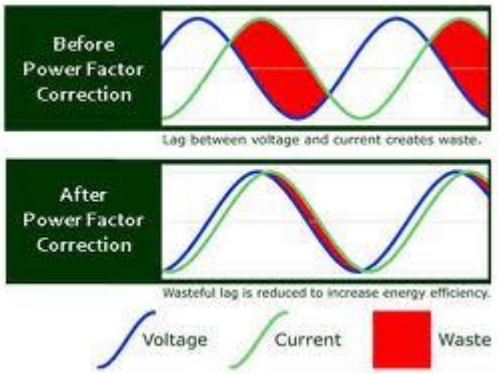
Installers

Consumption

What are the issues?

For historical reasons, technical and physical terms deployed in electrical engineering are often used incorrectly





These inaccuracies are increasingly causing problems in communication and give rise to misunderstanding between different stakeholders, e.g.:

(Low) power factor of individual loads / products is often incorrectly associated with:

- A (low) efficiency of the load / product
- An increase of the supply network and generation losses
- An increase of the voltage disturbance (THDv)
- The overload of supply network components (transformers , PEN conductors, …)
- Compensation by capacitors
- Power measurement problems

What is needed?

1. Correct terms & definitions → work in progress at IEC SC77A WG1 → IEC TR 61000-1-7

Power factor

As under periodic conditions, the power factor λ is defined as the ratio of the absolute value of the active power P to the apparent power S:

$$\lambda = \frac{|P|}{S} = \frac{\left|\frac{1}{kT}\int_{\tau}^{\tau+kT} u(t)\cdot i(t)\,dt\right|}{\sqrt{\frac{1}{kT}\int_{\tau}^{\tau+kT}[u(t)]^2\,dt}\cdot\sqrt{\frac{1}{kT}\int_{\tau}^{\tau+kT}[i(t)]^2\,dt}}$$

where:

$$u(t) = U_0 + U_1\sqrt{2}\cdot\sin(\omega t + \alpha_1) + \sum_{\substack{m>0\\ m\neq 1}} U_m\sqrt{2}\cdot\sin(m\omega t + \alpha_m)$$

$$i(t) = I_0 + I_1\sqrt{2}\cdot\sin(\omega t + \beta_1) + \sum_{\substack{m>0\\ m\neq 1}} I_m\sqrt{2}\cdot\sin(m\omega t + \beta_m)$$

m is the harmonic order and is a positive real number different from 0 and 1
$0 < m < 1$ sub-harmonics (or sub-synchronous inter-harmonics)
$1 < m \leq 40$ harmonics and inter-harmonics*
$40 < m < 180$ supra-harmonics

* It is an integer number for harmonic components and a non-integer number for inter-harmonic components

and can be written as the product of two factors:

$$\lambda = \lambda_1 \cdot \lambda_N$$

where

λ_1 is the fundamental power factor, which is related to the phase angle (displacement) between the fundamental voltage and current components

λ_N is the non-fundamental power factor, which depends on the direct, harmonic, sub-harmonic, inter-harmonic and supra-harmonic voltage and current components.

What is needed?

1. Correct terms & definitions → work in progress at IEC SC77A WG1 → IEC TR 61000-1-7

2. Correct measurement methods → upcoming work in IEC SC77A WG1

3. Understanding the propagation and distribution of the different voltage and current components in the supply network, including the interaction between these components.
   - Phase-angle
   - Direct
   - Harmonic
   - Sub-harmonic
   - Inter-harmonic
   - Supra-harmonic

4. Quantification of the influence of the different voltage and current components on the supply network with regard to:
   - Efficiency (losses)
   - Quality (voltage disturbance, overload of the supply network components)

5. Define adequate requirements for the current and voltage components at system and product level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