Commission « DC & Digital »

SBA SMART BUILDINGS ALLIANCE for SMART CITIES

« RESEAUX COURANT CONTINU POUR LA VILLE DURABLE »

Prof. Jean-Luc THOMAS

Visioconférence TEAMS – 05 juin 2020

- UN CONSTAT -

Vers une société plus électrique ...
… au cœur de la ville durable

- UNE QUESTION -

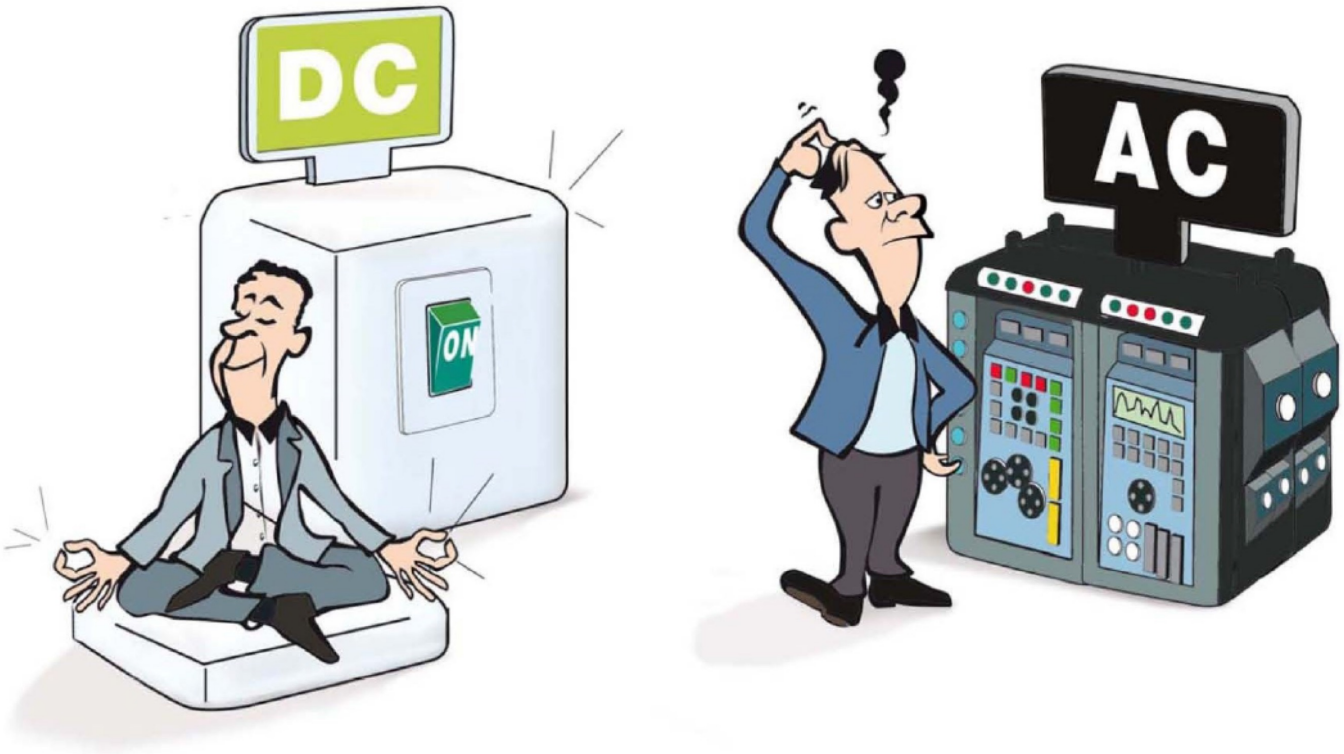
Architecture optimale de réseaux de distribution de l'énergie électrique ?

Ville durable = AC + DC ?

- LE CONTEXTE -

- La **renaissance du courant continu** (DC) en réponse aux **nouveaux usages / besoins numériques**
- Vers une **décentralisation de la distribution électrique** à travers les réseaux « microgrids », de type **hybrides AC et DC**, intégrant plus de **stockage**
- Disponibilité de **transformateurs DC/DC** de plus en plus performants
- L'**autoconsommation** individuelle et collective font partie intégrante de cette problématique, basée sur des **réseaux AC et DC**,
- Les **réseaux à courant continu** intègrent naturellement les contraintes liées aux infrastructures de recharge des véhicules électriques, plus généralement de la **mobilité électrique,**
- Les aspects **sociétaux, économiques, environnementaux, règlementaires** sont à considérer au même titre que le volet **technologique**,

- UNE QUESTION -



Ville durable = AC + DC ?

- DEFINITIONS -

Architectures hiérarchiques de réseaux électriques

Grid – T&D Centralisé – (HVDC)

Micro-Grid – Inter Bâtiments – (MVDC)

Nano-Grid – Intra Bâtiments – (LVDC)

- LE RAPPORT - CSA Group -

Groupe CSA
Services d'essai
et de certification

This research study reviewed current trends in DC-based distribution technology, including standards development activities, and evaluated forty-three recent DC microgrids (including commercial, institutional, industrial, and nanogrid residential projects).

1. Establishing standard DC voltage levels and ranges;
2. Developing approval criteria for DC power metering equipment for revenue billing;
3. Establishing standard receptacle and plug configurations for DC circuits;
4. Updating product standards to enable commercialization of DC lighting, motor drives, and electric vehicle supply equipment;
5. Clarifying rules for interconnection of distributed energy resources;
6. Determining life safety installation provisions for DC microgrids; and
7. Developing product standards and installation rules for DC protective devices.

- LE RAPPORT du CSA Group -

"DC-powered systems promise a few advantages over AC, but in its current state, the technology is still in its infancy."

- LE RAPPORT du CSA Group -

The status quo is well entrenched: most current design methods, industry practices, manufacturing, and safety standards are geared towards AC. As a response to the need for change, this research study analyzed the current standards environment to determine gaps and identify the most critical steps to enable adoption of DC power systems. The following are the seven highest priority items that were identified:

- LE RAPPORT du CSA Group -

1. Establish standard DC voltage levels and ranges. In determining these, key factors that need to be balanced are: safety, cost, energy efficiency, compatibility, and range constraints.
2. Develop approval criteria for DC power metering equipment for revenue billing. This is a crucial cornerstone for this technology to become commercially competitive.
3. Establish standard receptacle and plug configurations for DC circuits in order to enable plug-and-play functionality which would be crucial for mass-market adoption. The widely used USB and PoE interfaces only address lower-power devices.

- LE RAPPORT du CSA Group -

4. Update product standards to enable commercialization of DC utilization equipment, with lighting equipment, motor drives, and electric vehicle supply equipment being the most immediately relevant.

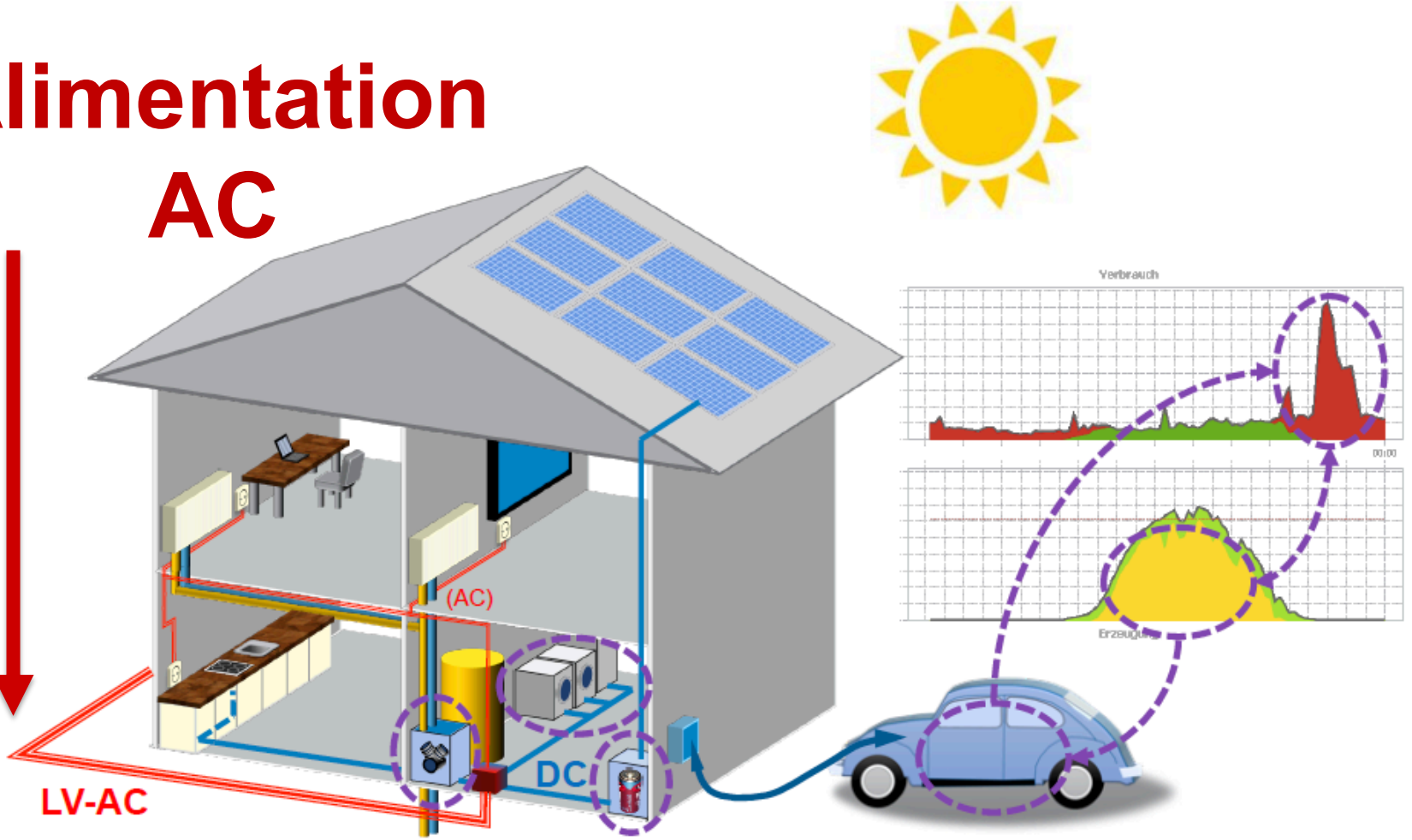
5. Clarify the rules for interconnection of DERs. As distribution systems with DERs become more complex, updated rules are needed to accommodate these dynamic environments. The main issues to be considered are: islanding, isolating means, interconnection locations, microgrid control and demand management, conductor sizing, and interrupting current.

- LE RAPPORT du CSA Group -

6. Determine life safety installation provisions for DC microgrids, namely, emergency power, lighting, fire alarm, and fire protection.
7. Develop product standards and installation rules for DC protective devices.

Smart eHome with DC-Link, heat pump and PV connected to AC Grid

Alimentation AC

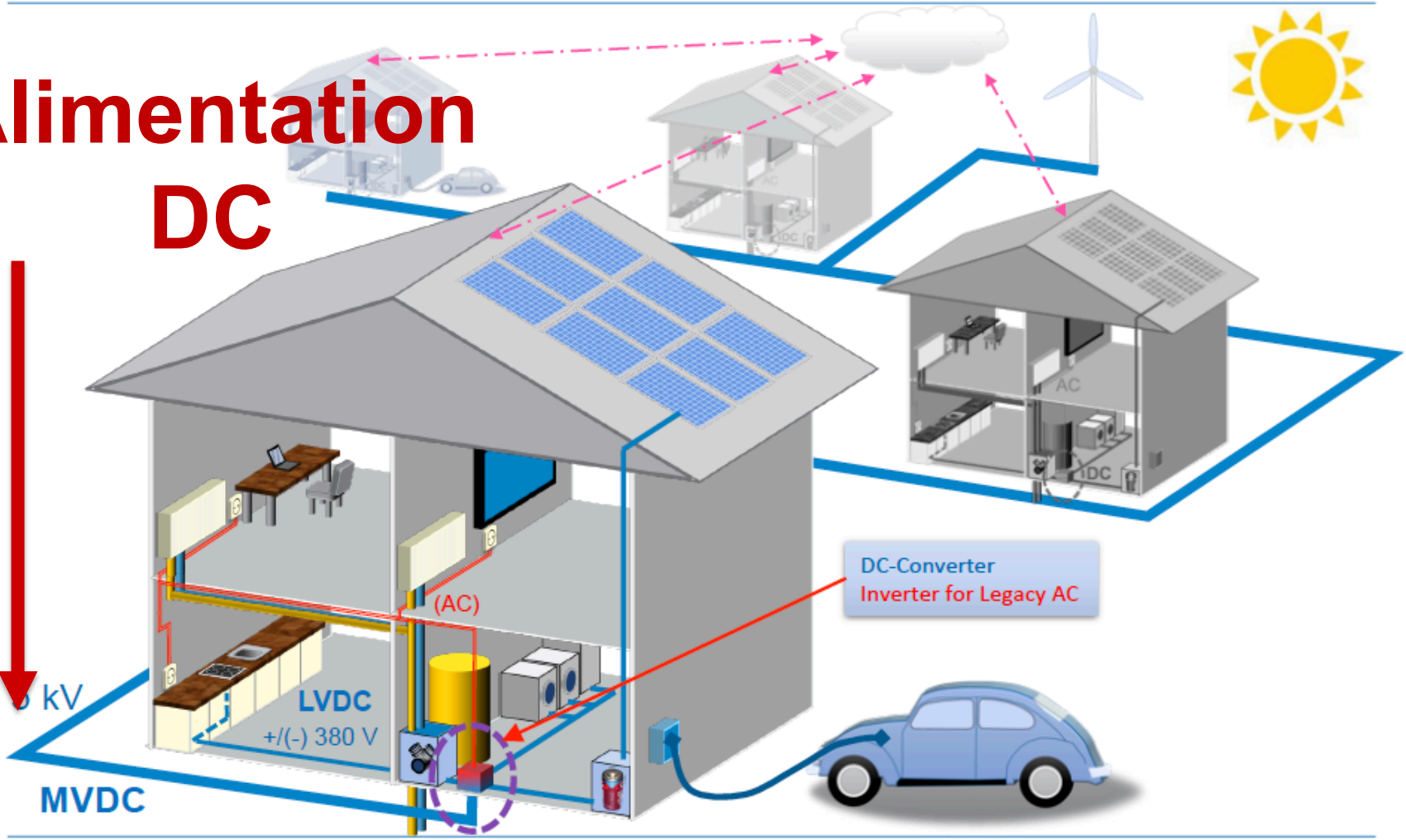


Source: Prof. Rik de Doncker

DC-grid and energy management in a DC quarter

Lower infrastructure cost, higher efficiency, and bidirectional

Alimentation DC

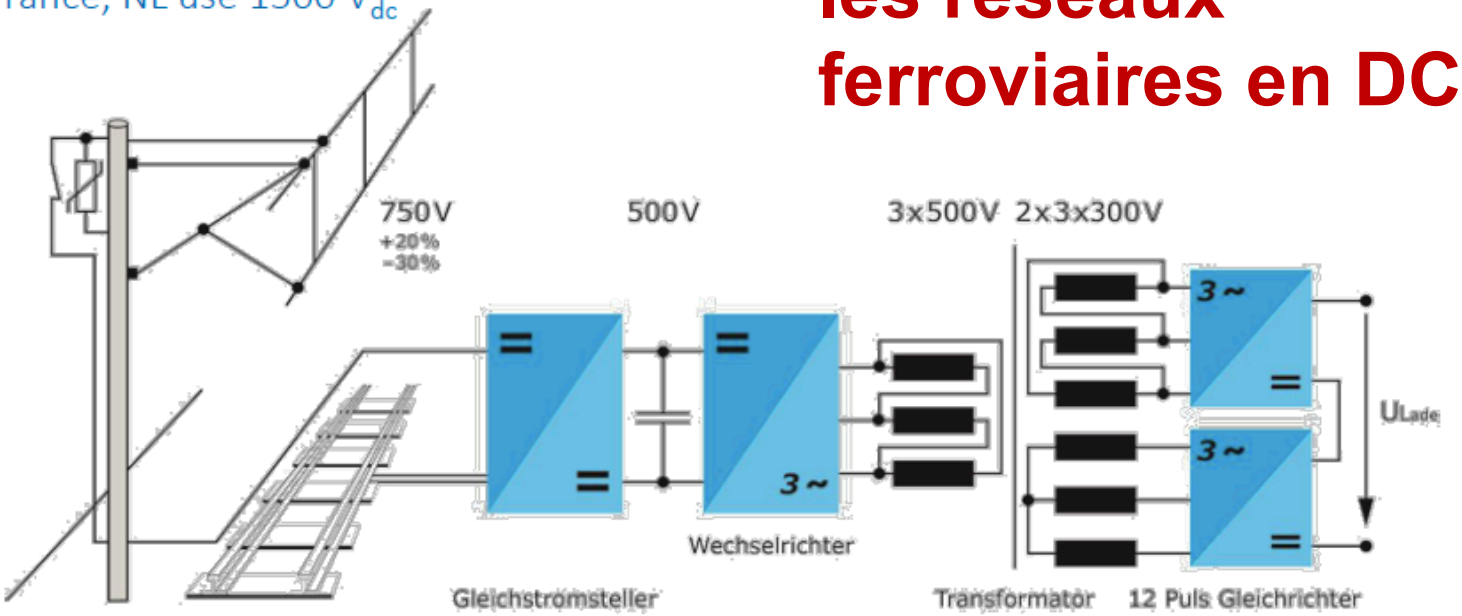


Source : Prof. Rik de Doncker

Available Fast-Charging Infrastructure
Dual Use of Railway and Light Rail Infrastructure

- Low utilization of large capacity railway infrastructure (12%)
- Existing capacities can be used for fast charging
- Railway and light-rail grids are available in cities
  - Light rail typically 750 V_{dc}
  - Belgium, Spain, Italy, Russia use 3000 V_{dc}
  - France, NL use 1500 V_{dc}

Interconnexion avec les réseaux ferroviaires en DC !

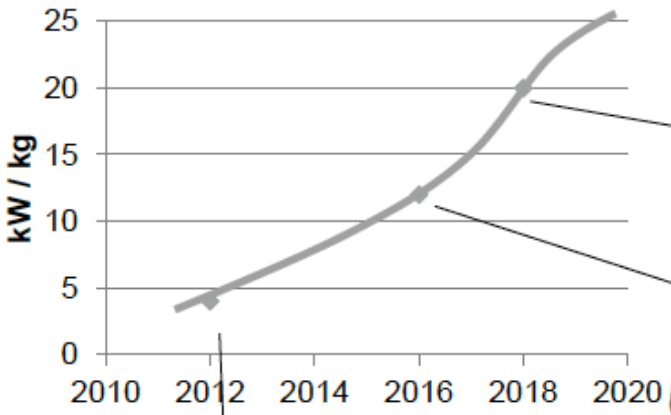


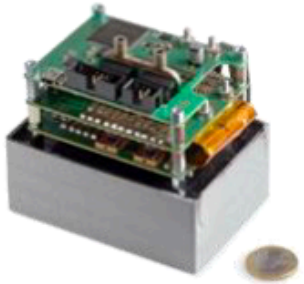
Source: Müller-Hellmann

Source : Prof. Rik de Doncker

Power Density Development of DC-DC Converters

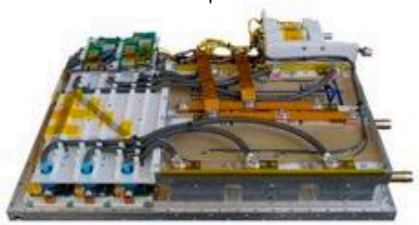
E.ON Energy Research Center





2018
- f_{sw} = 400 kHz
- discrete SiC devices
- 3D-printed cooler and inductor bobbin

2016
- f_{sw} = 150 kHz
- SiC-Module
- classic cooler and inductances



2012
- f_{sw} = *16 kHz*
- *Si-Module*
- *classic cooler and inductances*