DC Grids Opportunities and challenges

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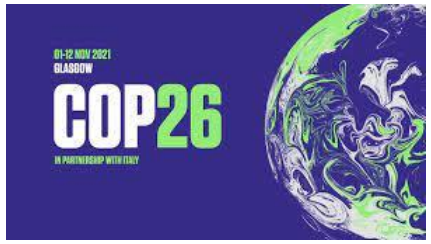
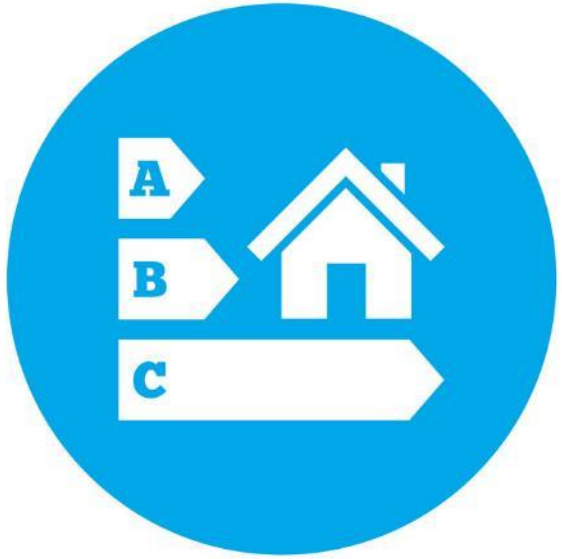
Context

- 2020 climate & energy package : Kyoto 20-20-20 target
- 2030 climate & energy framework : Paris COP21 40-27-27 target
- 

Greenhouse gases emissions

Renewable energy



Energy efficiency

DC Grids (r)evolutions

❑ DC ecosystem is quickly evolving

- Major progresses in power electronics architectures
- Game changing technological innovations (SST, SiC, GaN, etc.)
- Decrease of costs driven by major industries (DER, electromobility, railways…)

❑ Most of the power consumed in residential, tertiary and industrial sectors is DC

Directly (LED lighting, consumer electronics, domestic appliances, IoT…),

Through variable-frequency drives for optimal motor piloting (fridge, washing machine, heat pump…)

❑ 3 new « DC native » applications steadily developing

- Photovoltaic panels, Electric Vehicles and Storage
- Integration challenges on LV and MV grids questioning their design

⇨ **Could DC grids improve electric systems operation and efficiency, and reduce costs ?**

EDF response to climate challenges, the DC side

- Development plans for 3 big assets

Solar Power Plan : **30 GW in France by 2035**
(8GW today)

LE PLAN **stockage** électrique

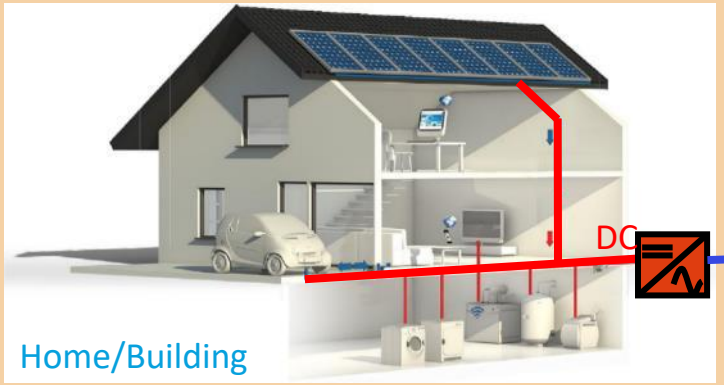
Electricity Storage Plan :
10 GW in France by 2035
(5GW today)

A potential Electricity Mobility Plan :
Aiming at 100TWh a year of Electricity in the Mobility sector (France)
(10TWh today)

- All have **Direct Current** as a common vector

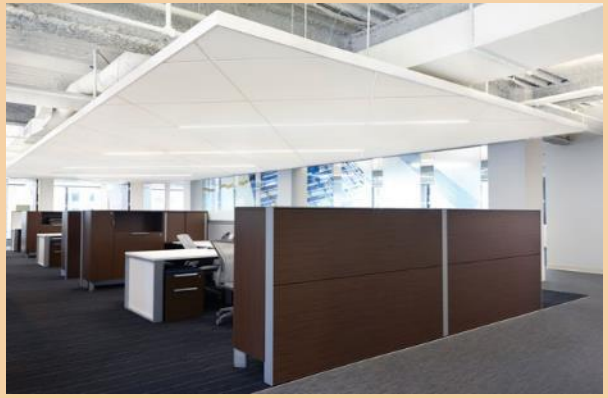
DC : an opportunity in different sectors

❑ Residential



Energy efficiency
Self-consumption (& storage)
EV integration

❑ Commercial

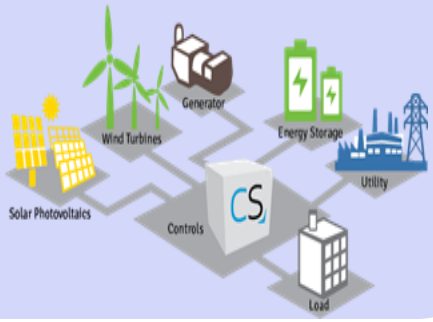


❑ Industrial

Consumption optimisation
Energy and Telecom networks convergence
Cost reduction (Capex and Opex)

❑ Distribution grids

Energy efficiency
Controllability enhancement
Cost reduction (Capex and Opex)



Challenges and needs

- **Technologies**
  - Protection of assets and people
  - Metering
  - Converters and « grand gap » Power Electronics components
- **Tools and methodologies**
  - Operational scheduling and real-time grid optimisation

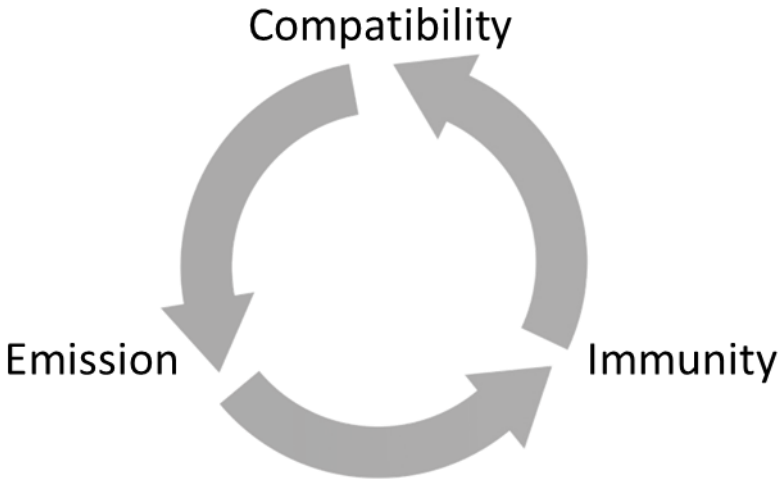
- **Regulations**
  - Transition requires regulation evolutions (new DC-ready buildings and appliances)

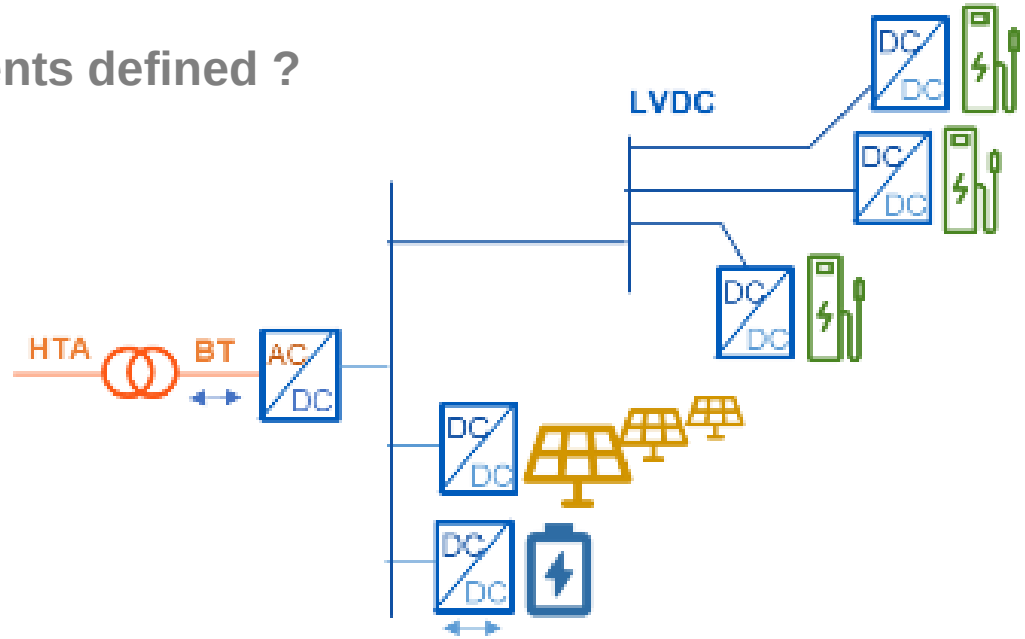
- **Standardization**
  - Architectures allowing to maintain system quality and reliability
  - Methods for ensuring compatibility of appliances with the grid
  - Rules for safe and secure installations

- **People and operators' training**

Challenges for DC metrology

- **DC Power Quality : how are DC voltages and currents defined ?**
  - What is a disturbance ?





- **DC metrology, defining the measurement methods and means**
  - Energy metering
  - Disturbance monitoring
  - Protection : monitoring fast voltage and current transients

} adapted to all envisioned UC

A potential approach…

- **Business Use Cases definition** in Residential, C&I and distribution grids
  - current market structure → Emergence conditions
  - regulatory framework → Adjustment strategies
- Research on **high-potential equipment**
  - Storage, Electric vehicle, Renewables
    → Higher performance and reliability at lower costs
- Grid **architecture optimisation** and control
  - Converters control and Protection components
- **Demonstration** with real-scale tests
- **Training** of people

…for a EU impact

- Aiming at a significant leadership for Europe in the design of electric networks offering **energy efficiency, reliability, economic value and security of the whole electric system**
- **Development of strategic EU industrial sectors**
  - Power Electronics, Energy, ICT…
- New markets domains:
  - from **Smart Homes to Smart Factories**.
- Double positive environmental impact:
  - **Cost-efficient integration of DERs**, i.e. distributed storage, electric vehicles and renewables,
  - Reduction of energy consumption by improving the **electric system efficiency**


Thank you !