Intelligent solutions to the Integration of Distributed Energy Resources (DER) in Active distribution networks

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Study Committee C6 chair

cigre
For power system expertise

Drivers in the development of electricity distribution systems

- **Energy transition** with drive towards sustainability of the electric energy supply
  -> replacing fossil fuel dependence to renewable energy resources (solar, wind, biomass, marine, other forms of energy);
  -> electrification of various sectors, i.e. electric vehicles
- Worldwide **deregulation** of electric energy production and electricity supply allowing access to markets of smaller distributed energy resources (**DER**) owners and operators
  -> **decentralisation** of the electric energy system
- Increased emphasis on electric energy supply **reliability, security** and **resilience**

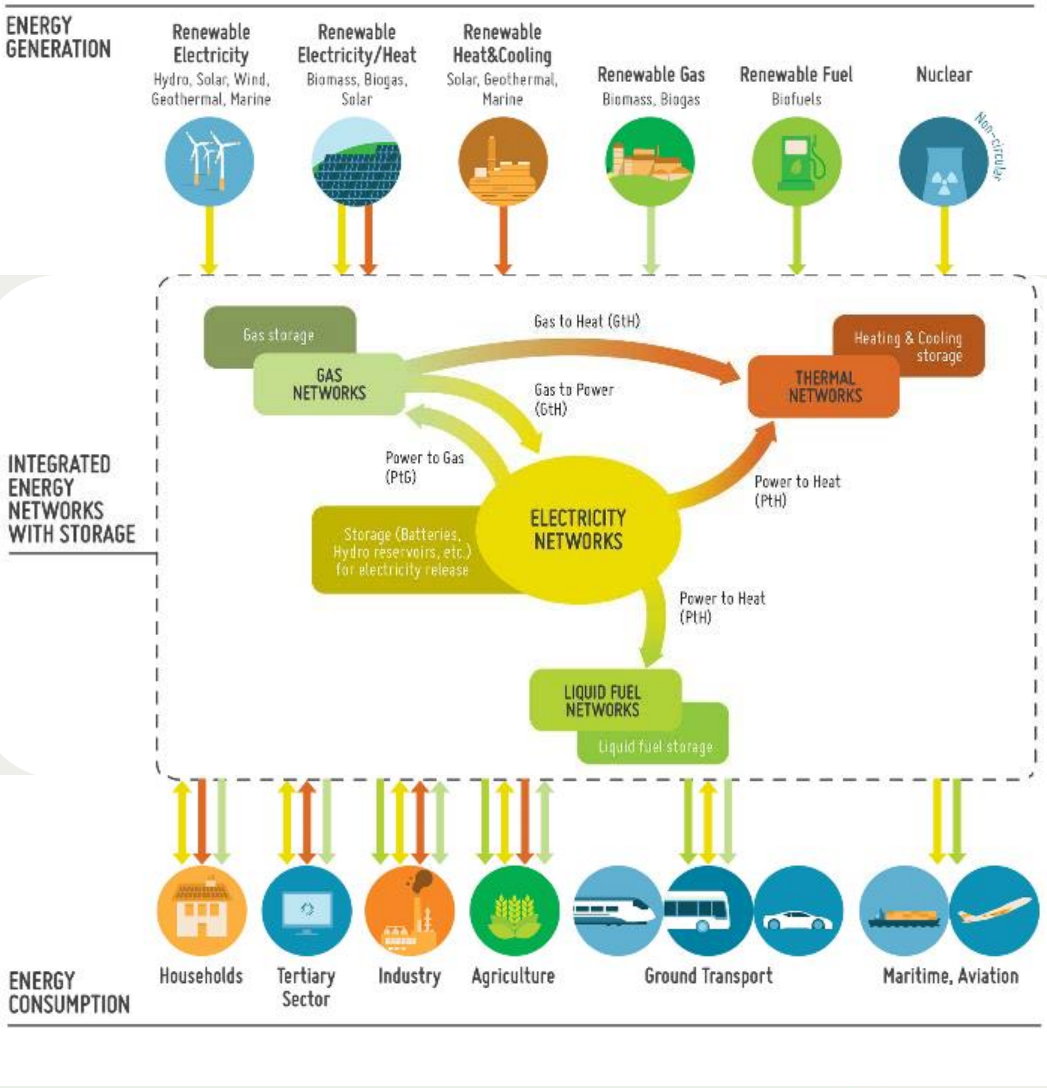
Increasing renewable generation worldwide supporting electrification

Source: McGranaghan, CIGRE Paris 2018

The future of electricity networks

VISION 2050

A SYSTEM OF SYSTEMS



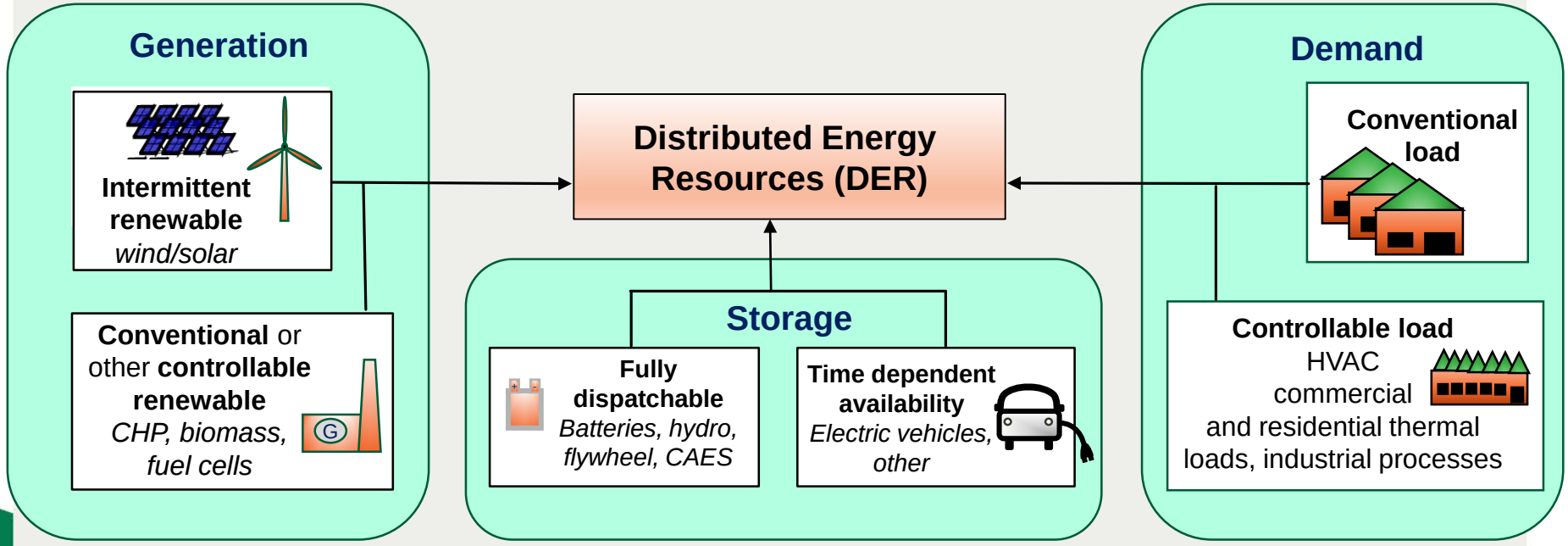
ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

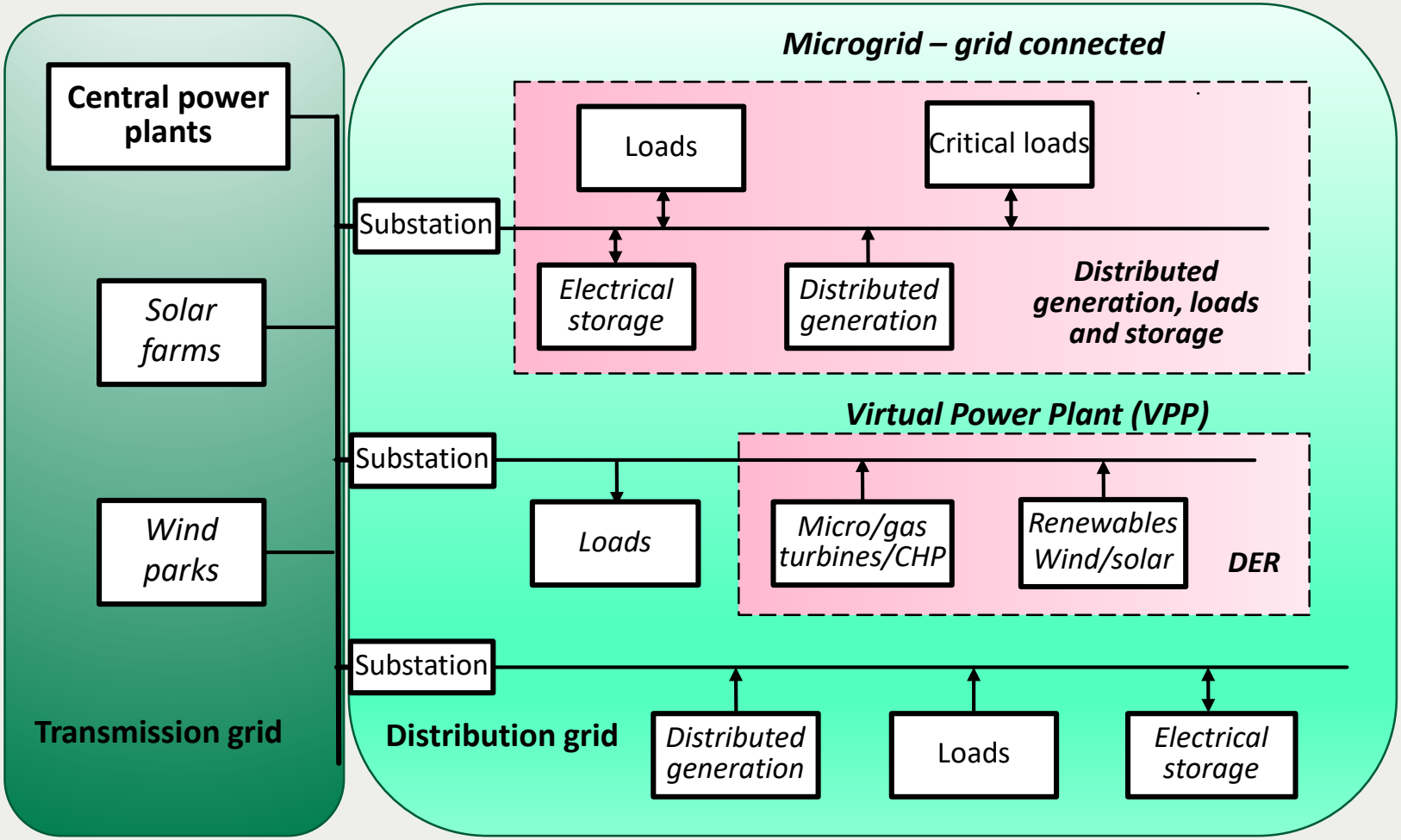
SMART NETWORKS FOR ENERGY TRANSITION

The future integrated energy systems with conversion and storage devices

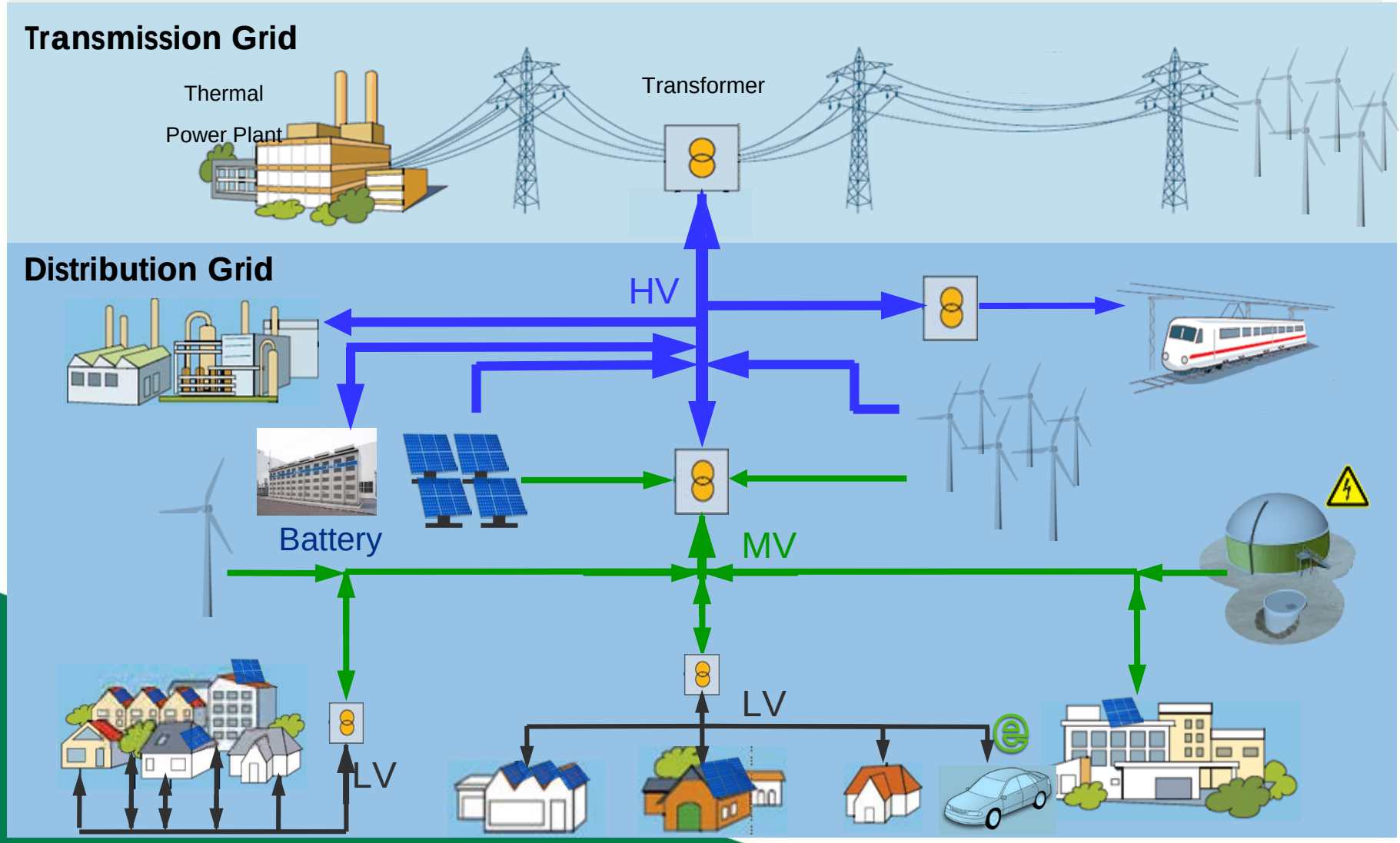
Distributed Energy Resources



Deployment of DER

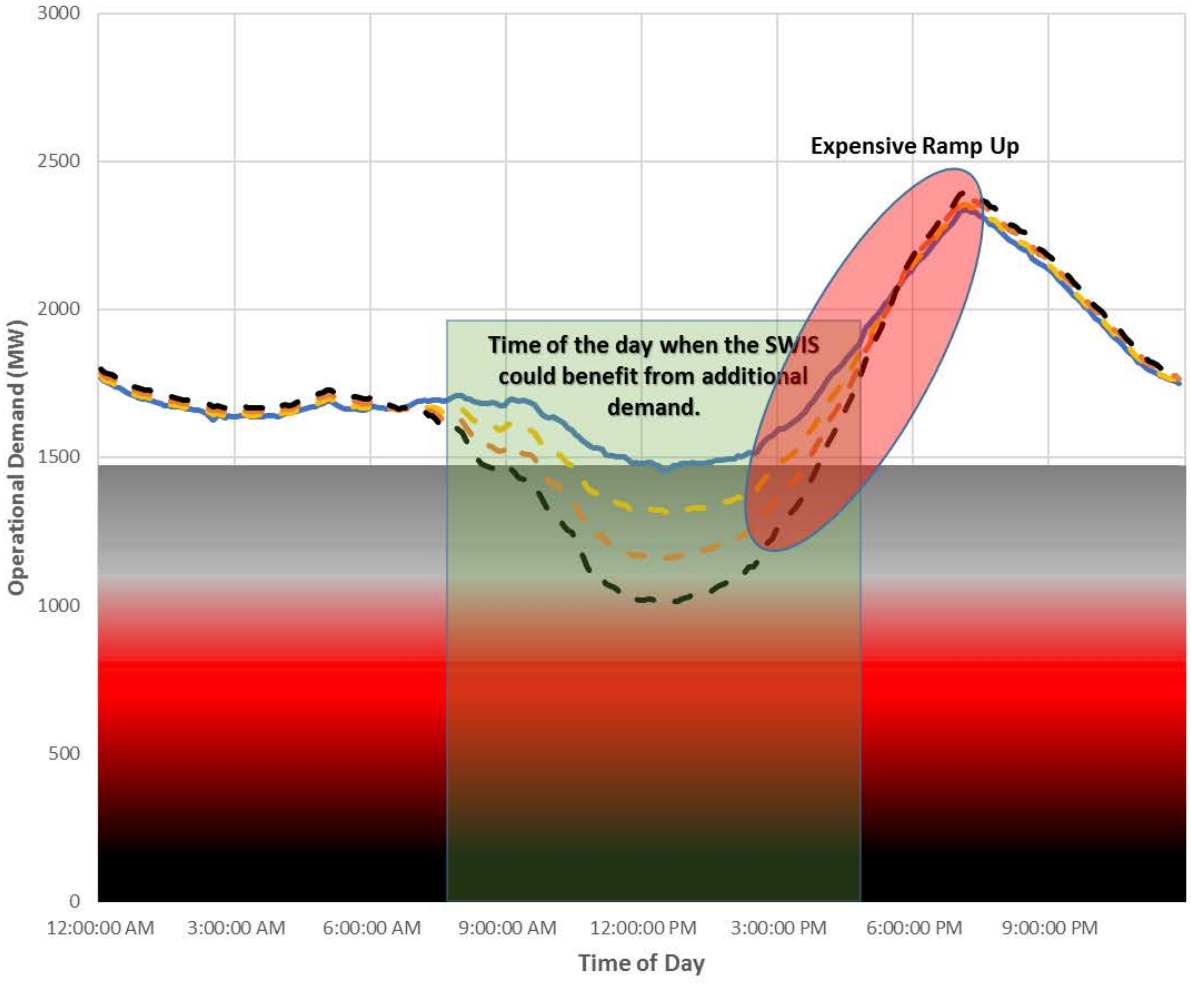


Challenge: Increasing complexity



Source: J. Vanzetta, CIGRE Paris 2018

Challenge: Problems faced with increasing PV Integration – The duck curve

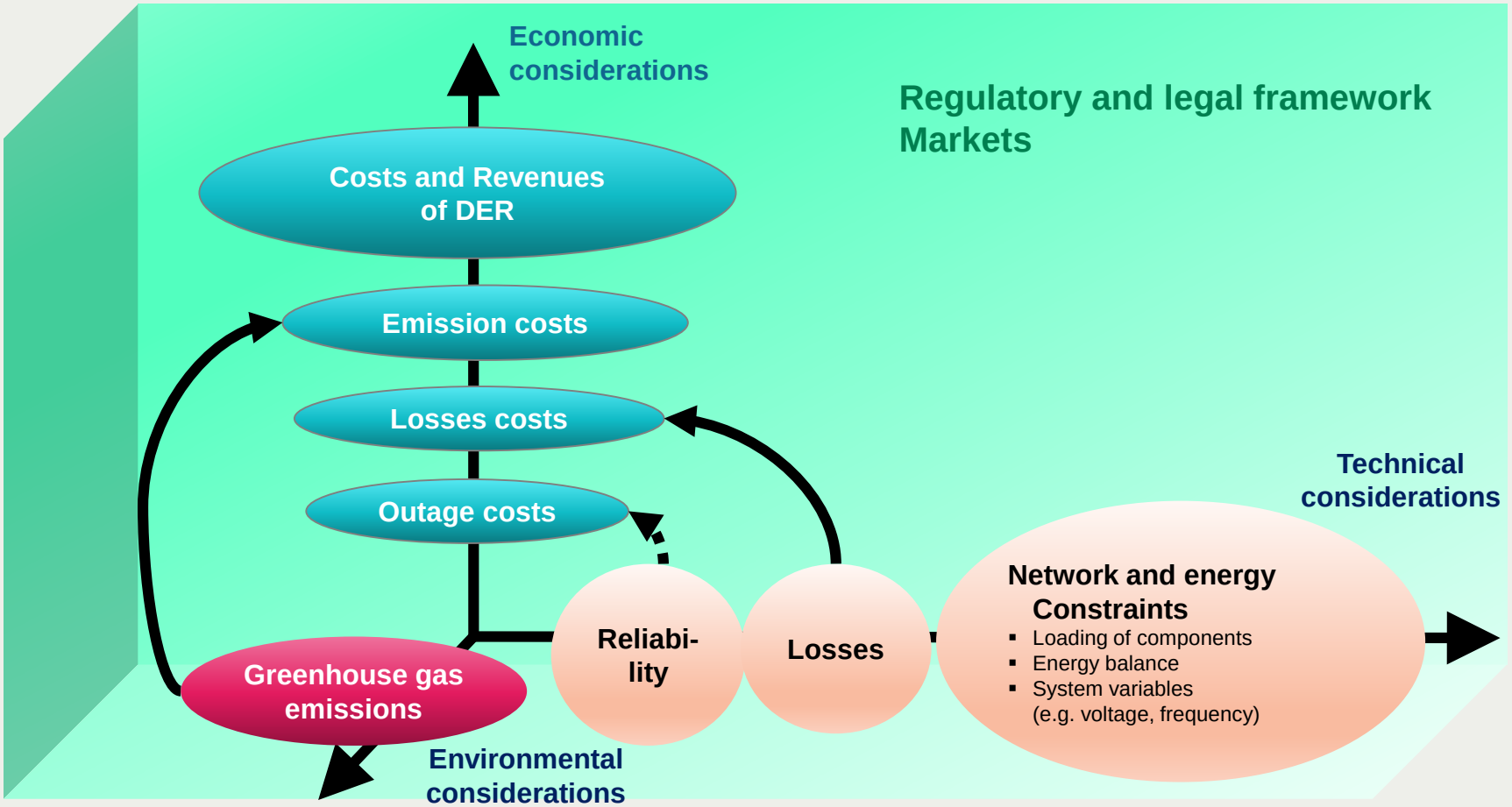


Example:
Western Australia

- Scheduled Generation Inefficiencies
- Market Inefficiencies
- Security Risks
- 2017/18
- 2018/19
- 2019/20
- 2020/2021

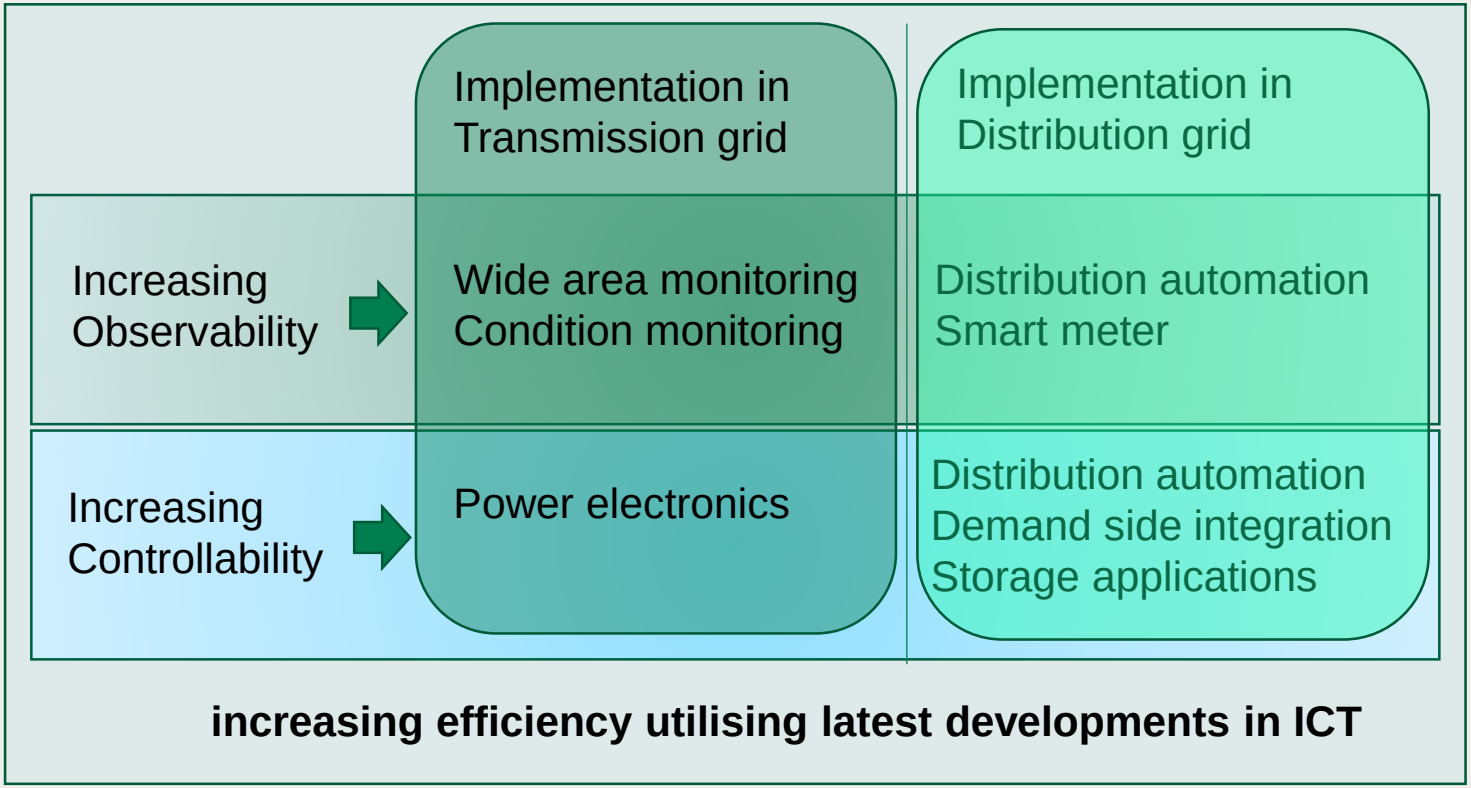
Source: Parrotte, CIGRE Paris 2018

Active distribution network impact assessment

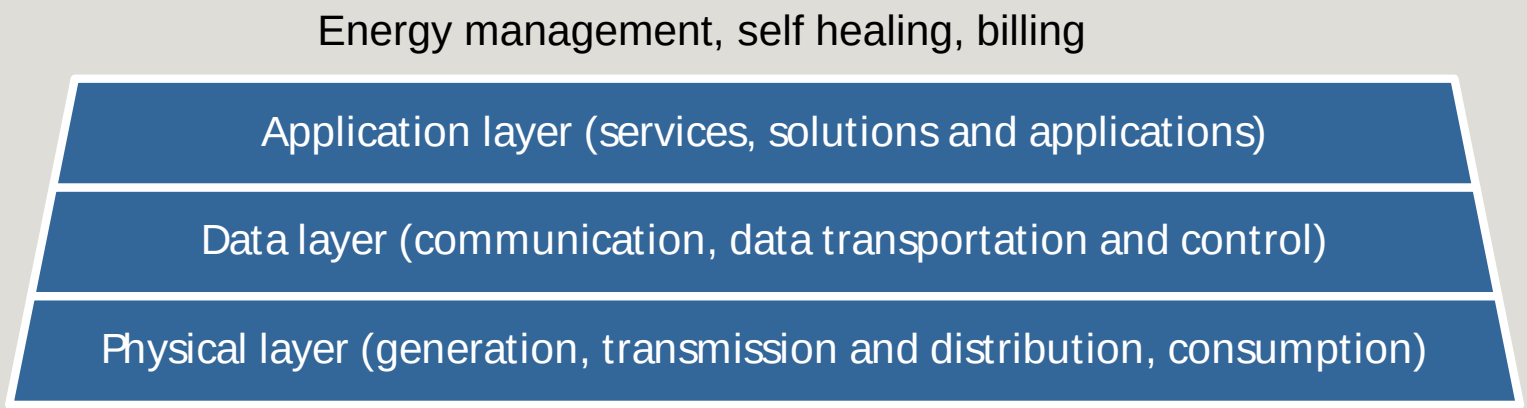


Active distribution networks

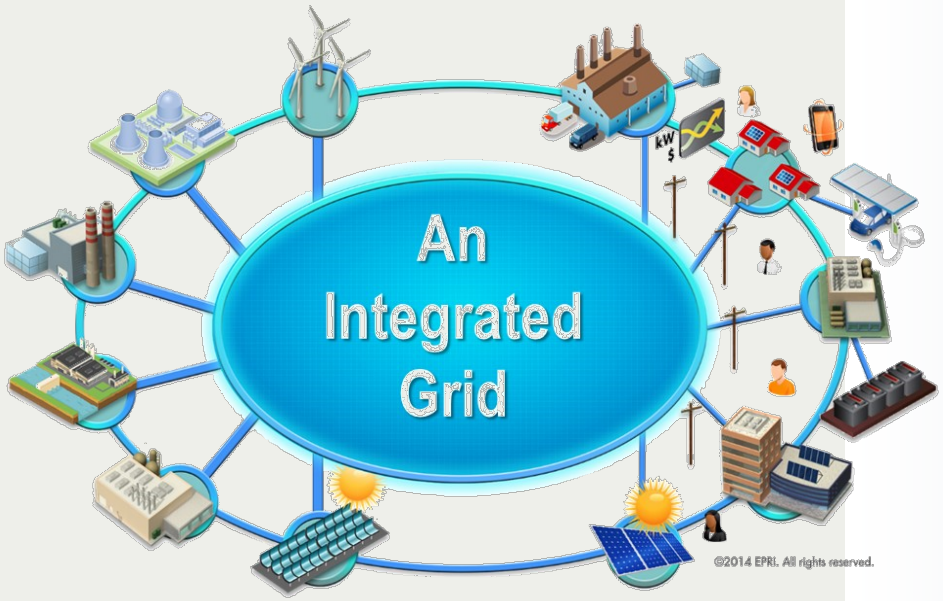
Active distribution networks with



Applications in active distribution networks



The vision – an integrated grid

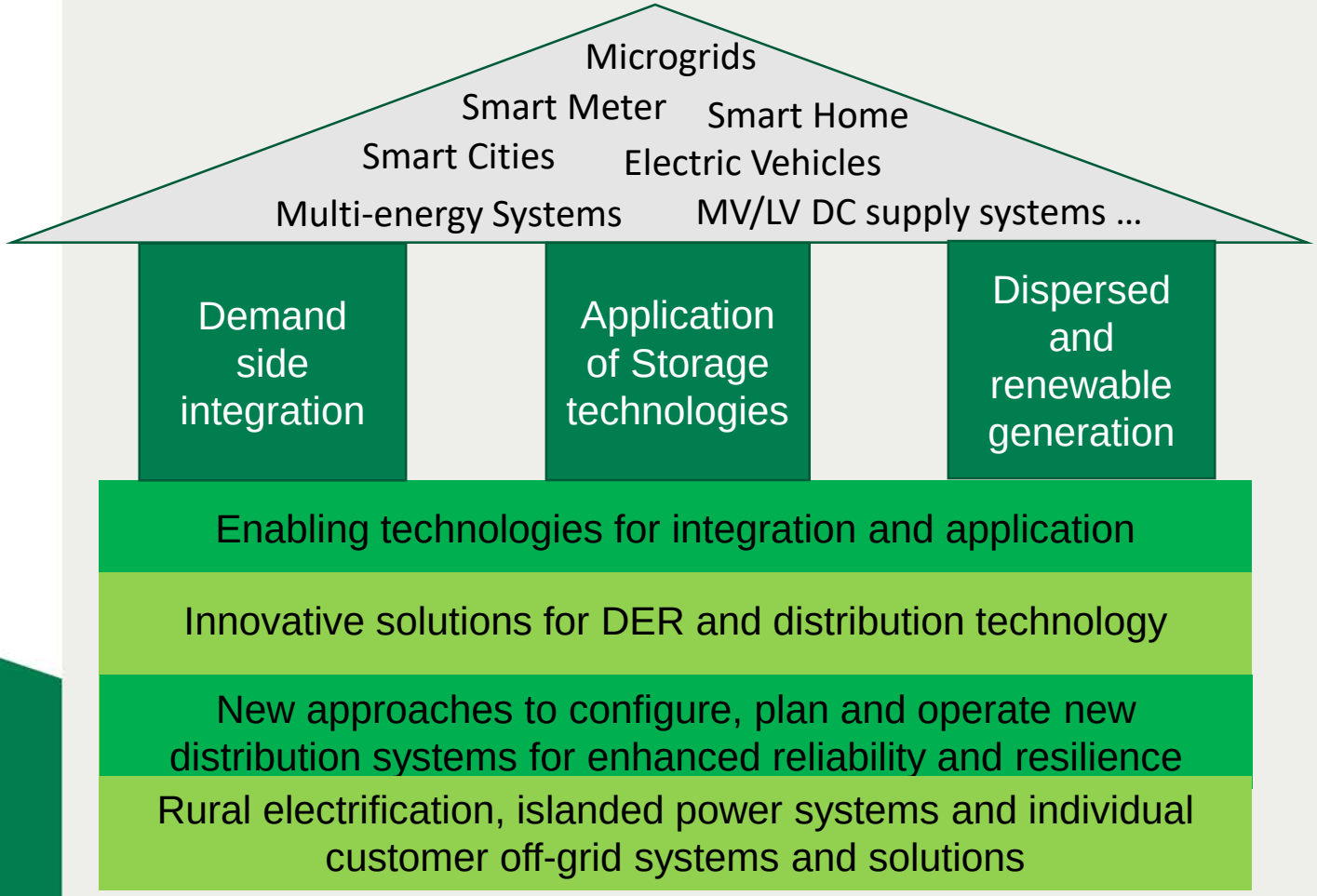


Integration of:
Electricity,
Telecommunications,
and Customer Local
Energy Networks

The Integrated Grid makes *Local Energy Optimization*
Part of *Global Energy Optimization*

Source: McGranaghan, CIGRE Paris 2018

Activities of CIGRE SC C6

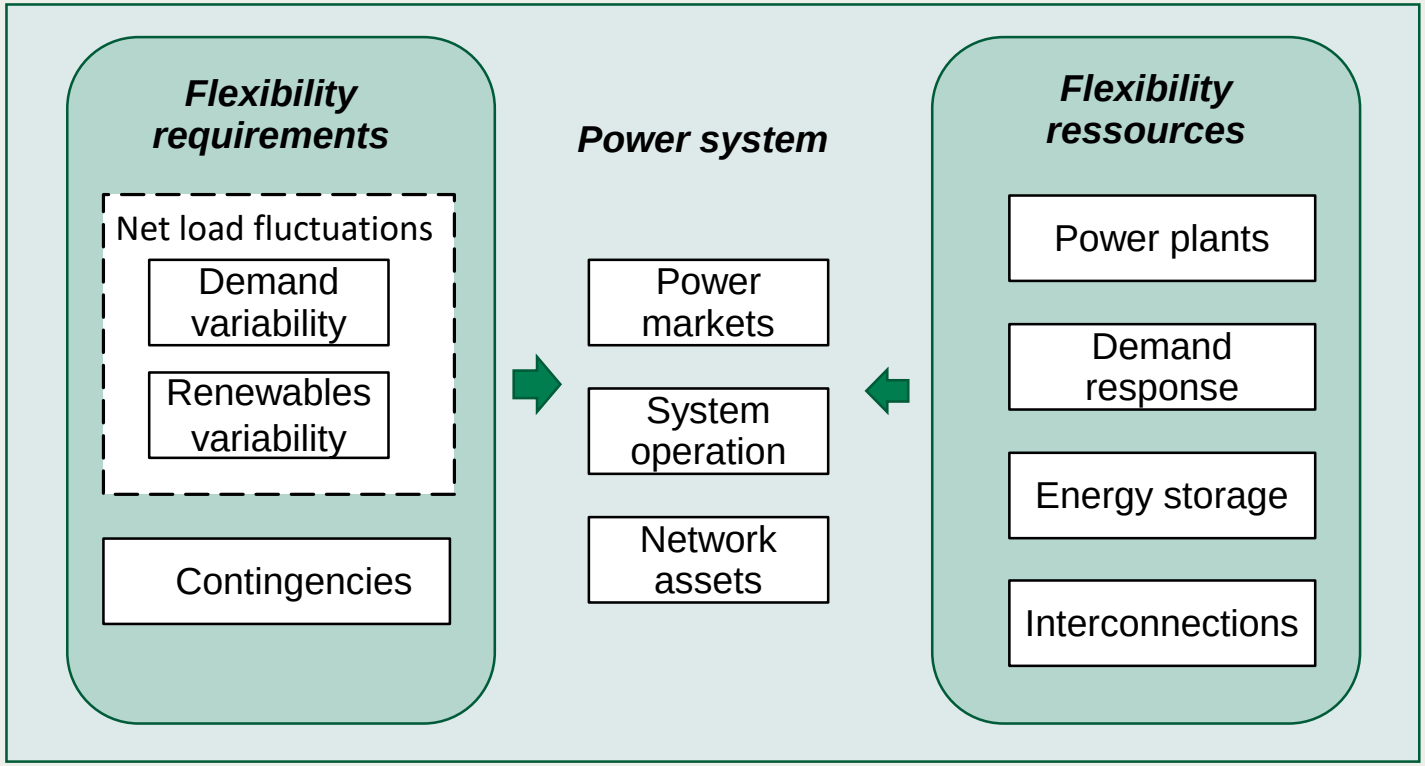


The rooftop:
Applications of interest

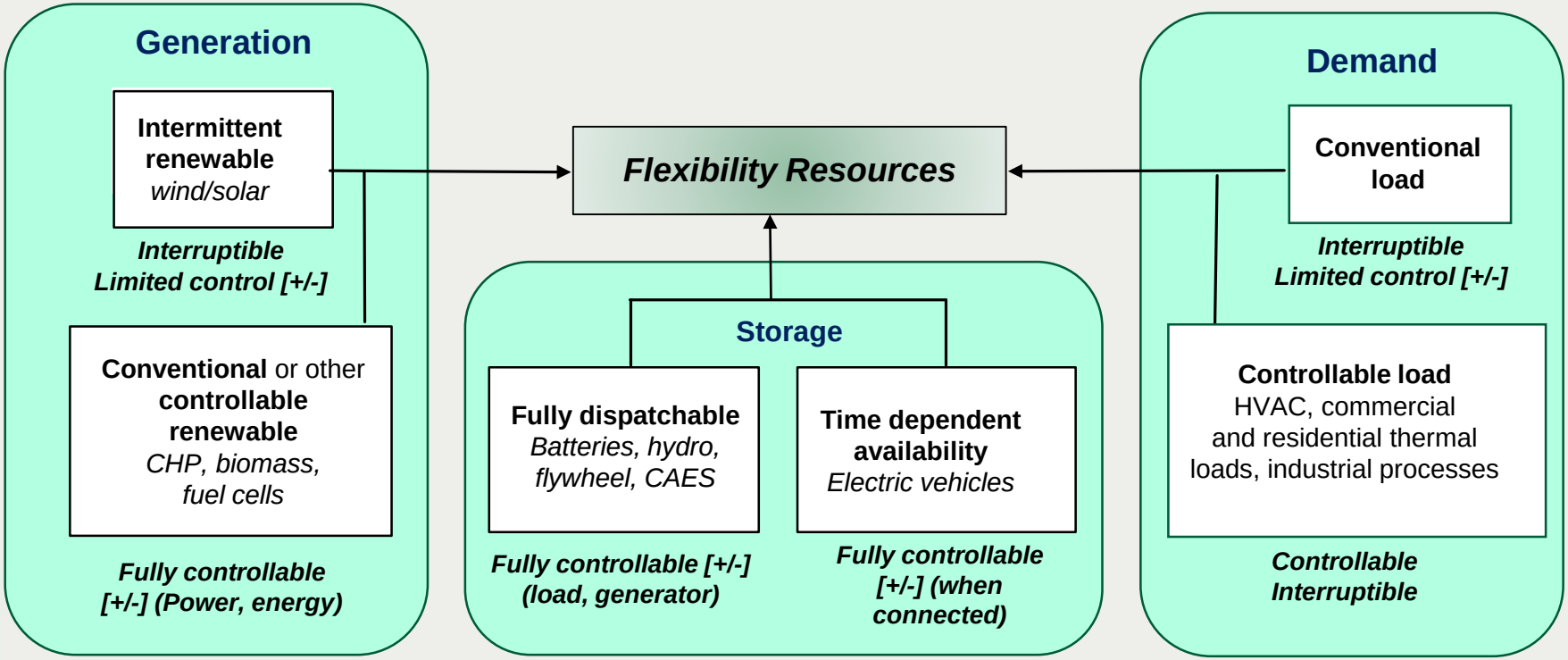
The pillars:
DER in distribution systems

The base:
Areas of attention

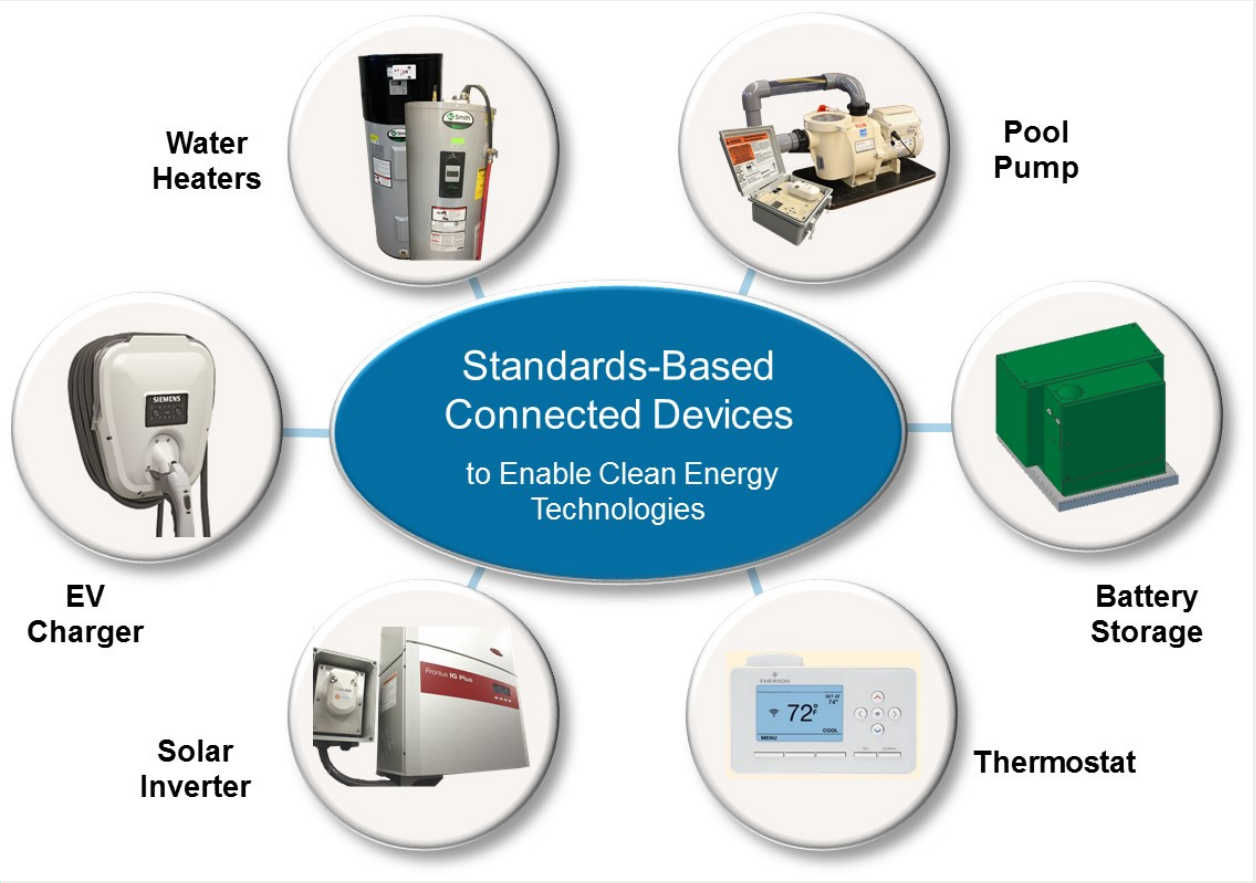
Flexibility as a key requirement in future networks



DER providing flexibility



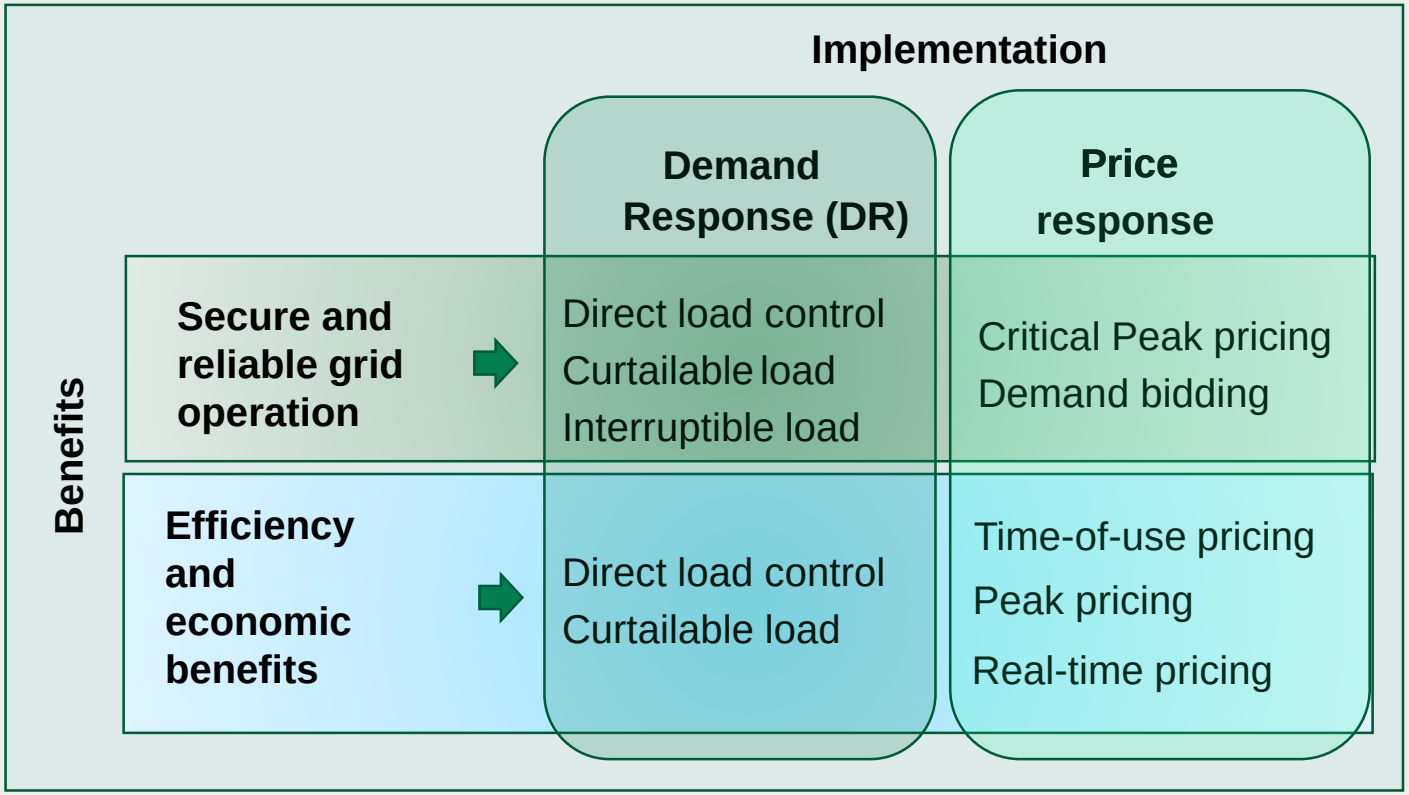
Making every customer and community part of the solution



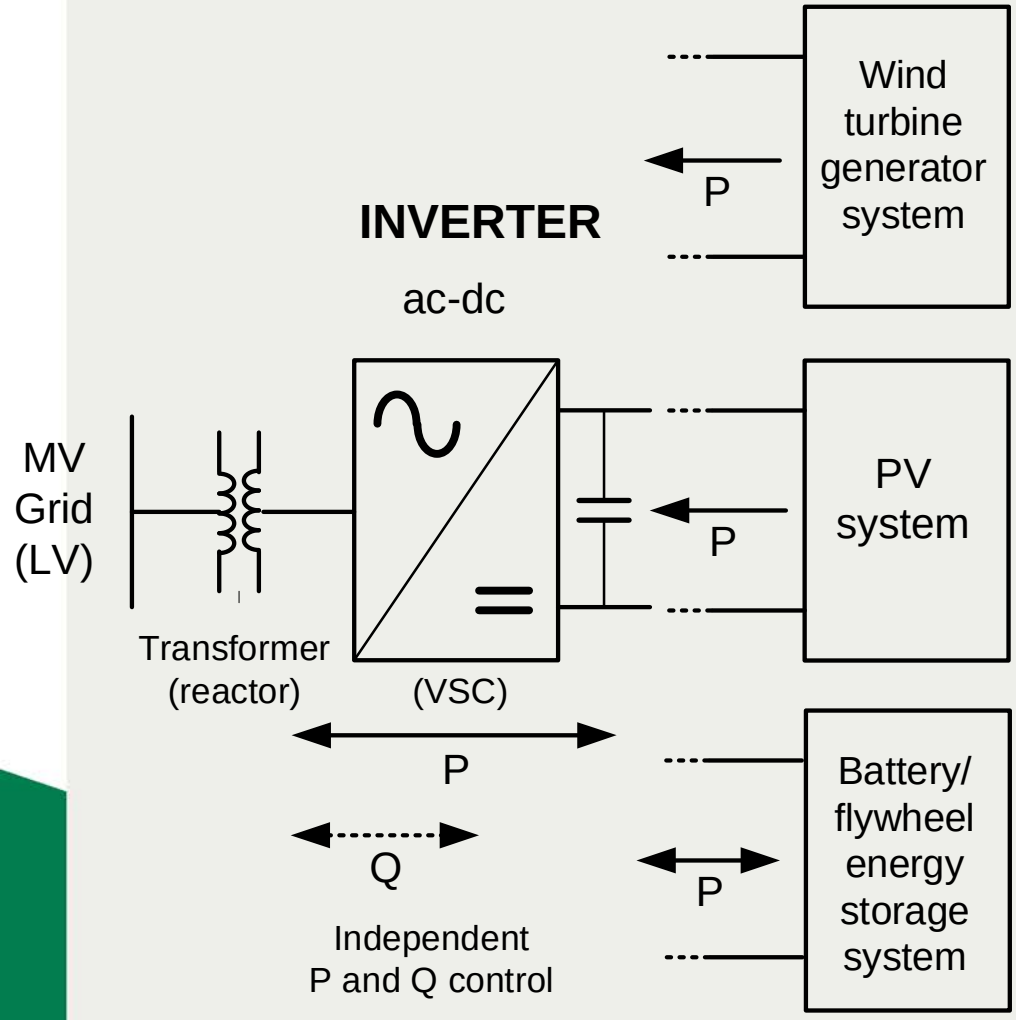
Internet of things (IoT) makes it possible

Source: McGranaghan, CIGRE Paris 2018

Classification Criteria for Demand Response Programs and Initiatives



Distributed Energy Resource (DER) structure and grid interface



Inverters

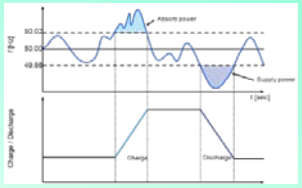
- Have grid supportive capabilities – Q injection, P injection
- Have communication capability – P and Q outputs can be independently controlled
- Can be equipped with supplementary control functions/loops, to help support the grid including
  - Peak power P limitation/curtailment at the point of connection
  - Reactive power(Q) regulation as a function of bus voltage
  - P regulation as a function of bus voltage
  - P regulation as a function of system frequency

Source: CIGRE WG C6-30 brochure

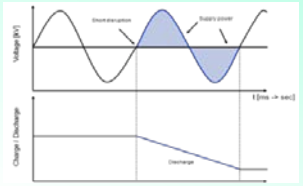
Application of Battery energy storage

- Electric energy storage systems – benefits in distribution systems

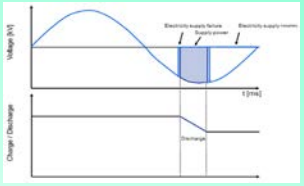
Stabilization/
Frequency



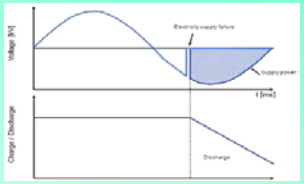
Power quality



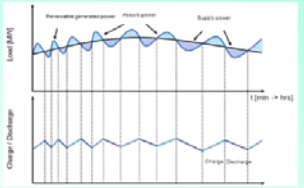
Spinning Reserve



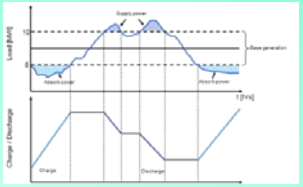
Standalone/
Island mode



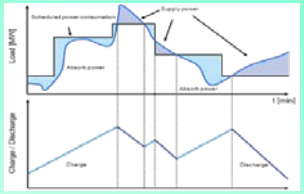
Smoothing/
Capacity firming



Peak Shaving



Load Shifting/
Leveling



Power

ms

hrs

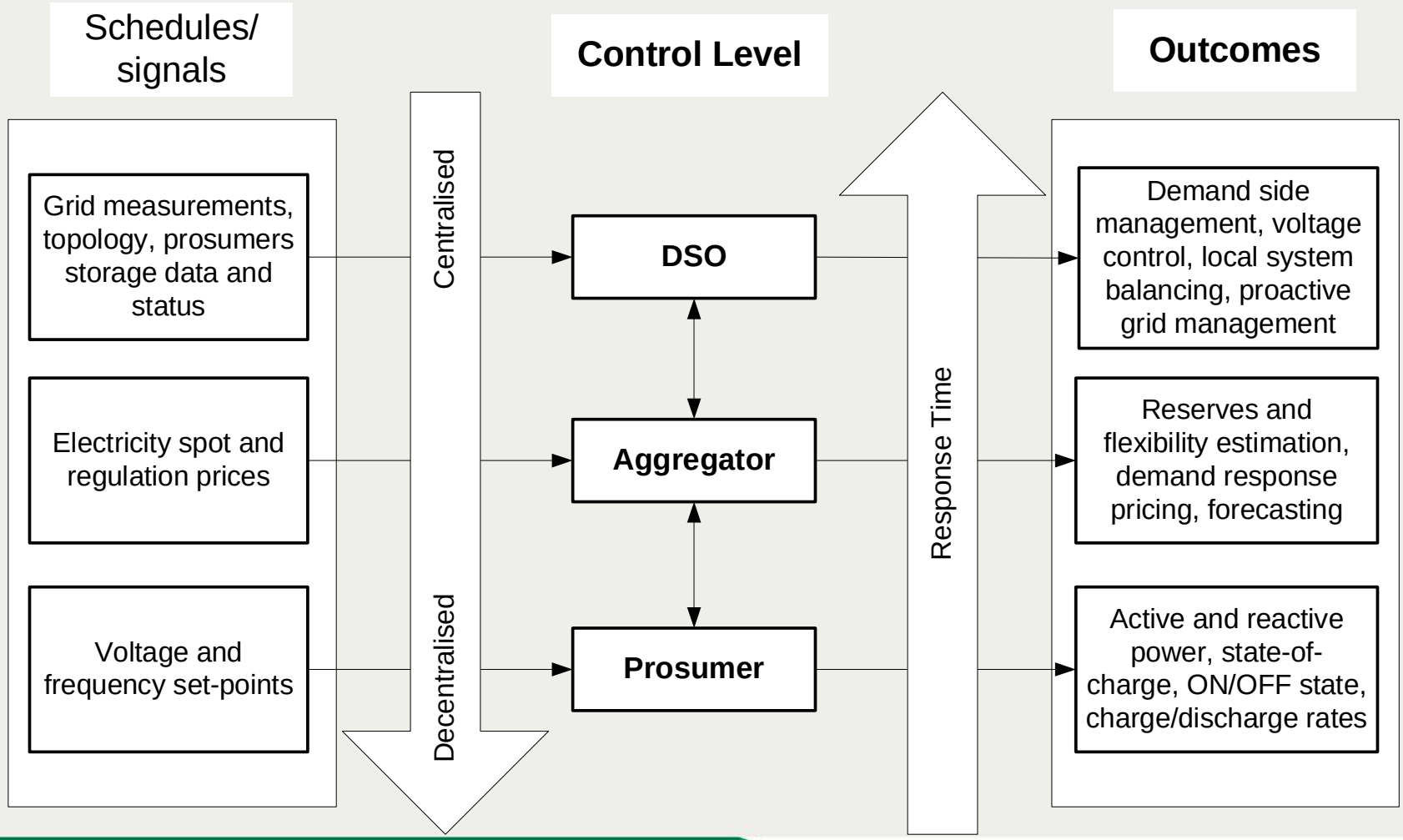
GRID STABILISATION

Time (Energy)

ENERGY STORAGE

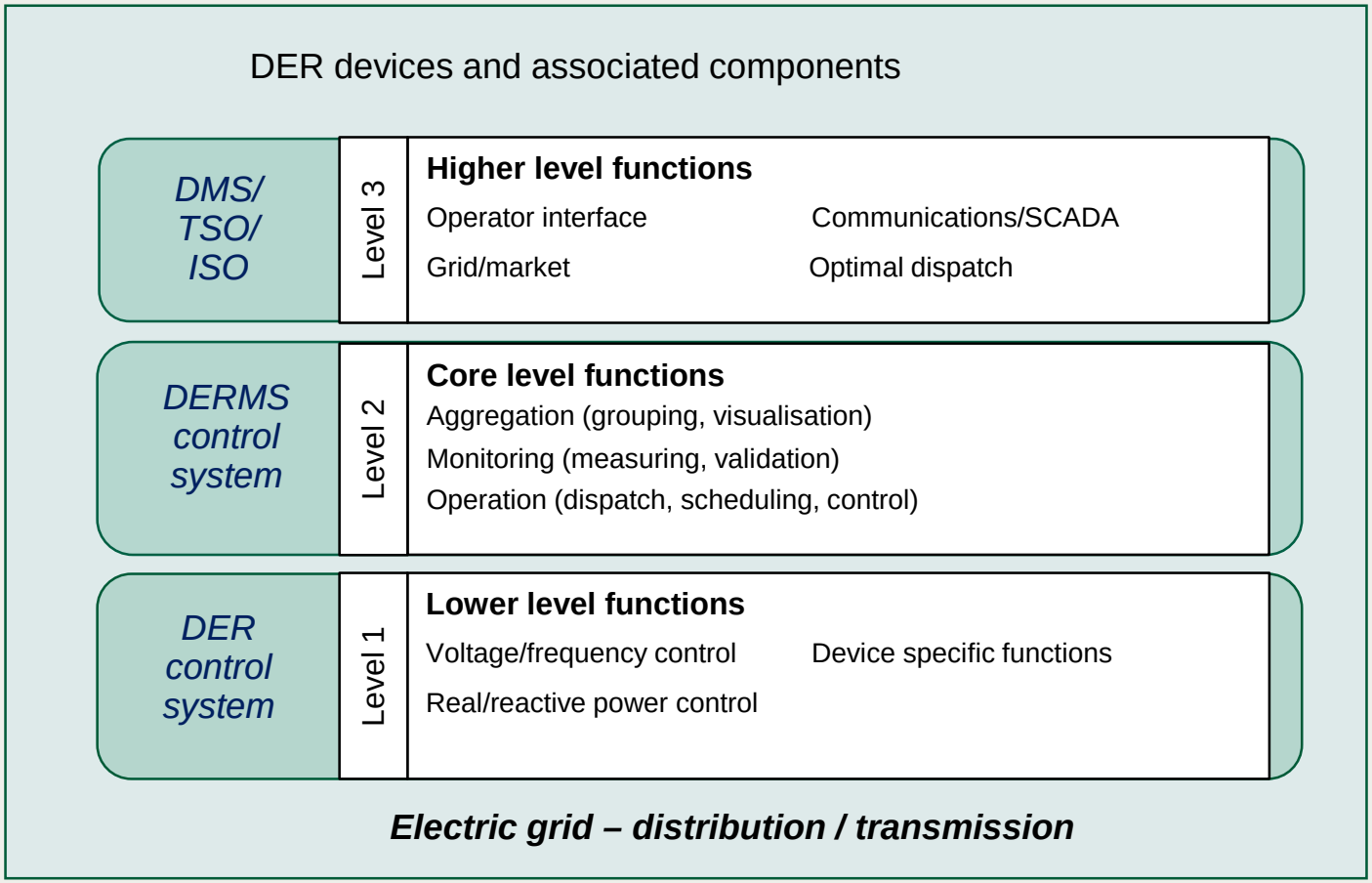
Source: CIGRE WG C6-30 brochure

Framework for operation of BESS in distribution grids

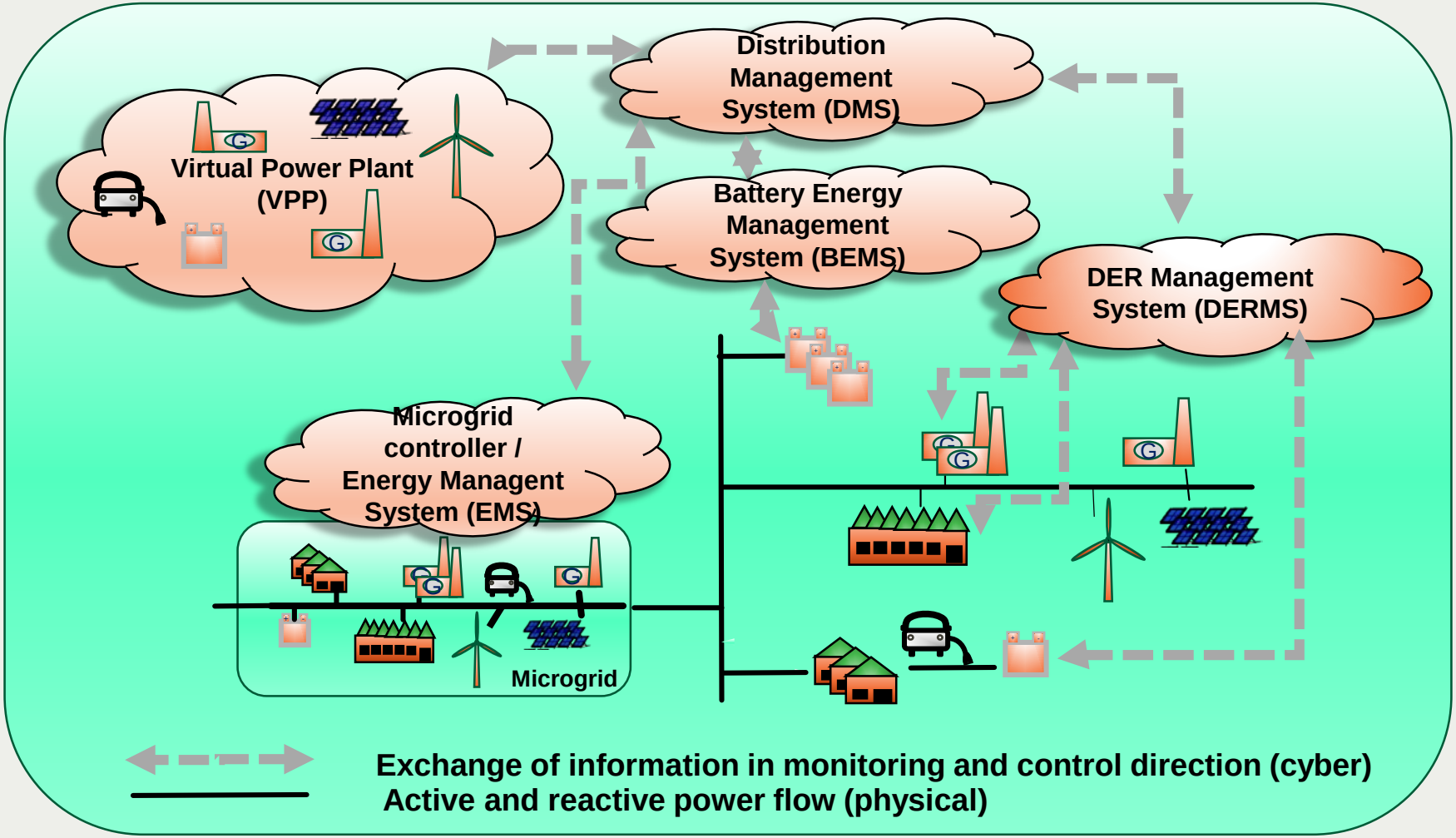


Source: CIGRE WG C6-30 brochure

Levels of DER control



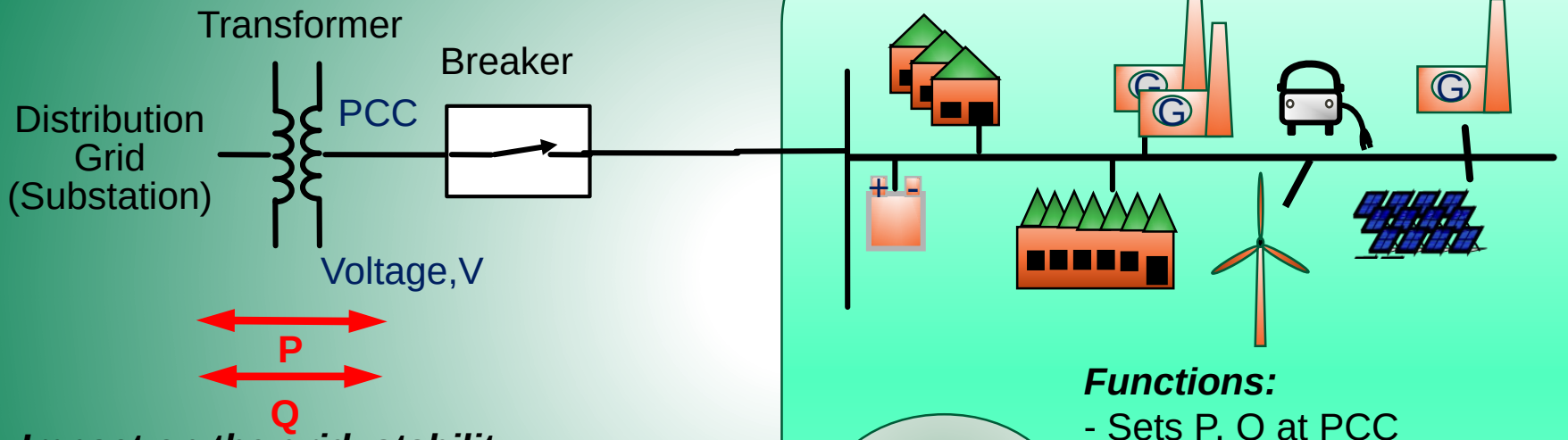
DER control with aggregation technologies



Microgrids

Grid connected

- Interconnection requirements
- Interconnection agreements



Impact on the grid, stability:

- Voltage and frequency set by grid
- Operation meets grid codes
- Internal/external power flows set by controller
- Node voltages managed by controller

Functions:

- Sets P, Q at PCC
- Manages connect/disconnect
- Coordinates asset dispatch
- Enables ancillary services
- Enables market participation

Increased hosting capacity for renewable generation with intelligent solutions

Network integration of local generation requires detailed analysis of given network