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**Best Practices Study Tour cum Training**  
**GRID MANAGEMENT, NETWORK MONITORING & LOSS REDUCTIONS**  
*Reactive Power Management with Large Scale RE Generation*

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# Today's energy challenge

Cut link between growth, energy use and emissions

Meeting these challenges requires the world to:

Reduce the correlation  
between economic growth  
and energy use

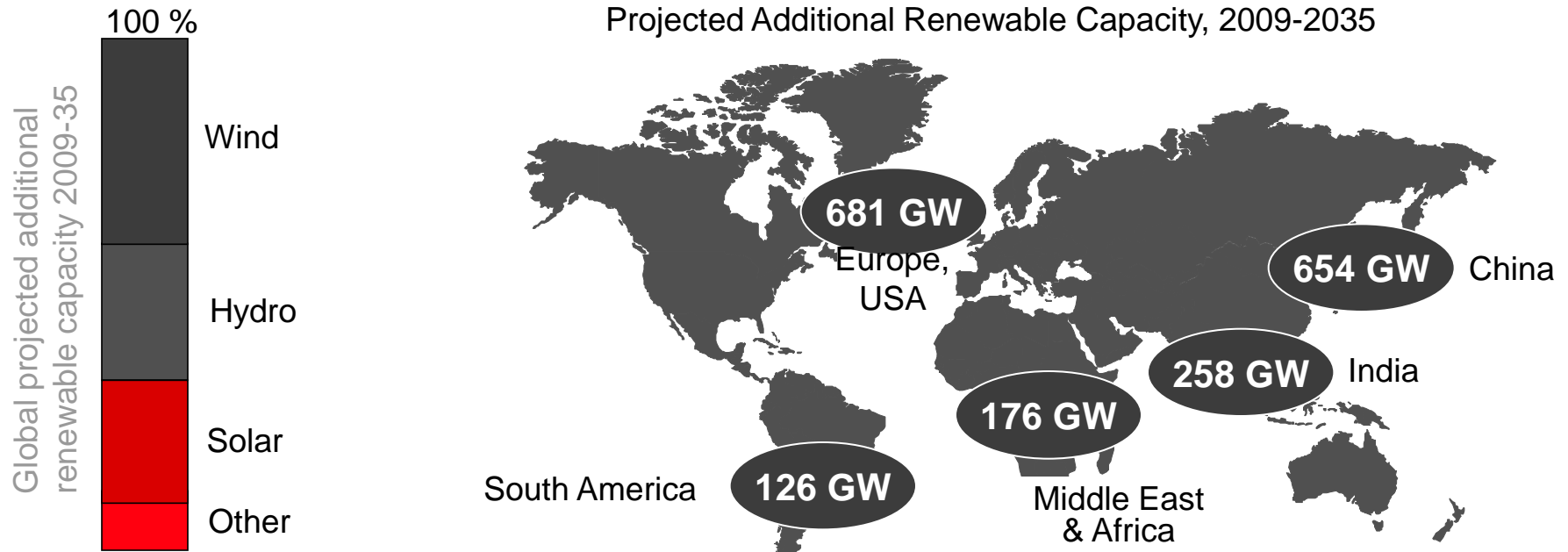
Reduce the correlation  
between energy use and  
emissions

Energy  
efficiency

Renewable sources  
of energy

# Additions of renewables brings new growth opportunities

Wind, hydro and solar are most prevalent technologies

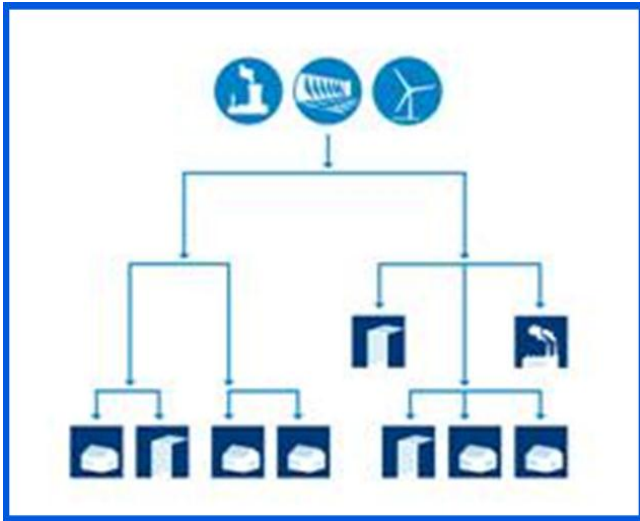


Source: IEA 2013, New Policies Scenario

# The evolving grid

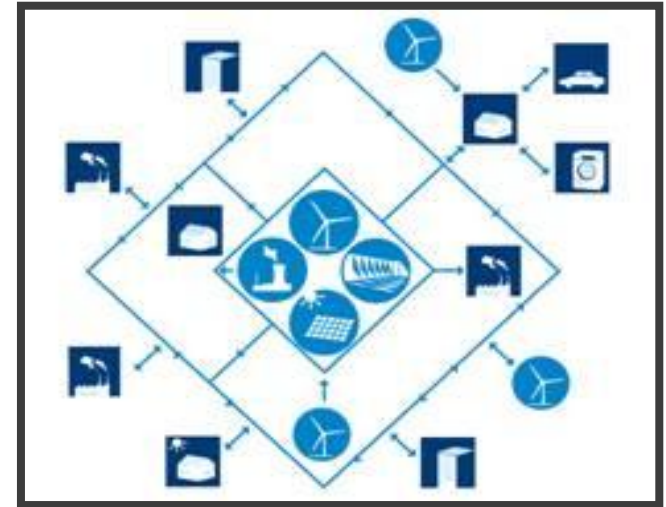
From traditional to Inter-Connected grid

Traditional grid – Relatively Simple



- Centralized power generation
- Generation follows load
- One-directional power flow
- Top-down operations planning
- Operation based on experience

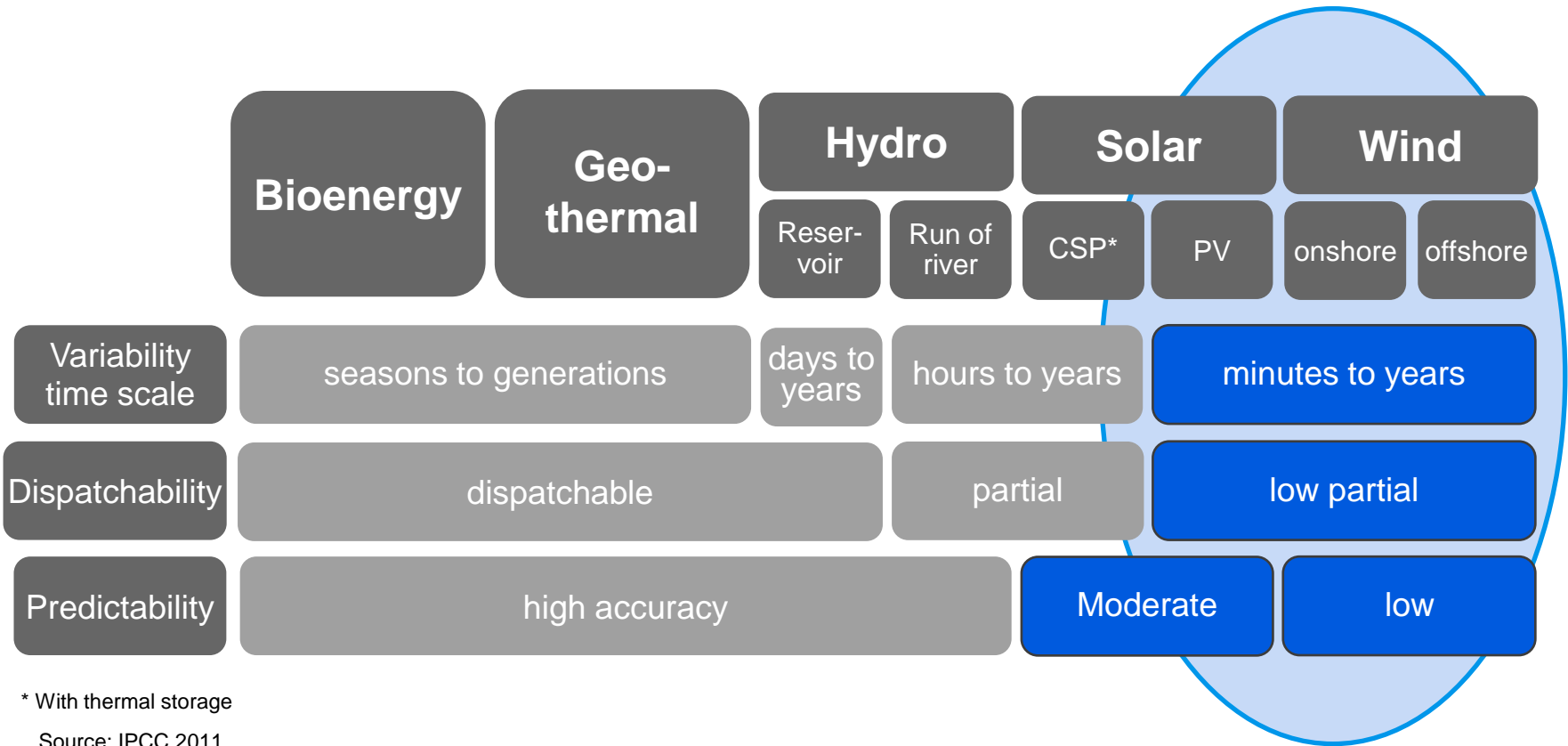
Interconnected grid – New Complexities



- Centralized and distributed power generation
- Intermittent renewable power generation
- Multi-directional power flow
- Consumption integrated in system operation
- Operation based on real-time data

# Characteristics of renewable energy sources

Wind and Solar PV: What is different?



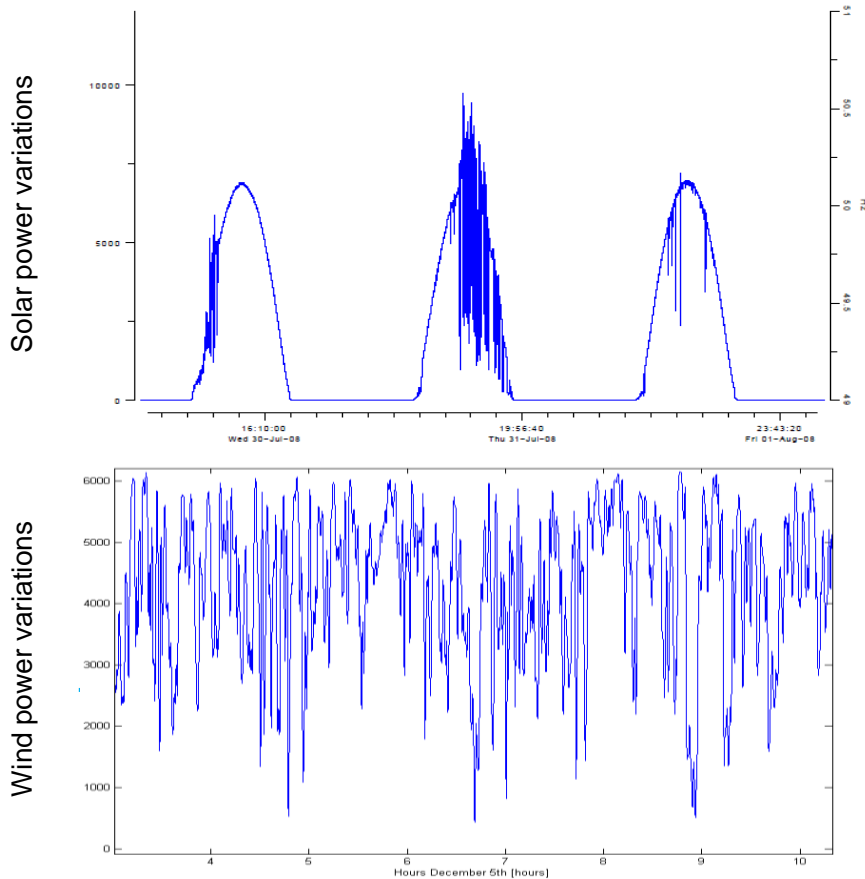
\* With thermal storage

Source: IPCC 2011

**Balancing electricity supply and demand at any time is becoming more challenging given the volatility and uncertainty of wind and solar energy sources**

# Renewable energy integration challenges

## Managing power output fluctuations



Inherent volatility of renewable energy (RE) can compromise grid stability

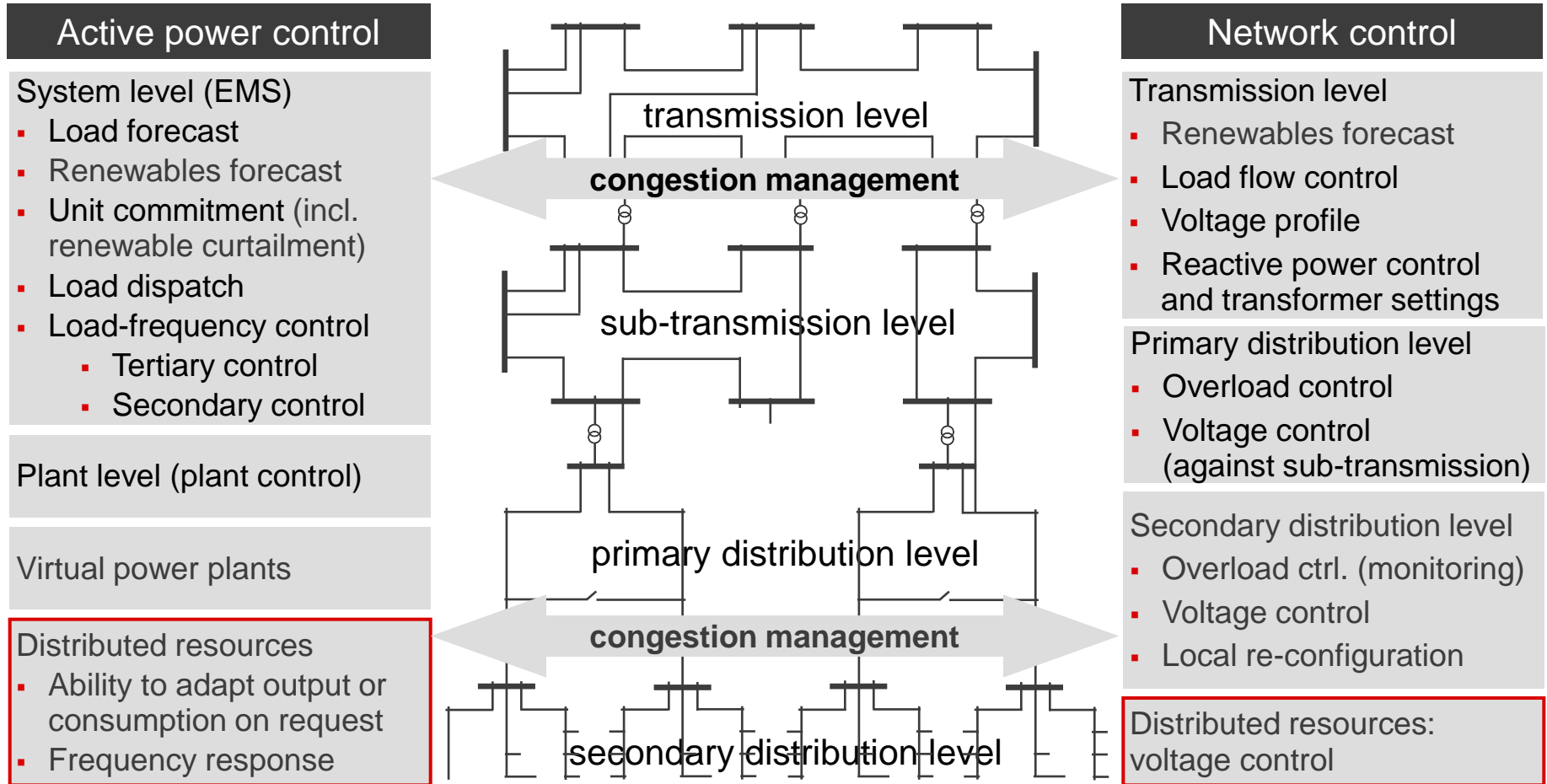
The renewable energy integration solution must address requirements traditionally fulfilled by diesel generation (base load)

- Frequency and voltage control
- Sufficient spinning reserve
- Sufficient active and reactive power supply
- Peak shaving and load levelling
- Load sharing between generators
- Fault current provision

Renewable energy (RE) generation capacity should be sized to maximize ROI and fuel savings

# Control tasks in a power system

With distributed resources and renewable generation



# Reactive Power management

The role of reactive power comes into play when addressing the grid instability w.r.t the voltage, also known as voltage instability

The regulation of reactive power addresses the following factors of grid management:

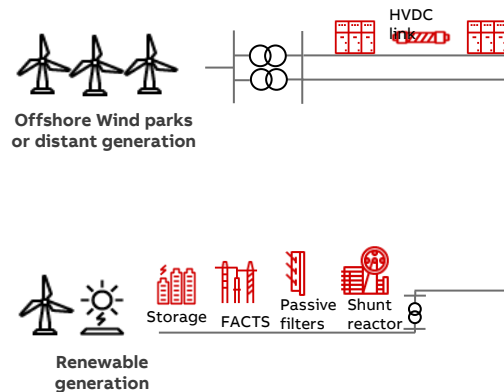
- Improved utilization of Active Power
- Voltage instability
- Power Factor
- Power Quality
- Improved system efficiency
- Adherence to the grid code



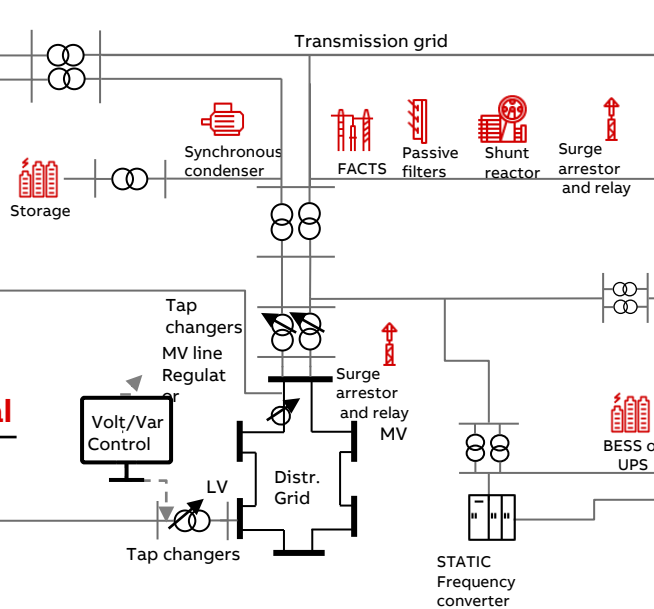
# Power Quality technologies

Increased penetration of power electronics based generation and consumption influences the traditional power quality business

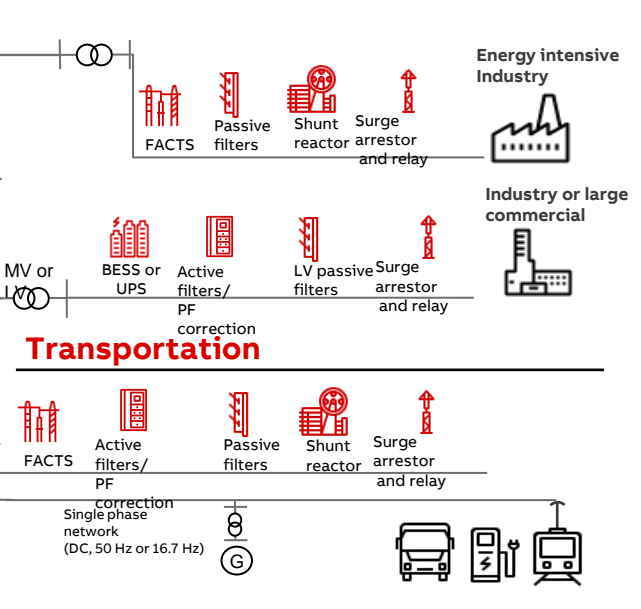
## Generation



## Grid



## Industry and large commercial



## Residential and small commercial

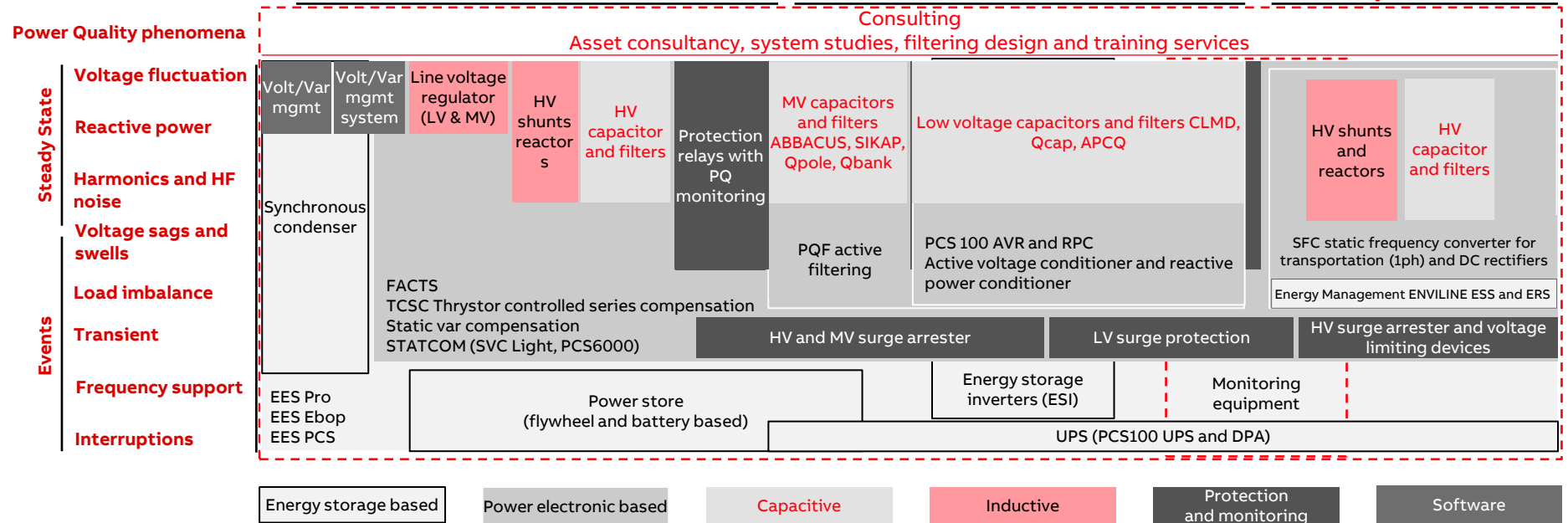


# Expansion along the value chain is a key trend

## Utilities

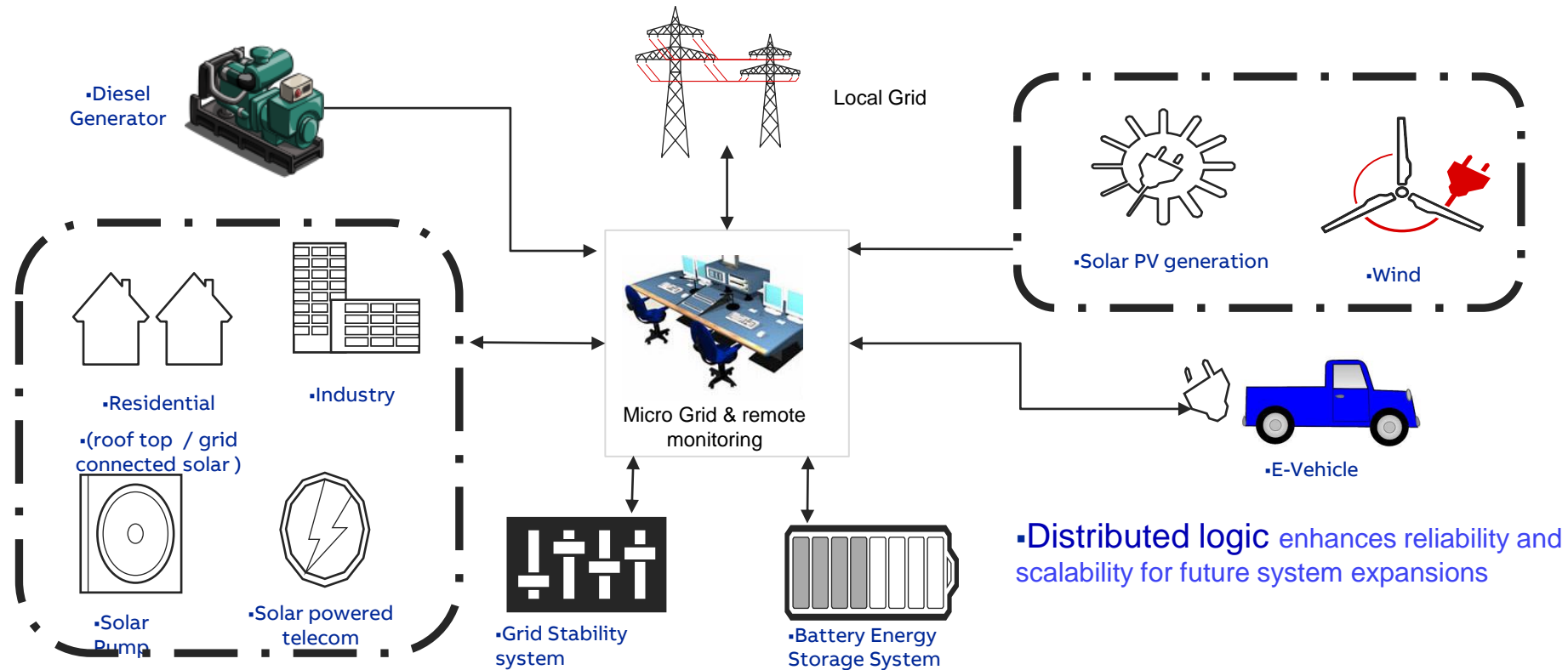
## Industrial

## Transportation

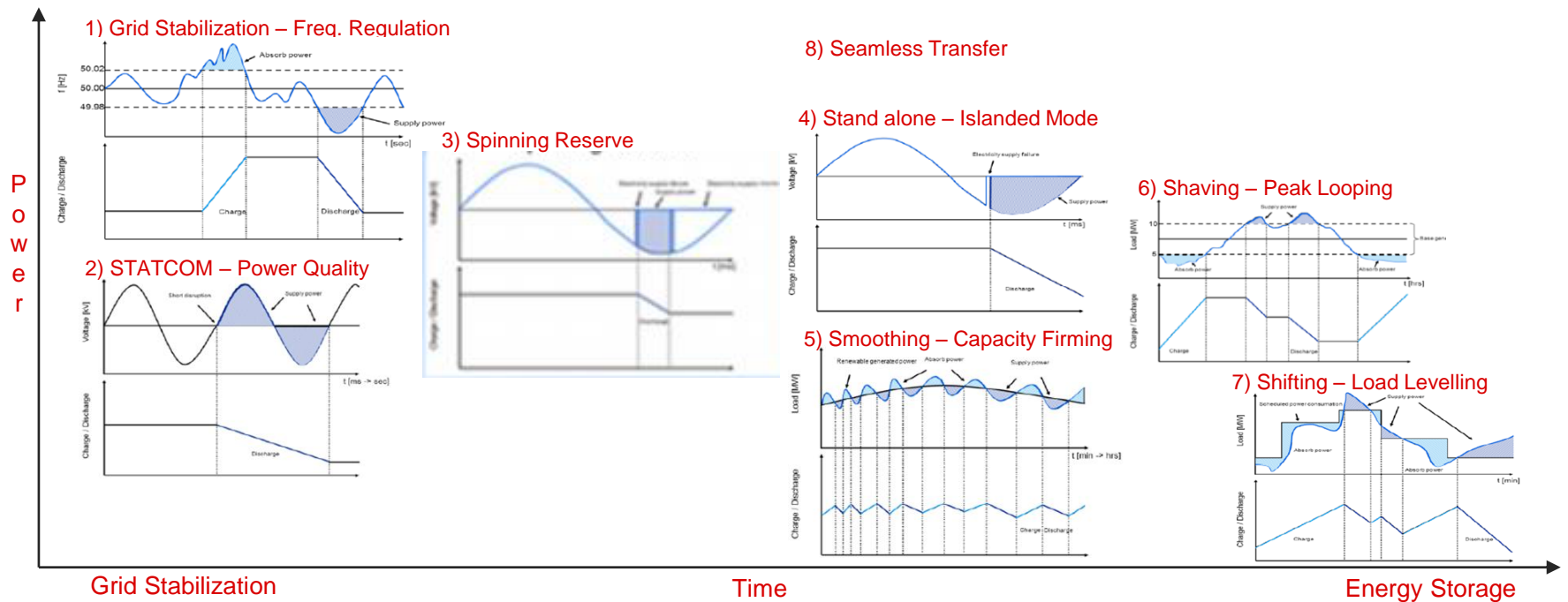


# Sustainable access to electricity anywhere

## Microgrid with renewables and power storage

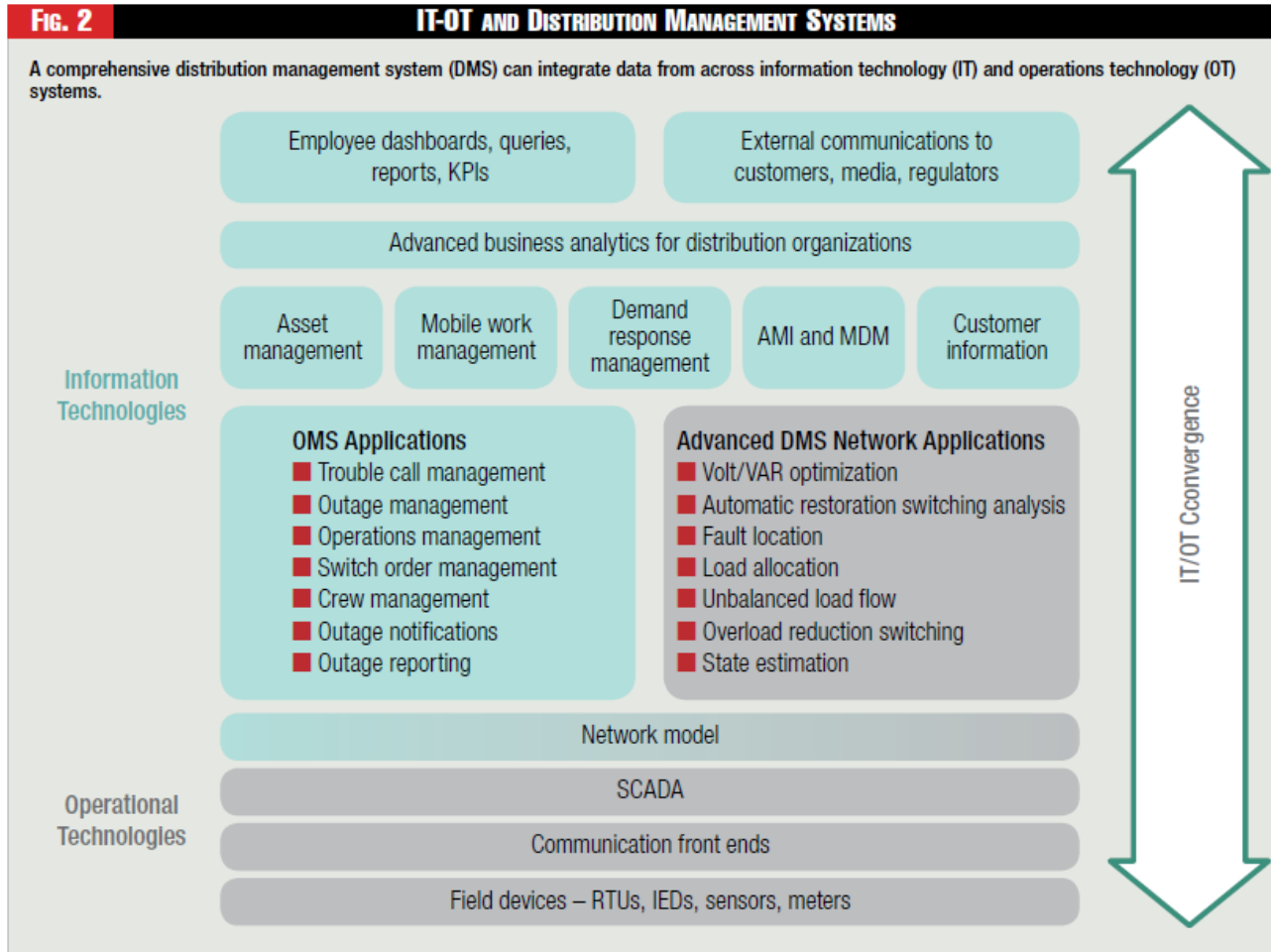


# Microgrid Applications



# Advanced Grid Management Solutions

## IT/OT convergence in Distribution - ADMS



Power and productivity  
for a better world™

