Flexibility for a sustainable energy system

Outcome of the EUWP Working Party Workshop
Rome 20 March 2019

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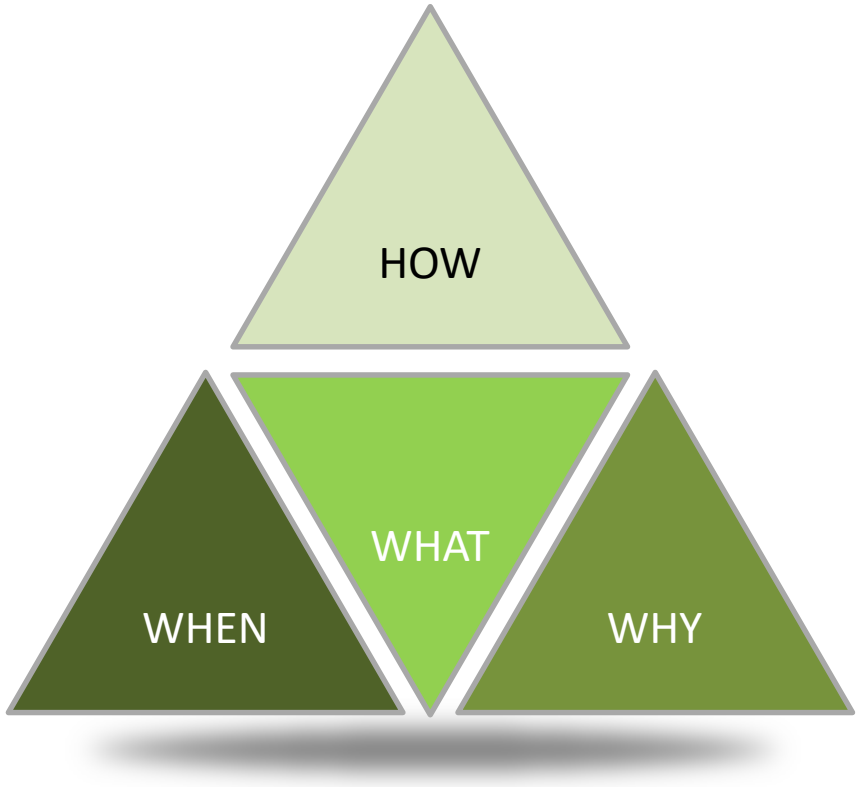
Vienna – May 13, 2019

TARGETS AND APPROACH



HOW

- Scene setting (Global and specific)
- International context and initiatives (TCPs)
- Italian projects/solutions and technologies

WHAT

- Define flexibility
- Address need and impact along value chain
- Discuss Italian experience and contribution in European and international context

WHY

- Flexibility as key element for decarbonisation
- Cross sectoral approach
- Importance of international collaboration

WHEN

Back-to back to EUWP Spring Meeting – Rome March 20, 2019

http://www.rse-web.it/eventi/Flexibility-for-a-sustainable-energy-system.page

https://www.iea.org/delegates/cert/euwp/euwpmeetings/20-22march2019/

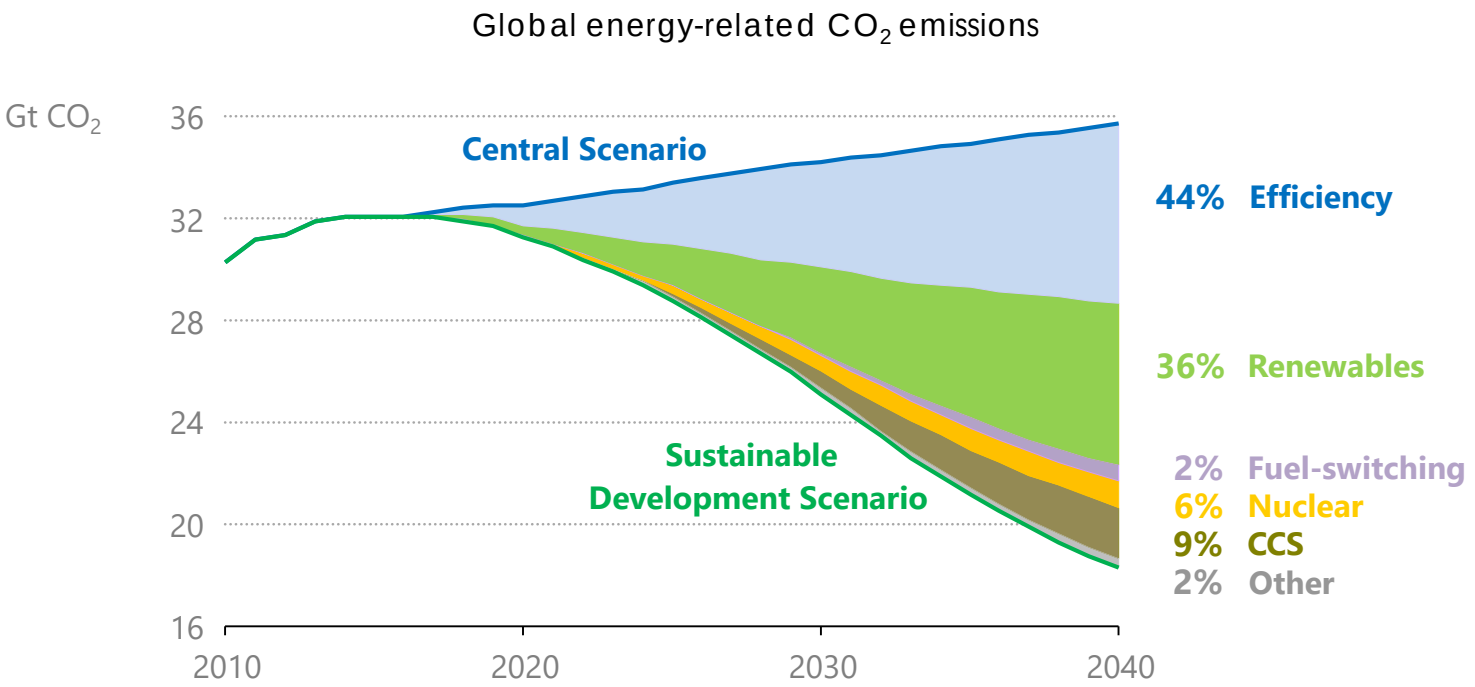
Defining flexibility

1. “Power system flexibility refers to a power system’s ability to respond to both **expected and unexpected** changes in demand and supply” (Cochran et al. 2014)

2. “Power system flexibility is defined as all relevant characteristics of a power system that facilitate the **reliable** and **cost-effective** management of **variability and uncertainty** in both supply and demand across all relevant timescales” (IEA, 2018)

3. Flexibility is the capability of a power system to cope with **variability and uncertainty** that VRE generation introduces into the system in different time scales, from the very short to the long term, avoiding **curtailment of VRE** and **reliably** supplying all the demanded energy to customers (IRENA, 2018)

Setting the scene – global

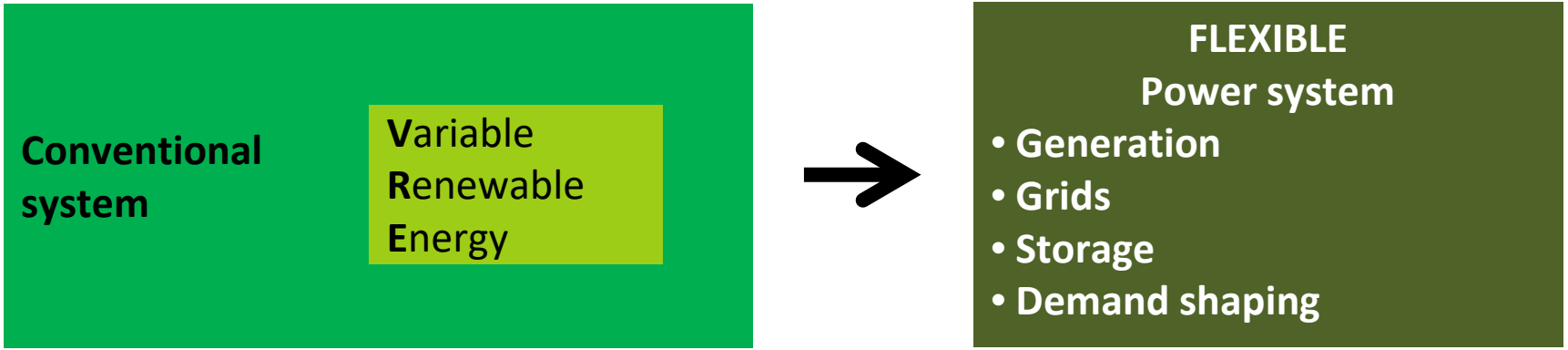


A wide variety of technologies are necessary to meet sustainability goals, notably energy efficiency, renewables, CCUS and nuclear

Setting the scene – global

Three main messages on system integration

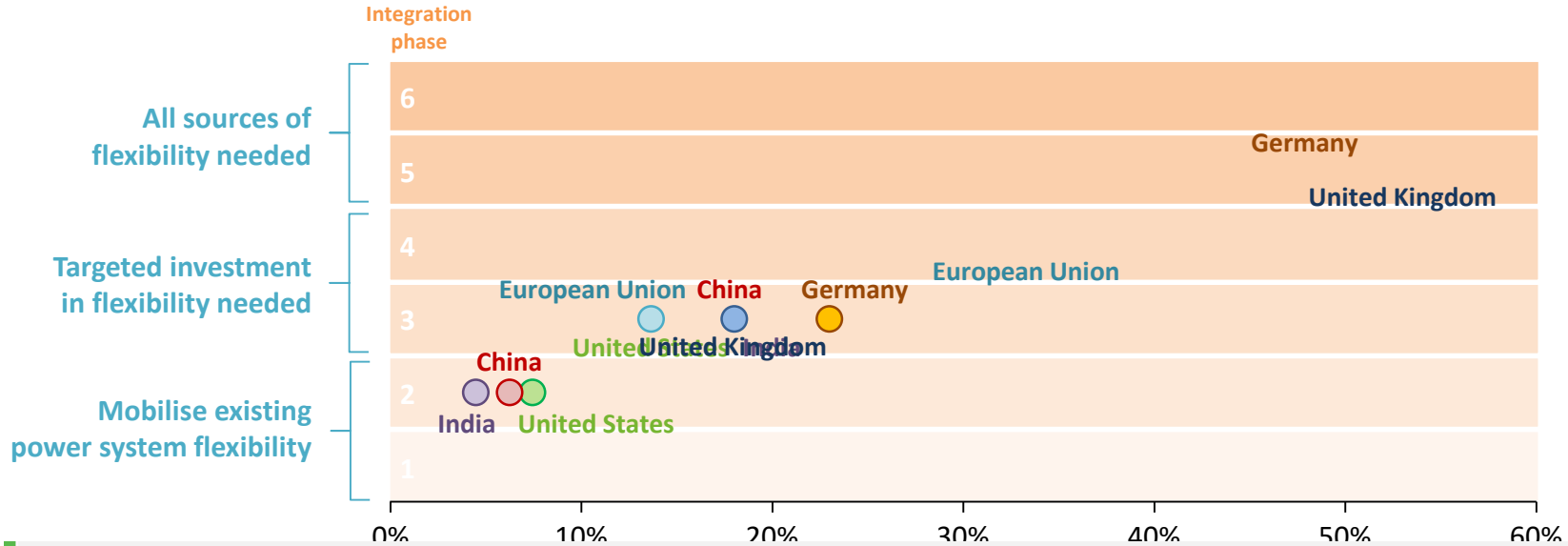
1. Very high shares of variable renewables are technically possible
2. No problems at low shares, if basic rules are followed
3. Reaching high shares cost-effectively calls for a system-wide transformation



Setting the scene – global

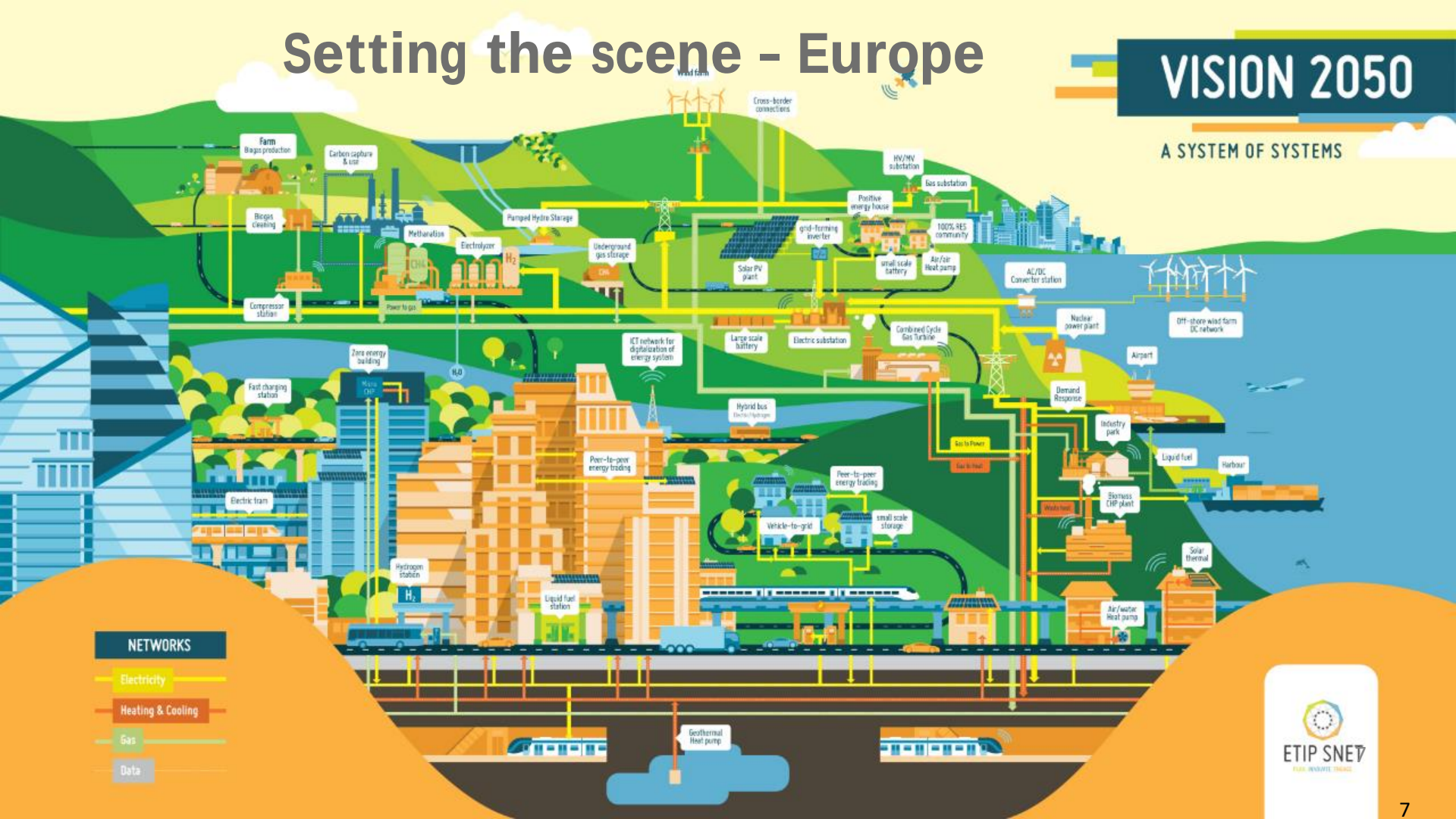
Flexibility: the cornerstone of tomorrow's power systems

Phases of integration with variable renewables share, 2030



Higher shares of variable renewables raise flexibility needs and call for reforms to deliver investment in power plants, grids & energy storage, and unlock demand-side response

Setting the scene – Europe



Setting the scene – Italy

Italian scenario – 2030 – as considered in NIPEC

RES on final energy demand	17,4% (2017)	30%
RES Electrical	34%	**55,4%**
RES Therml	18,9%	33%
RES Transport	7,2%	**21,6%**
Energy from RES Electrical	104 TWh	187 TWh
PV	19,7 GW	**50 GW**
Wind	9,8 GW	18 GW
PV yearly increase 2018-2030		2,33 GW/year

- Demand = **329 TWh**
- Peak (summer) = **64 GW**
- Import/export = **28,5 TWh**
- **Phase out coal by 2025**
- **12 GW of PV** with **storage** to foster subsidiarity

Flexibility along the value chain

- CEM Campaign
- Generator operator
- Technology provider.

- IEA TCP DSM
- Demand aggregators
- Technology provider

- IEA TCP – ISGAN, ECES
- Network operator
- Technology provider.

- IEA TCP IETS
- Standardisation/Legisl
- Solutions
- Blockchain

Flexibility from generation

The greatest and cheapest source of flexibility is conventional power generation (thermal and hydro)

Technically available flexibility remains unexploited, because of regulation, market design, contractual arrangements. (existing, retrofits, future)

Innovative market models for ancillary services (or capacity market) are needed to leverage flexibility from generation .

POTENTIAL

ISSUES

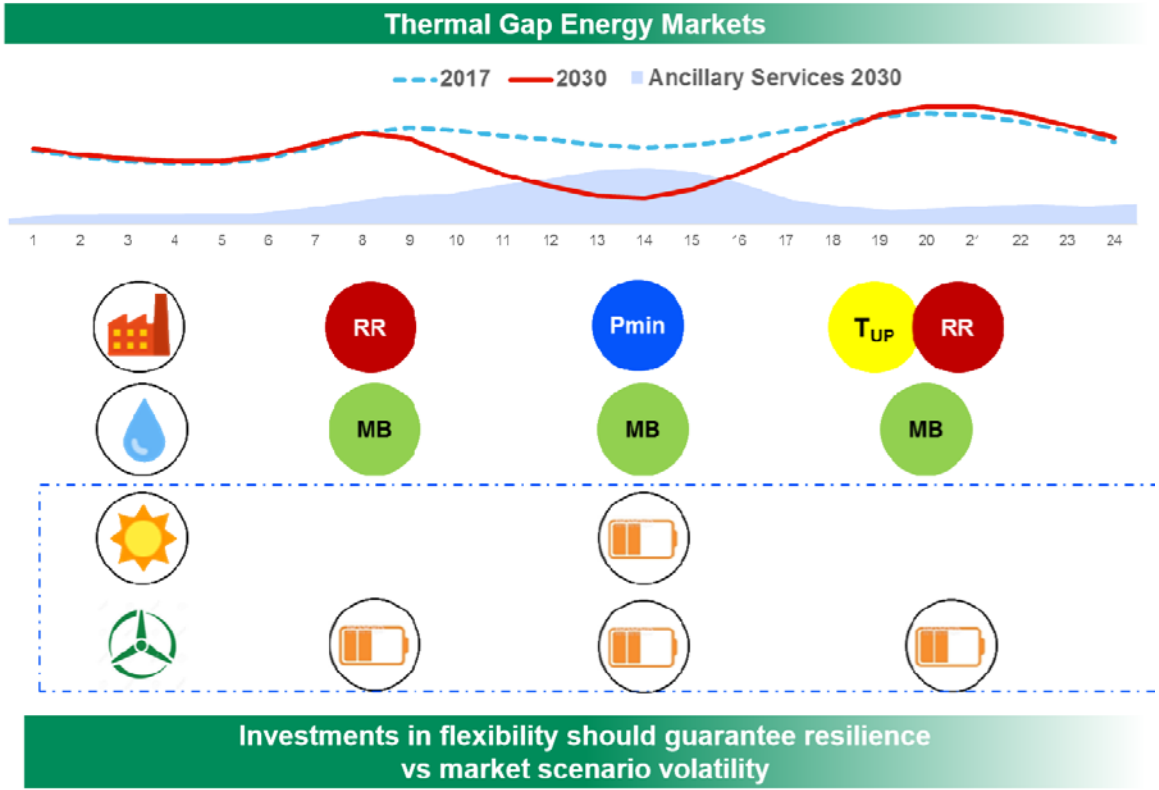
CHALLENGES

REGULATION/MRKT

Ramp rate, Technical minimum, Startup time, Modulation band

ADVANCED POWER PLANT FLEXIBILITY

Flexibility needs and solutions – thermal PP



RR Ramp Rate

T_{UP} Start-up time

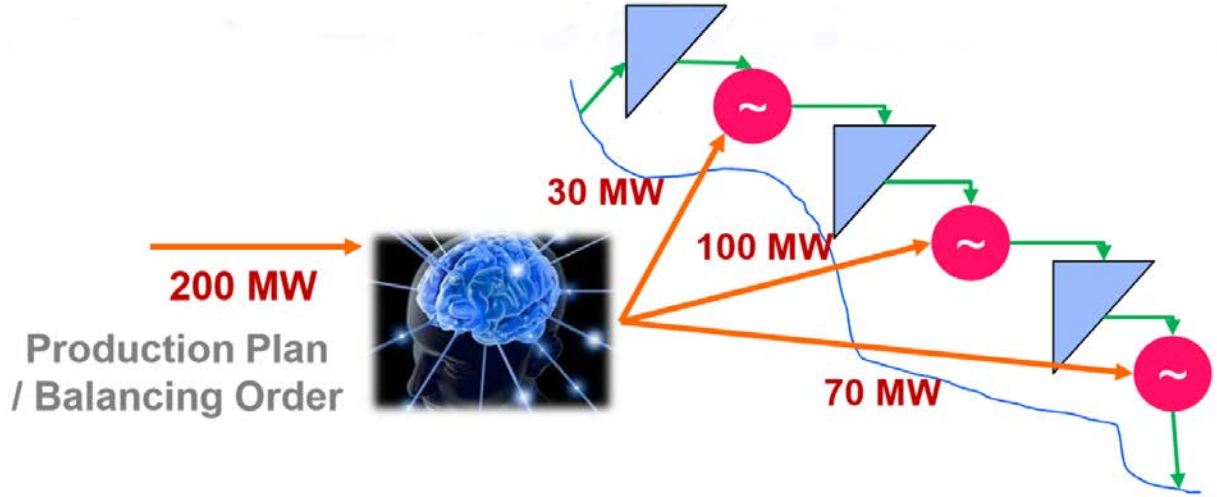
Pmin Min Tec

MB Modulation Band

- Improve thermodynamics (integrating cycles);
- Tune pollution control and cooling system management at low regimes;
- Manage water system management to improve ramping rate;
- Refurbish GT controls;
- Modify startup sequences

Source: enel

Flexibility needs and solutions – Hydro PP



Actuator splits Production Plan and eventually Balancing Orders in Real Time between the single generators of the cascade taking into account technical features, levels of reservoirs and hydraulic constraints

- **Cascade Aggregation of plants**: Revised production plan execution based on AI, local intelligence (meters, sensors) and modification of control systems.
- **Participation in Ancillary Service Markets** (in particular Secondary Reserve): 2 projects already in operation.
- Participation in **New Pilot Projects Del.300/17 (UVAM, UPR):** Investments in hardware and software mainly in communication and execution systems.

Source: enel

Technology provider solutions presented

ANSALDO ENERGIA

Power Plant flexibility

Achieved results in Italy and abroad

start-up times **down to 120 (cold), 60 (warm) and 30 (hot) minutes**

minimum environmental load (MEL) **down to 25% or even less**

up to 50 (cold), 100 (warm), 150 (hot) starts per year and **more than 8000 cycles from MEL to base load** during plant lifetime

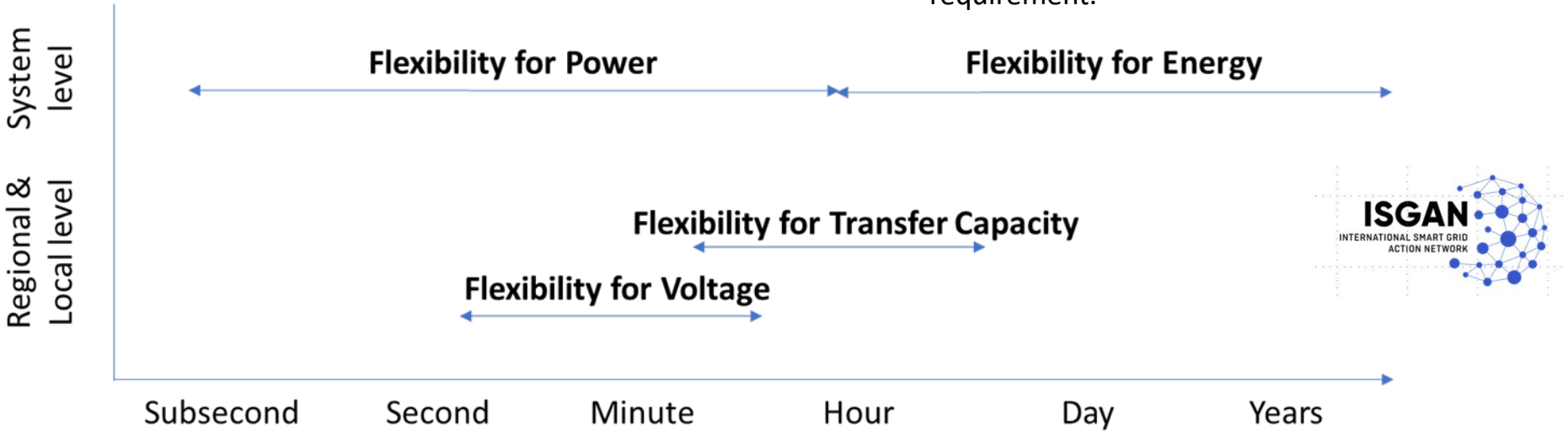
power plant loading ramp rate **up to 50 MW/min and more**

plant efficiency **more than 40% at 25% load**

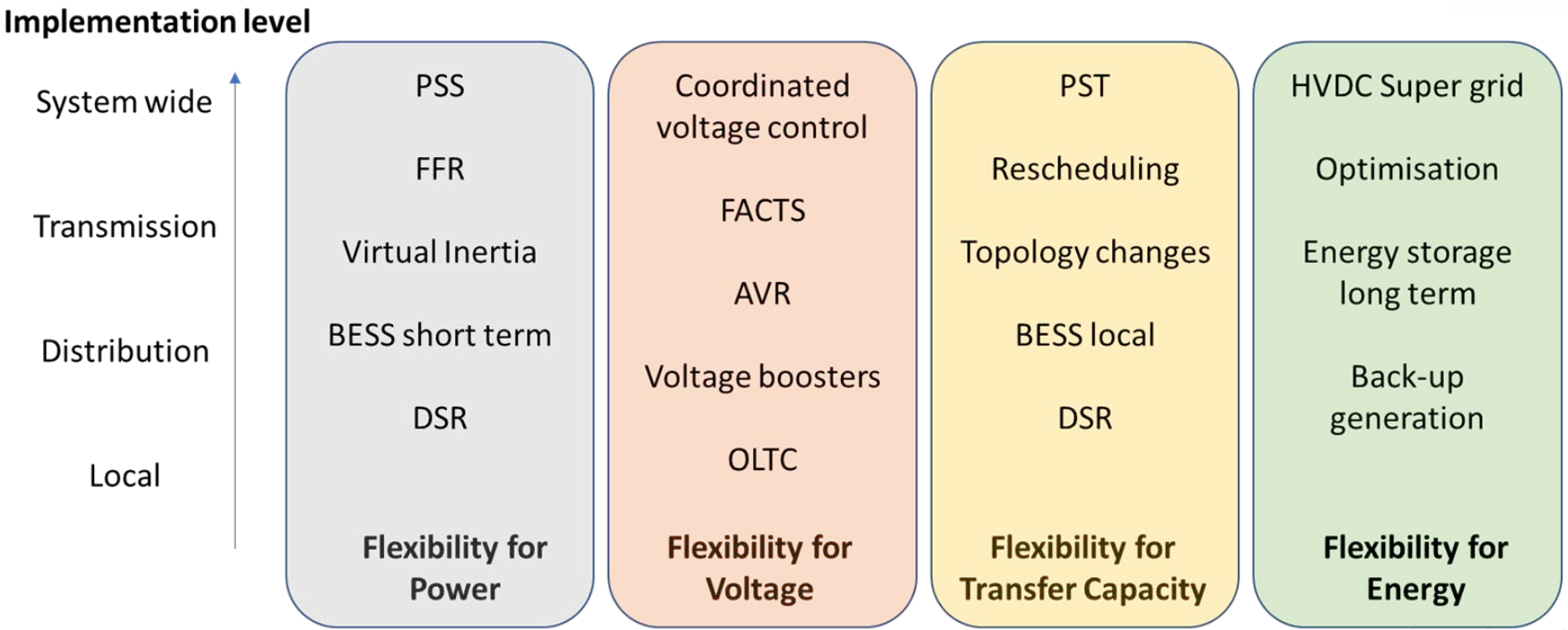
CO emissions **down to 30 mg/Nm³** and NO_X emissions **down to 10 mg/Nm³**

Flexibility from the network and storage

- **Flexibility for Power:**
  - **Short term equilibrium** between **power supply and power demand**, a system wide requirement for maintaining the frequency stability.
- **Flexibility for Energy:**
  - **Medium to long term equilibrium** between **energy supply and energy demand**, a system wide requirement for demand scenarios over time.
- **Flexibility for Transfer Capacity:**
  - Short to medium term ability to **transfer power between supply and demand**, where local or regional limitations may cause bottlenecks resulting in congestion costs.
- **Flexibility for Voltage:**
  - Short term ability to **keep the bus voltages within predefined limits,** a local and regional requirement.

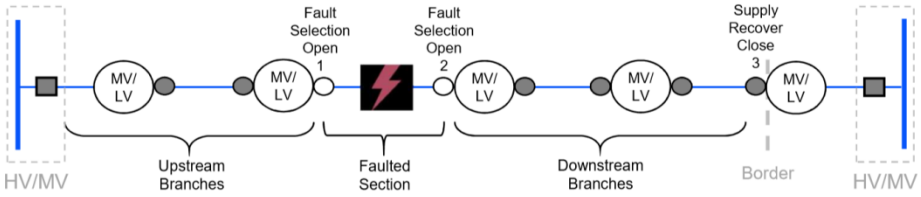


Flexibility from the network and storage



Network operator solutions presented

Smart Fault Selection



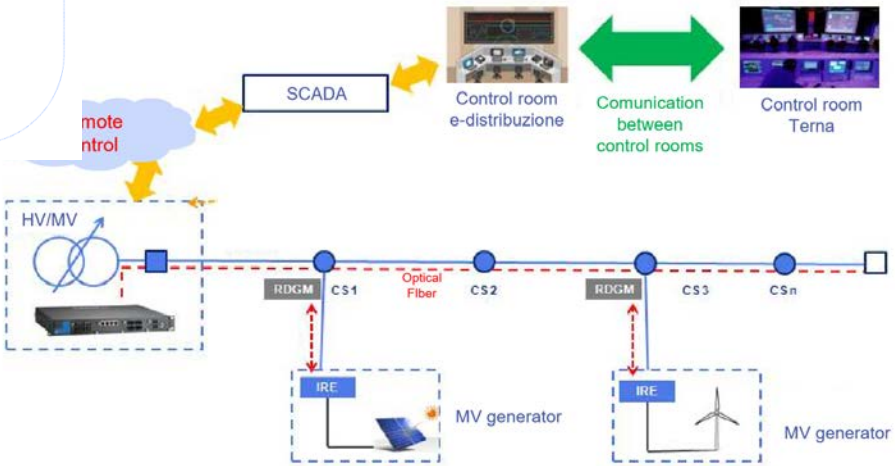
Advanced automation technique of the MV network, which allows to select the faulted section and re-energyse the downstream network within 1 second (transient interruption).

Are needed:

- Installation of advanced equipment in 3 nodes of the line plus a border node with the re-feeding line
- fast and “always on” telecommunication system

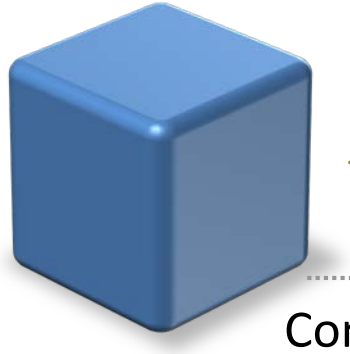
Flexibility from Network Configuration: Smart fault selection automatization

Flexibility from Network active agents: Voltage/VAR and active Power control



e-distribuzione

Flexibility from demand

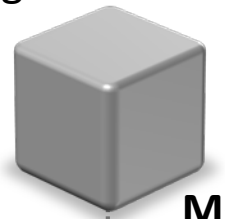


Flexibility from demand

Type of loads in term of flexibility services

Controllable loads

Loads giving possibility of automation without reducing level of service



SHIFTABLE LOADS

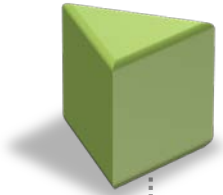
washing machine, tumbledryer, dishwasher

MODULAR LOADS

HP/boiler/fridge setpoint complying with range of functionality

Non controllable loads

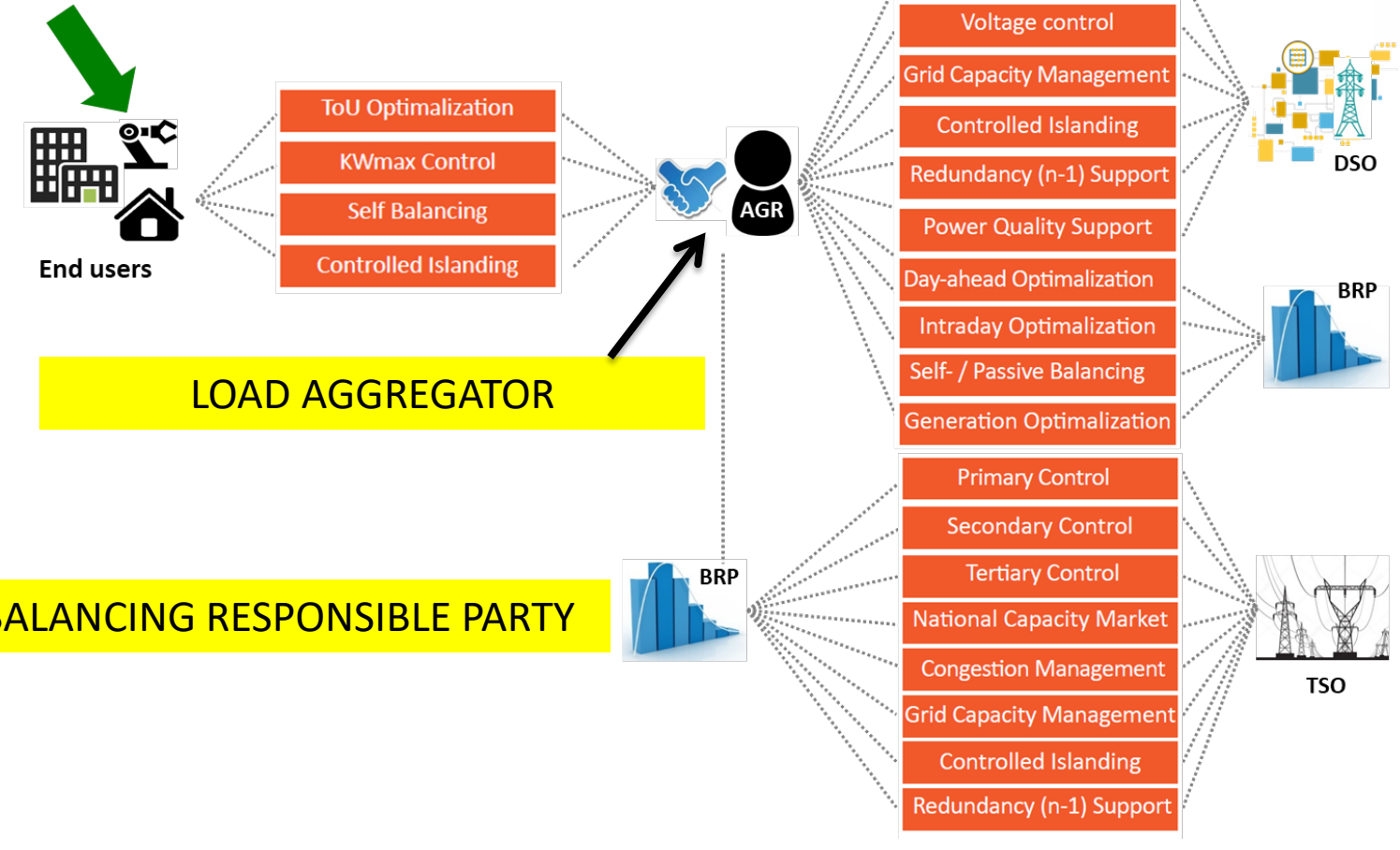
Loads that cannot be controlled without jeopardising the level of service



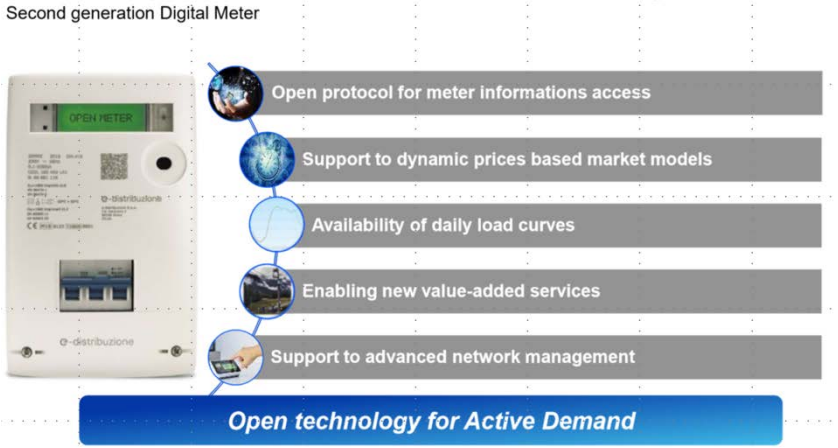
TV

COMPUTER

Value of flexibility from demand



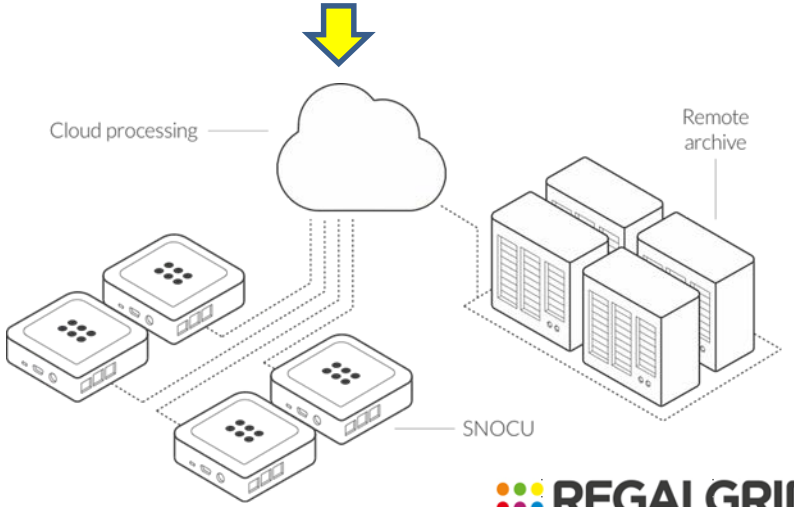
Tools enabling demand flexibility



SNOCU: Smart NOde Control Unit

- Communicates with local devices, collecting information and providing active commands
- Based on different communication protocols (**Wireless, Bluetooh, LAN, serial**)
- Uses **Internet** to connect to connect with a **CLOUD** infrastructure.

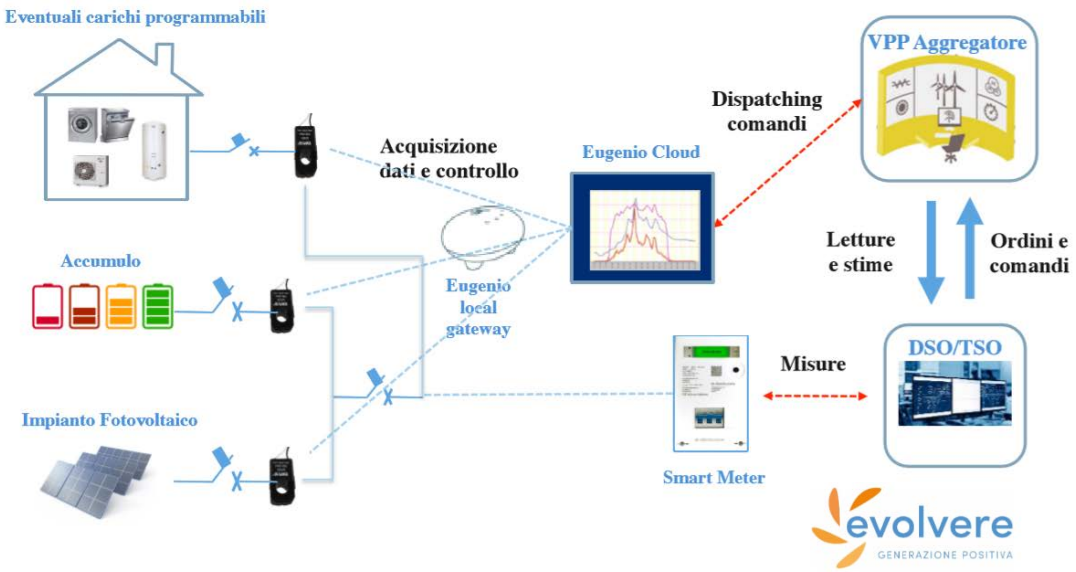
The advanced smart meter as the gateway for demand flexibility actions



e-distribuzione

REGALGRID

Tools enabling demand flexibility



IoT gateway for the "smarthome", integrated with different wireless sensors/actuators and enabling the supply of energy analysis and Demand Response services. Through the APP for smartphones, the user can easily create automation rules and scenarios, combining sensors and actuators with unlimited applications for expansion, efficiency and energy savings.

Regulation evol. – ancillary services markets

DCO 354/2013/R/eel

Identification of potential of DG and small vRES

1

DCO 298/2016/R/eel

First phase opening MDS: DG, vRES, Demand.

2

300/2017/R/eel

Setting the rules for MDS opening considering: Demand, RES, storage, call for pilot projects in view of **Integrated Dispatching Rules**.

3

372/2017/R/eel

Pilot project on aggregated demand; TSO sets grid codes and related rules.

4

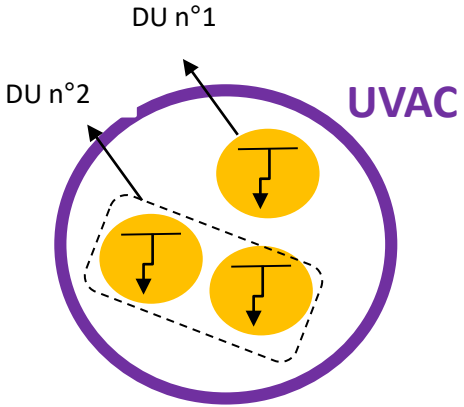
583/2017/R/eel

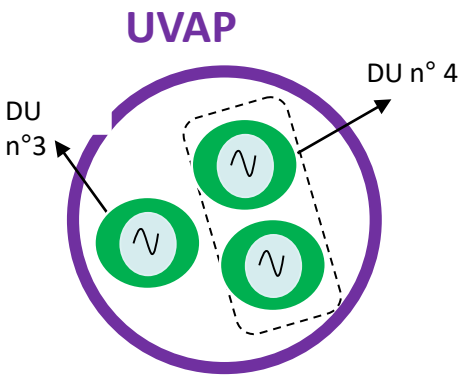
Pilot project on aggregated generation and DG; TSO sets grid codes and related rules.

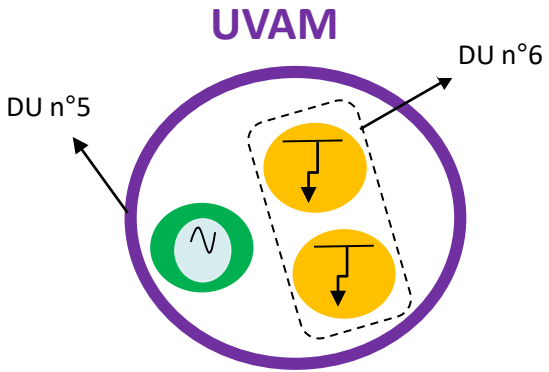
5

Regulation evol. – ancillary services markets

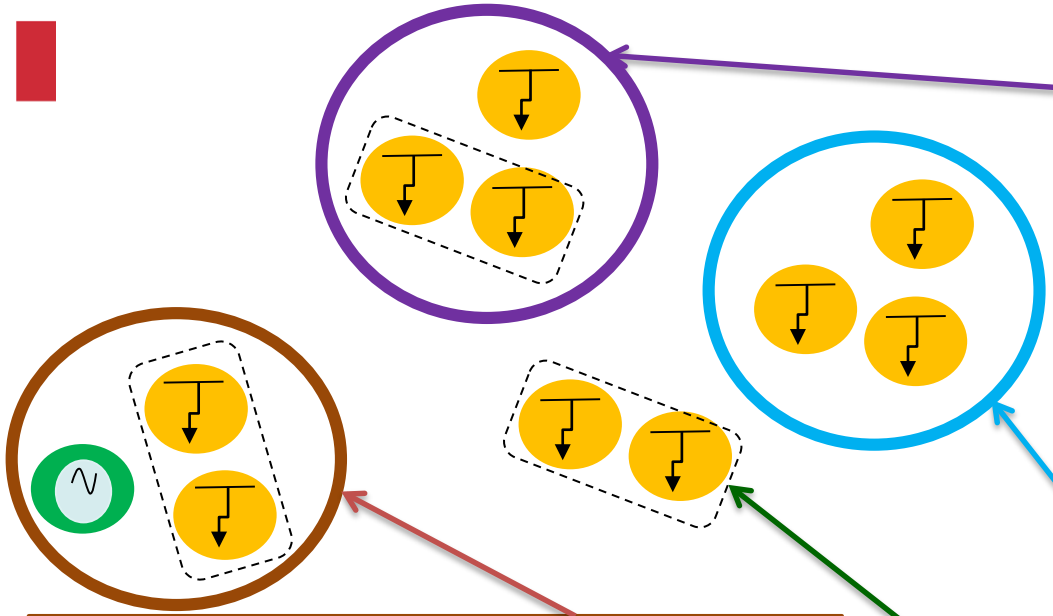
- The core of the pilot projects are the so-called **UVAs** (Unità Virtuali Abilitate, which stands for “Virtual Qualified Units”);
- Each UVA is a group of resources (Dispachting Unit) able to offer services on the ancillary services market;
- The UVA can be composed of only consumption units (**UVAC**), only production units (**UVAP**) or both (**UVAM**).







Evolution of the regulation – flexibility markets



UVAC – AGGREGATED USERS OFFERING SERVICES ON M.D.S

- MANAGED BY BALANCING SERVICE PROVIDER (BSP)
- MIN 10MW
- REACT WITHIN 15 MIN
- DURATION 4 H
- INCREASE ONLY (neg. Production)

UVAM: Participation to Ancillary services market of several types of distributed resources (consumption units, production units, storage units, also for electric mobility).

U.C. – AGGREGATED USER PARTICIPATING TO ENERGY MARKET

BUILDINGS – Clean energy for all Europeans

2030 ENERGY EFFICIENCY TARGET- LONGER TERM PERSPECTIVE FOR INVESTORS

REINFORCED LONGER TERM BUILDING RENOVATION STRATEGIES

- 2050 vision for a decarbonised and highly efficient building stock
- Intermediary milestones in 2030 & 40
- Stronger financing component
- Reinforcement of EPCs in connection with financial support

SMARTER BUILDINGS, BETTER CONNECTED

- A smart readiness indicator for buildings, for the benefit of consumers
- Reinforced building automation and controls
- Enhanced transparency of national building energy performance calculation methodologies

SUPPORTING E-MOBILITY

- E-mobility infrastructure deployment in buildings car parks
- Simplification of the deployment of recharging points (permitting procedures)
- Targeted exemptions (e.g. for SMEs)

* https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AL%3A2018%3A156%3ATOC&uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

** https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

*** https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0210.01.ENG&toc=OJ:L:2018:328:TOC

RSE Ricerca Sistema Energetico

eurac research

European Commission

BUILDINGS – EC Directives evolution

Smart Readiness indicator

CONCEPT - SMART READINESS INDICATOR - SRI

Measure the technological readiness of your building

https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_secondprogressreport_final_0.pdf

Industry issues with efficiency and flexibility

iets

- System energy efficiency and process integration
- Energy efficient energy and process technologies
- Electrification
- CCS/CCU (including biogenic, negative emissions)
- Industrial biorefineries
- Excess heat and industrial/societal symbiosis
- Circular economy solutions
- Digitalization and Big Data/AI

CONCLUDING REMARKS

FLEXIBILITY IS KEY FOR R.E.S. INTEGRATION – DECARBONISATION AND MUST BE CONSIDERED ALONG ALL ENERGY VALUE CHAIN. SEVERAL PROJECTS ALL OVER EUROPE.

FLEXIBILITY FROM LOAD: SMART METERS AND DEVICES FOR LOAD MANAGEMENT AND CONSUMER EXPERIENCE. REGULATION FOSTERS FLEXIBILITY MARKETS

FLEXIBILITY IN GENERATION: CONVENTIONAL PLANTS: SOLUTIONS FOR RAMPING, TECHNICAL MINIMUM, STARTUP, CYCLING. CASCADE AGGREGATION OF HYDRO PLANTS.

BUILDINGS EFFICIENCY IS FOSTERED BY EVOLUTION OF DIRECTIVES. R&D NEEDED ON BUILDING AUTOMATION CONTROL (BACS), SELF CONSUMPTION, LOW TEMPERATURE DISTRICT HEATING AND COOLING, BIDIRECTIONAL NETWORKS:

FLEXIBILITY FROM NETWORKS: FLEXIBILITY FOR POWER, ENERGY, TRANSFER CAPACITY, VOLTAGE. INTEGRATION OF RES MOTIVATES NETWORK OPERATORS TO ADOPT S.G.