La rivoluzione della generazione distribuita: l'integrazione di rinnovabili in "smart micro-grids"

Enrico Sangiorgi

Dipartimento di Ingegneria
dell'Energia Elettrica e dell'informazione
«Guglielmo Marconi»

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Smart grid

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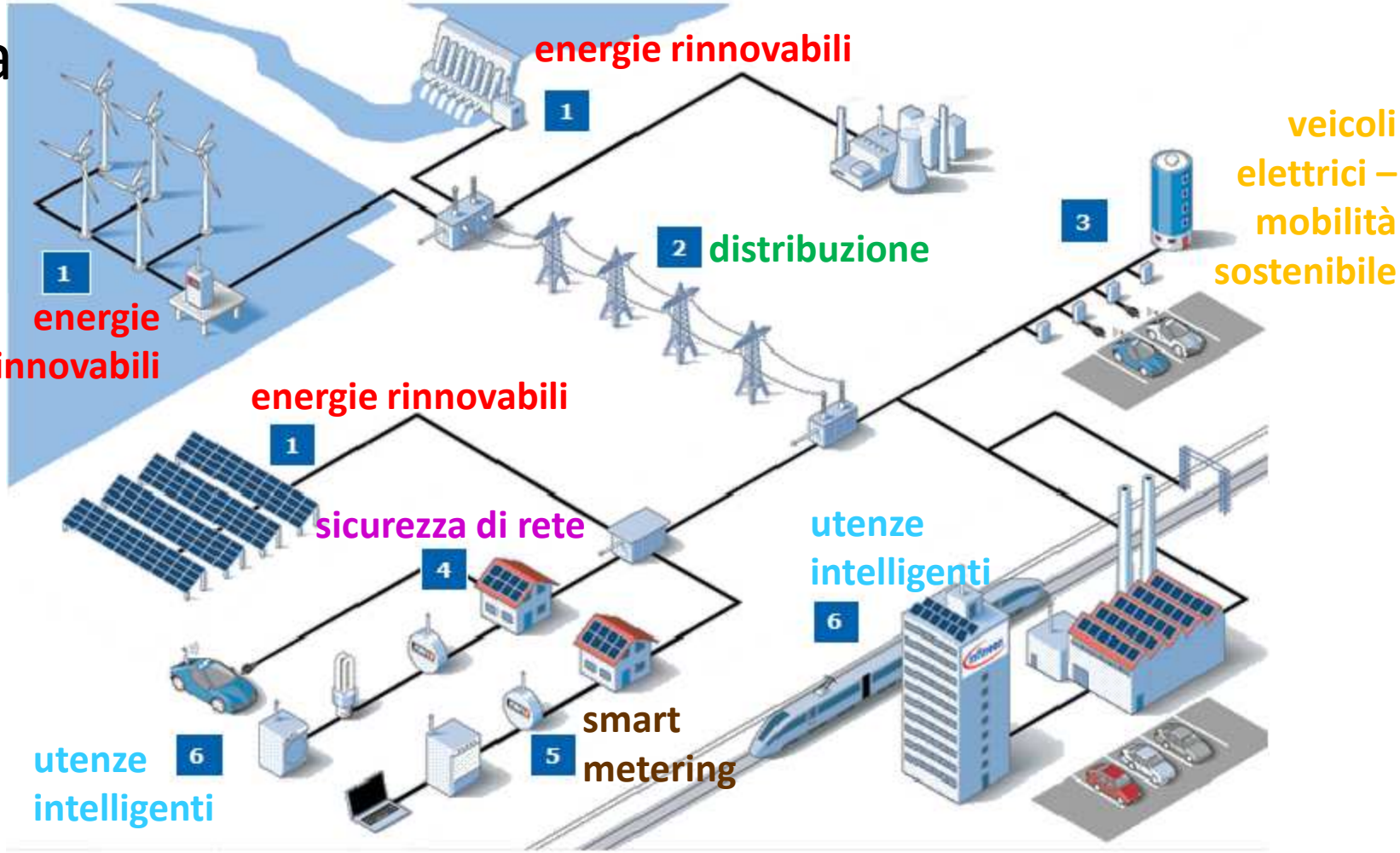
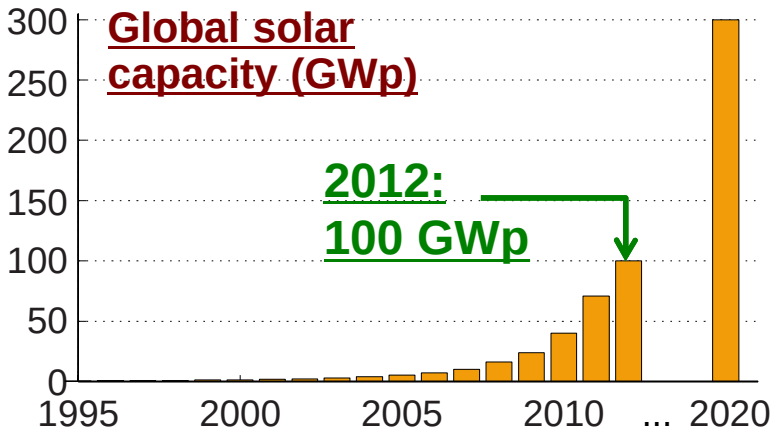
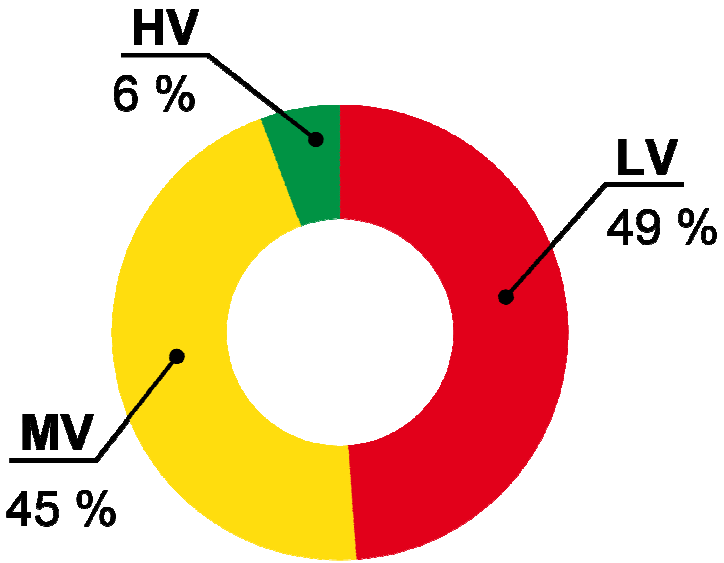

energie rinnovabili
1
2 distribuzione
3
veicoli elettrici – mobilità sostenibile
1
energie rinnovabili
energie rinnovabili
1
sicurezza di rete
4
utenze intelligenti
6
smart metering
5
utenze intelligenti
6

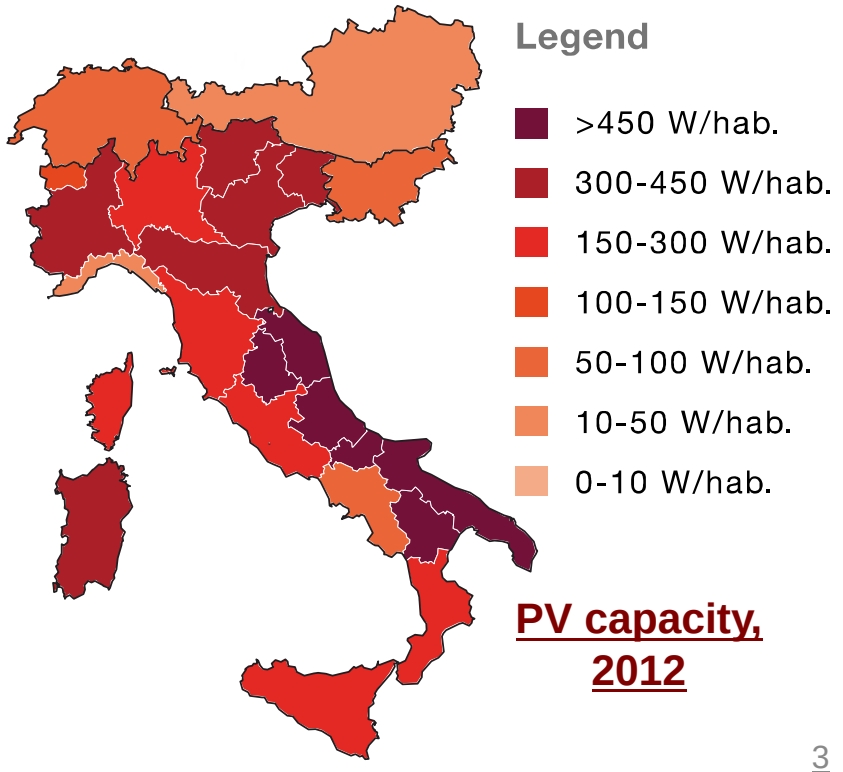
PV Installations in Europe / Italy





Source: www.pvgrid.eu

- High densitity of distributed generation
- 49% **Low Voltage (LV)** installations
- **Further increase** up to 300 GW in 2020

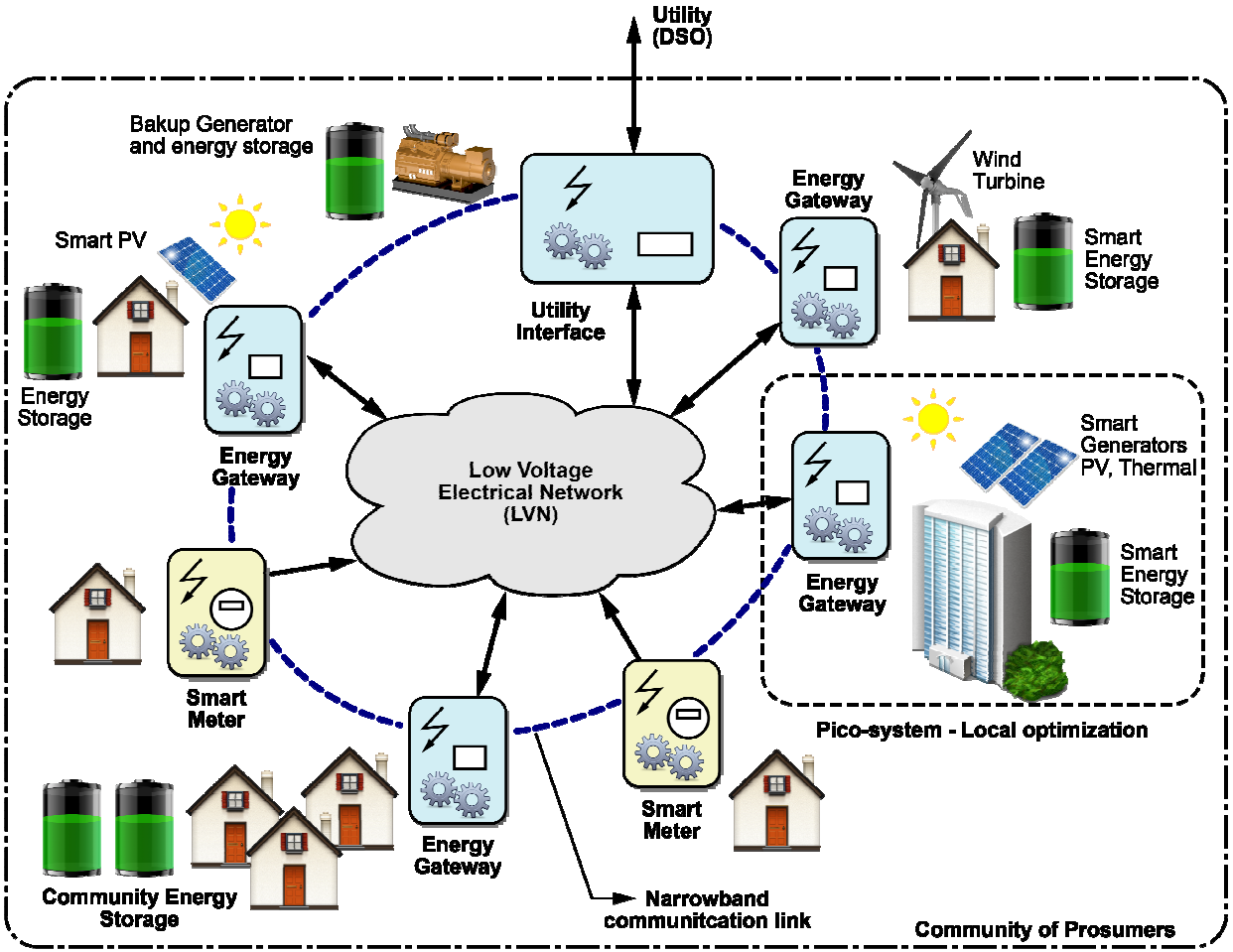


PV capacity, 2012

Effects of PV penetration in LV Grids

- **Intermittent** power generation
- Possible **overload** of distribution lines due to uncontrolled power sharing
- Possible detrimental **interaction** among distributed generation systems
- Reduction of **power quality** due to circulation of reactive currents,
- **Solution: to aggregate distributed loads and power sources to form LV microgrids, where energy resources are shared so as to improve local and global performances, i.e., energy efficiency, power quality, robustness against faults and transients, etc.**

LV Microgrid Architecture



Elements:

- LV distribution grid
- ICT infrastructure
- Passive loads
- Distributed (renewable) power sources
- Energy storage devices
- Smart meters
- **Energy gateways** (EG)
- **Utility Interface** (UI)

LV Microgrids: a win-win solution

Low-voltage microgrids equipped with Utility Interfaces feature:

- prompt adaptation to load and line variations
- management of intentional and non-intentional islanding
- voltage and fault ride-through capability
- black start and fault recovery
- reactive, harmonic and unbalance compensation
- management of interaction with DSO (demand response, fault recovery, intentional islanding …)

Final users (prosumers) take advantage of:

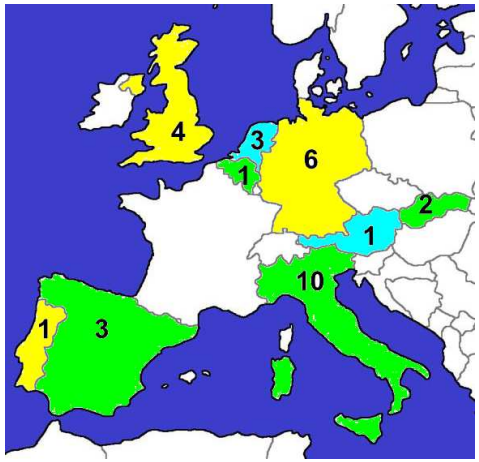
- Energy savings, reduced electricity bill, increased power quality
- Upgrade of role in the electrical market, increased negotiation capability

DSOs and ESCOs take advantage of :

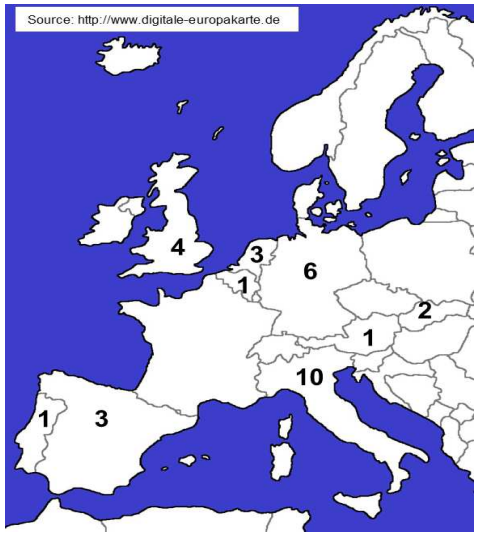
- Aggregation of end-users into efficient and programmable macro-users
- Participation of end-users to investments for distributed energy management and storage
- Increased operation flexibility and efficiency of distribution networks

Il progetto E2SG

- Cooperazione internazionale
  - 31 partners da 9 paesi europei
- Principali temi di ricerca
  - Microgenerazione, energy routing ed interfaccia verso la rete
  - Conversione di potenza
  - Grid sensing and metering
  - Controllo e struttura della rete
  - Affidabilità circuiti e dispositivi elettronici per la conversione di potenza



[Copyright: Infineon Technologies AG]



The consortium:
29 partners of 9 European countries

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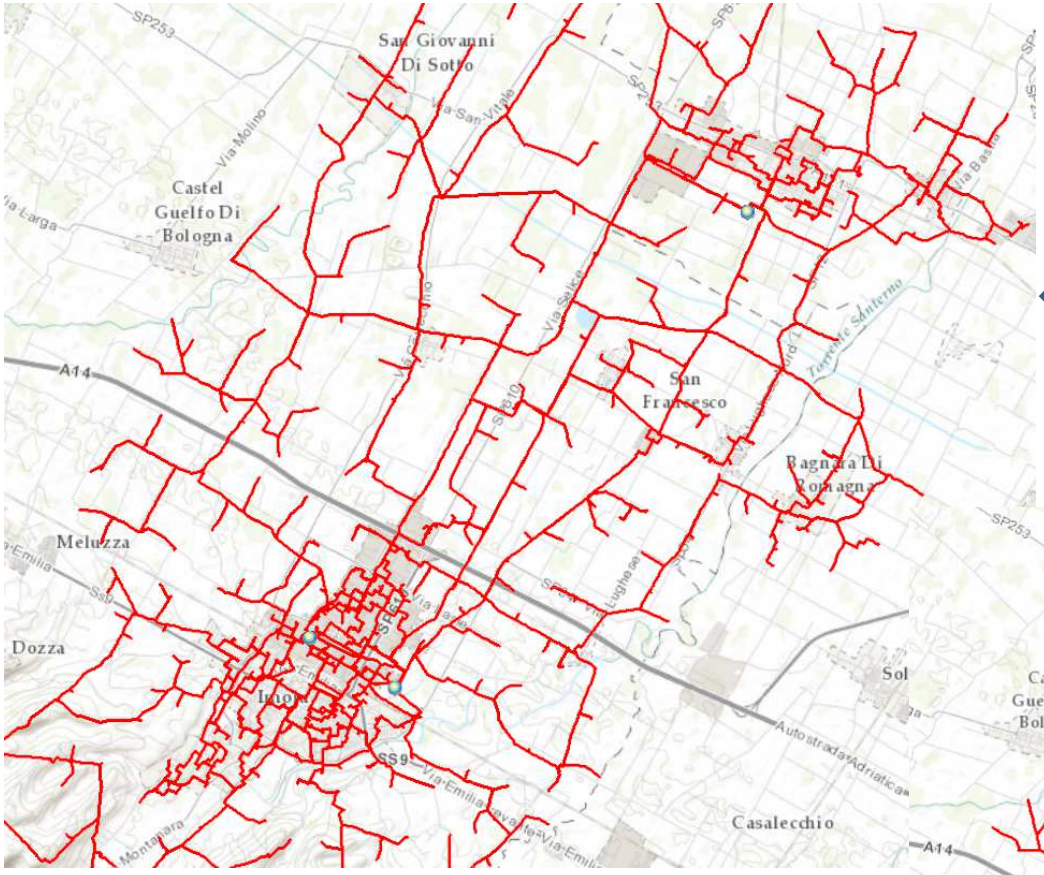
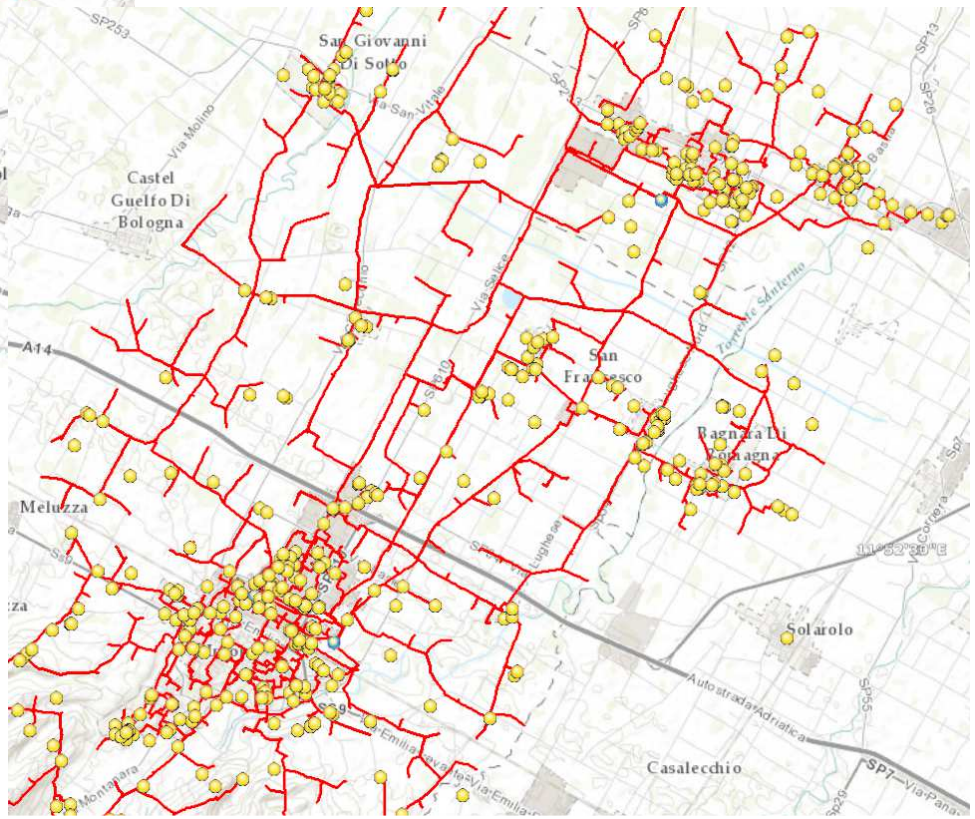
Motivazione



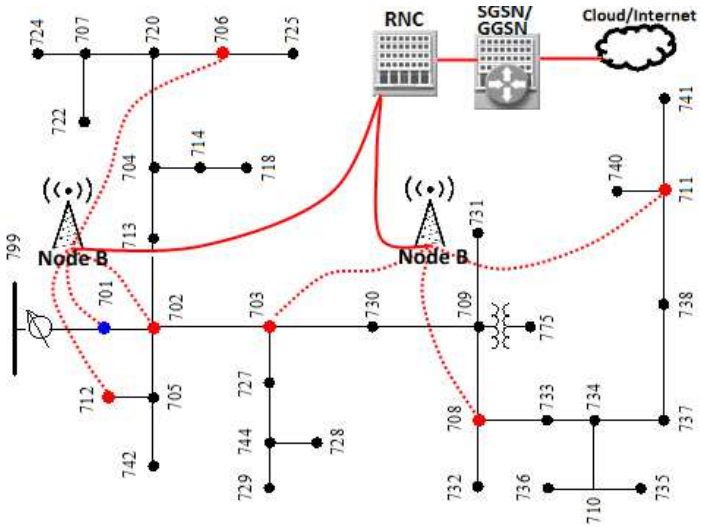
Rete di distribuzione in media tensione (in rosso) di Imola con linee aeree e cavi di lunghezza complessiva di circa 200km con tre cabine primarie (pallini blu) ognuna con 2 trasformatori da 30 MVA.

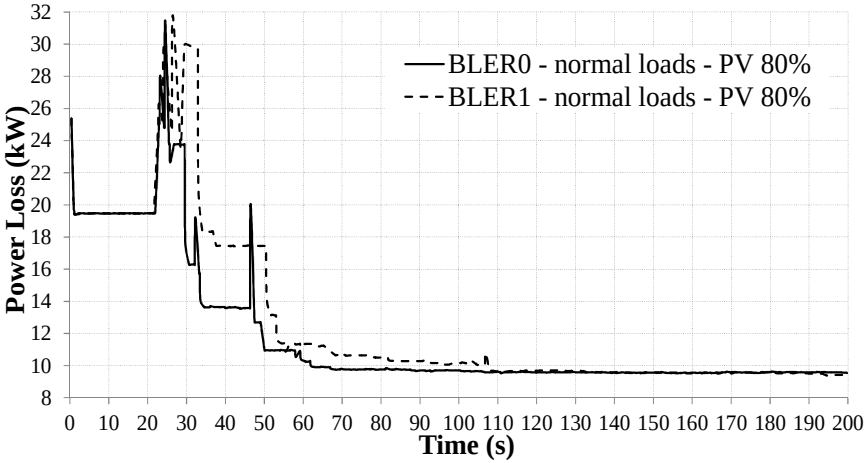
I pallini gialli indicano i circa 700 clienti attivi. Quelli connessi in MT complessivamente hanno capacità di generazione di 150 MW di picco. Quelli connessi in BT hanno capacità pari produttiva di 13 MW.
(dati HERA)



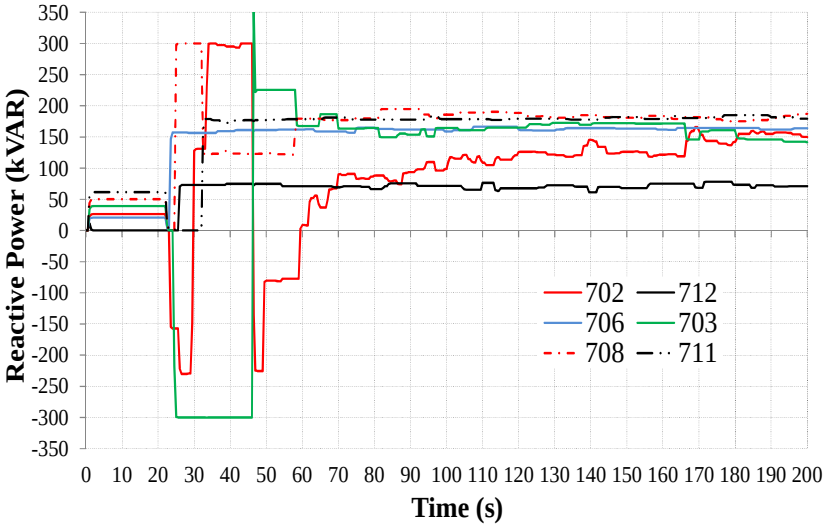
Primi esempi di studio

Dorsale con 33 nodi e 6 impianti fotovoltaici con sistemi di controllo anche della potenza reattiva connessi alla rete GPRS





Andamento delle perdite in rete



Variazione di potenza reattiva degli impianti fotovoltaici

Risultati ottenuti con lo sviluppo di un ambiente di co-simulazione EMTP-Opnet (ora Riverbed) descritto in:

R. Bottura, A. Borghetti, F. Napolitano, C.A. Nucci, ICT-power Co-simulation Platform for the Analysis of Communication-based Volt/Var Optimization in Distribution Feeders, in Proc. of ISGT 2014, Washington DC, 2014.

Bottura, R., Borghetti, A., Simulation of the Volt/Var Control in Distribution Feeders Obtained by a Networked Multi-Agent System, IEEE Trans. Ind. Informatics, in press, DOI: 10.1109/TII.2014.2331025, 2014.

BLER0 e BLER1 sono due livelli diversi di “block error” ossia perdita di informazione nella rete GPRS.

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Enrico Sangiorgi

Dipartimento di Ingegneria dell'Energia Elettrica e dell'Informazione "Guglielmo Marconi"

051 2093004

www.dei.unibo.it