The SmartGen project: an example of DMS development for VPP and Microgrids

Stefano Massucco, Federico Silvestro

University of Genova – Italy

DITEN-IEES Intelligent Electric Energy Systems

11th Microgrid Symposium 27-28 August 2015, Aalborg

SmartGen Project

- Title
  - “Study, development and validation of methodologies and tools for the management of active power distribution networks including renewable energy sources”
- Context: Smart Grids
  - Operation of generators of any size and technology
  - Load active role in the optimization of operation
  - Availability of more information and wider choice of suppliers
  - Reduction of environmental impact
  - Enhancement of reliability, security and quality of service

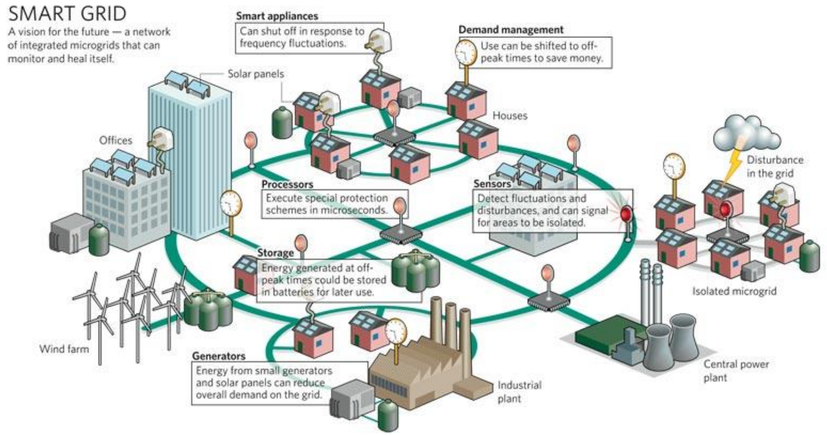

SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.
Smart appliances
Can shut off in response to frequency fluctuations.
Demand management
Use can be shifted to off-peak times to save money.
Solar panels
Houses
Offices
Disturbance in the grid
Processors
Execute special protection schemes in microseconds.
Sensors
Detect fluctuations and disturbances, and can signal for areas to be isolated.
Storage
Energy generated at off-peak times could be stored in batteries for later use.
Isolated microgrid
Wind farm
Generators
Energy from small generators and solar panels can reduce overall demand on the grid.
Industrial plant
Central power plant

Image published in **Consumer Energy Report** - http://www.consumerenergyreport.com/wp-content/uploads/2010/04/smartgrid.jpg - All rights reserved

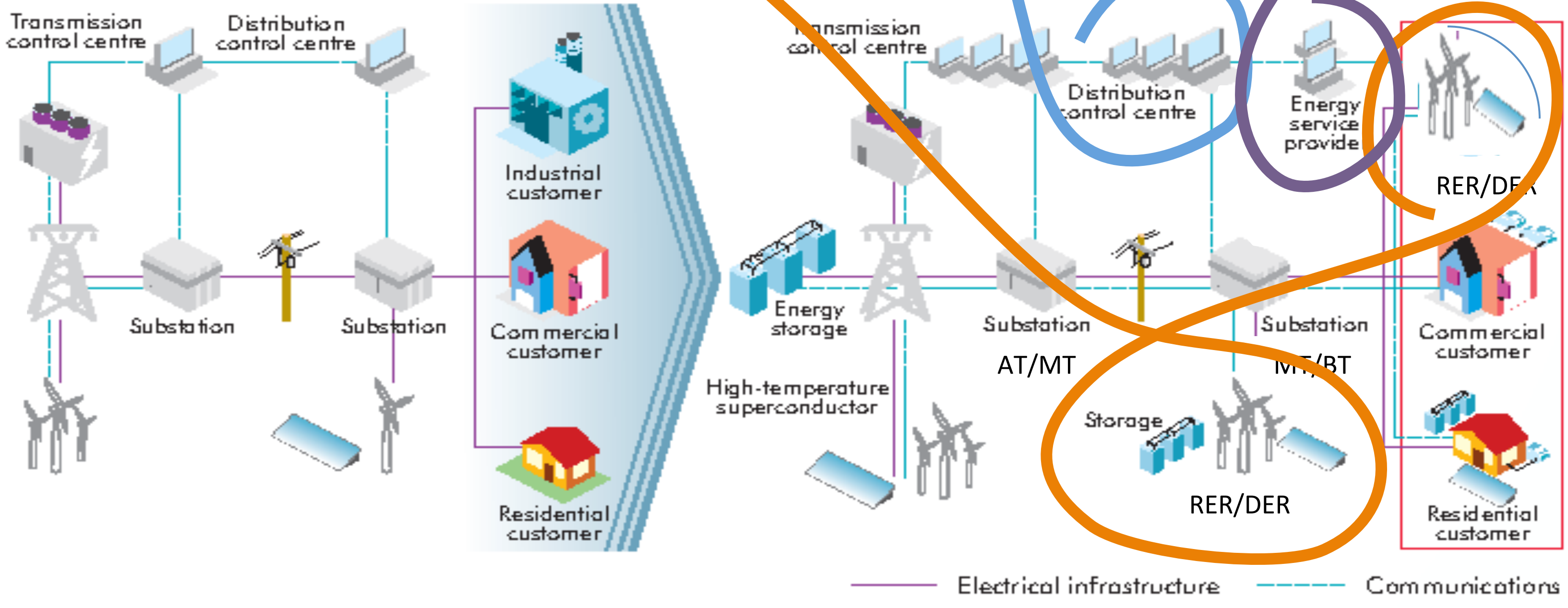
- Fundings
  - Funded by MISE (Italian Ministry for Economic Development) in the context of the Research Projects for the Electric Systems

Action areas

Advanced Distribution Management System

New services for liberalised market operators

Active distribution networks with distributed generation


Transmission control centre
Distribution control centre
Industrial customer
Substation
Substation
Commercial customer
Residential customer
Energy storage
High-temperature superconductor
nsmission
co rol centre
Distribution
ontrol centre
Energy
service
provide
RER/DE
Substation
AT/MT
Substation
MT/BT
Storage
RER/DER
Commercial customer
Residential customer
Electrical infrastructure
Communications

International Energy Agency

SMARTGEN

Main objectives

Analyzing scenarios of smart grids and active interaction with the electricity market

- with distributed generation (DG) and storage with the possibility of *load control*
- to identify main technical and economical constraints
- to define future actors (*aggregators*, price signals, active demand management)

Defining and implementing the architecture of innovative Distribution Management System

- Interfacing to data acquisition systems and SCADA (Supervisory Control And Data Acquisition)
- ***State estimation*** and simulation scenarios
- Management of optimization problems, control of power flow, voltage and supply of ***ancillary services from DG***, and load dispatch
- Study of different distribution management modes: normal , dysfunctional, and/or emergency mode (islanding)

Demonstrating features and benefits in real user cases

- Definition of complex reference scenarios
- Validation of ***real network functional efficiency***
- Integration of real networks and simulation in pilot sites

Project Consortium

University of Genova - *DITEN*

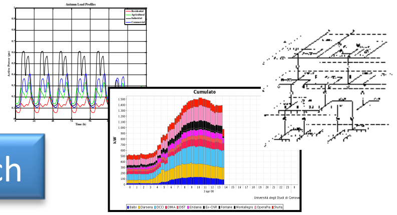
UNIVERSITÀ DEGLI STUDI DI GENOVA

Scientific coordinator
DMS architecture, technology survey and enhancement, dissemination

University of Bologna - *DIE*

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

DMS advanced functionalities and monitoring interfaces



Academic research

Softeco Sismat S.r.l.

softeco sismat information technology

Project coordination
System integration, automation and communication software, wholesale market management

s.d.i. S.p.A.

s.d.i.

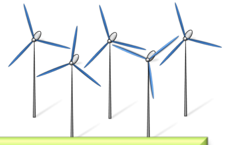
SCADA & DMS design and implementation, innovative power network management

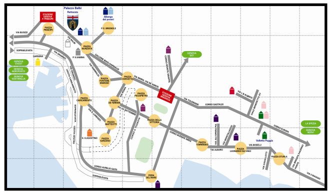
Industrial research

Enel Engineering and Research

Enel CINQUANTA 1962 2012

System requirements, DMS architecture definition, piloting and demonstration



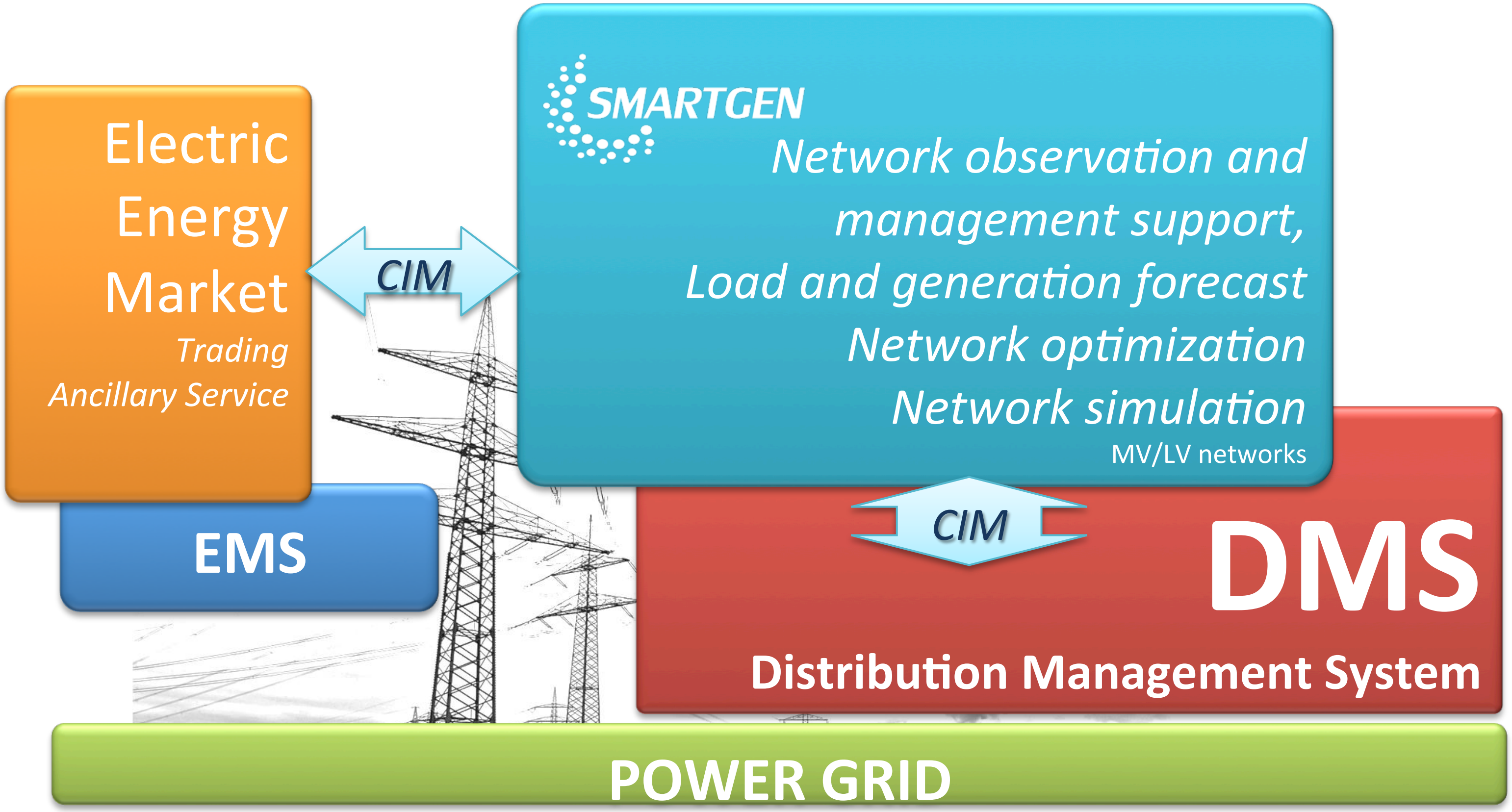


Industrial infrastructure research

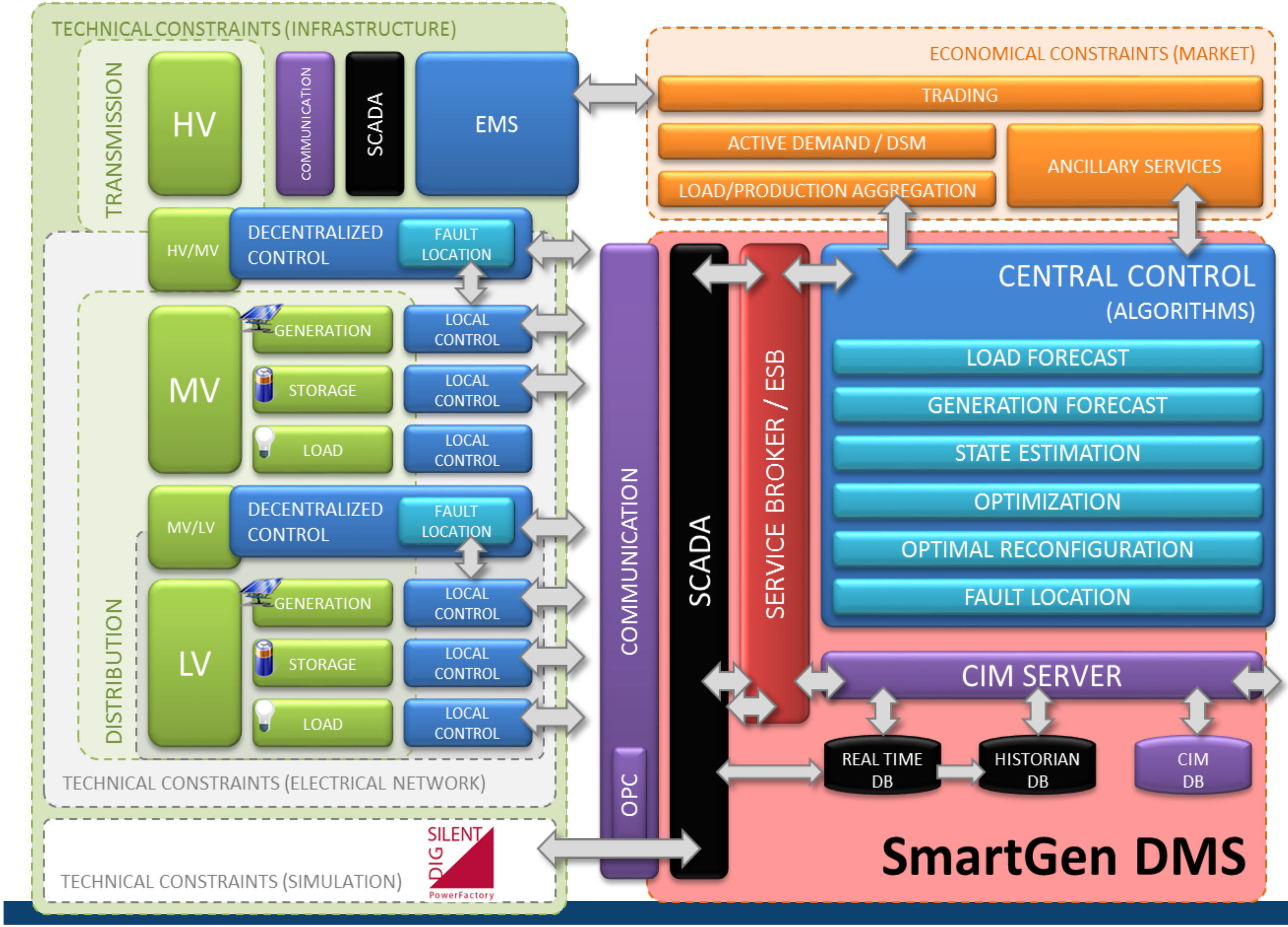
START: January 2011
DURATION: 36 months
COSTS > 2.8 M€
Financing = 1.1 M€

The product of the project

Smartgen has developed a platform that "extends" a DMS with new features


Electric Energy Market
Trading
Ancillary Service
CIM
SMARTGEN
Network observation and management support,
Load and generation forecast
Network optimization
Network simulation
MV/LV networks
EMS
CIM
DMS
Distribution Management System
POWER GRID

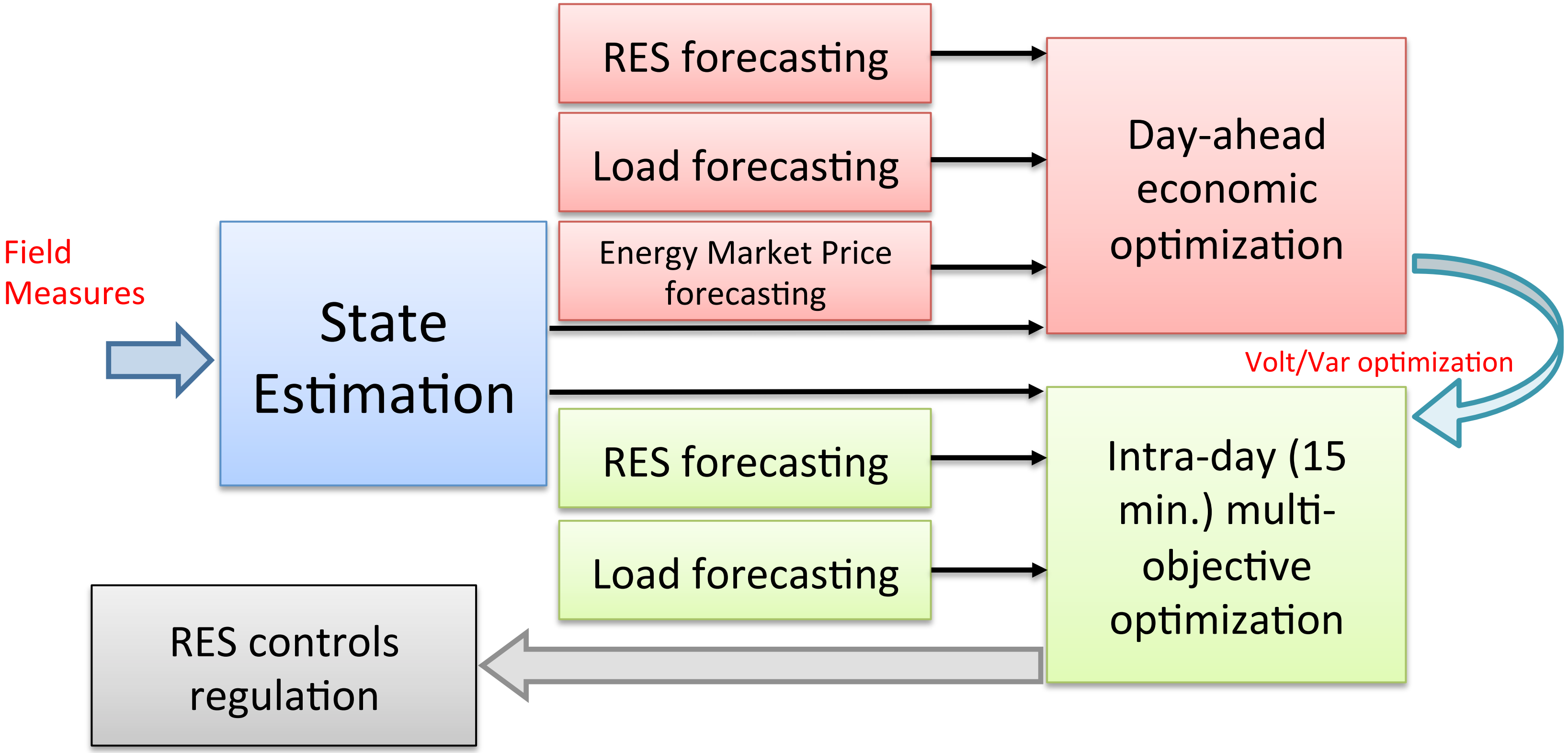
Smartgen architecture


TECHNICAL CONSTRAINTS (INFRASTRUCTURE)
TRANSMISSION
HV
COMMUNICATION
SCADA
EMS
HV/MV
DECENTRALIZED CONTROL
FAULT LOCATION
MV
GENERATION
STORAGE
LOAD
LOCAL CONTROL
LOCAL CONTROL
LOCAL CONTROL
MV/LV
DECENTRALIZED CONTROL
FAULT LOCATION
LV
GENERATION
STORAGE
LOAD
LOCAL CONTROL
LOCAL CONTROL
LOCAL CONTROL
DISTRIBUTION
TECHNICAL CONSTRAINTS (ELECTRICAL NETWORK)
TECHNICAL CONSTRAINTS (SIMULATION)
DIGSILENT PowerFactory
ECONOMICAL CONSTRAINTS (MARKET)
TRADING
ACTIVE DEMAND / DSM
LOAD/PRODUCTION AGGREGATION
ANCILLARY SERVICES
COMMUNICATION
OPC
SCADA
SERVICE BROKER / ESB
CENTRAL CONTROL (ALGORITHMS)
LOAD FORECAST
GENERATION FORECAST
STATE ESTIMATION
OPTIMIZATION
OPTIMAL RECONFIGURATION
FAULT LOCATION
CIM SERVER
REAL TIME DB
HISTORIAN DB
CIM DB
SmartGen DMS

SmartGen functionalities

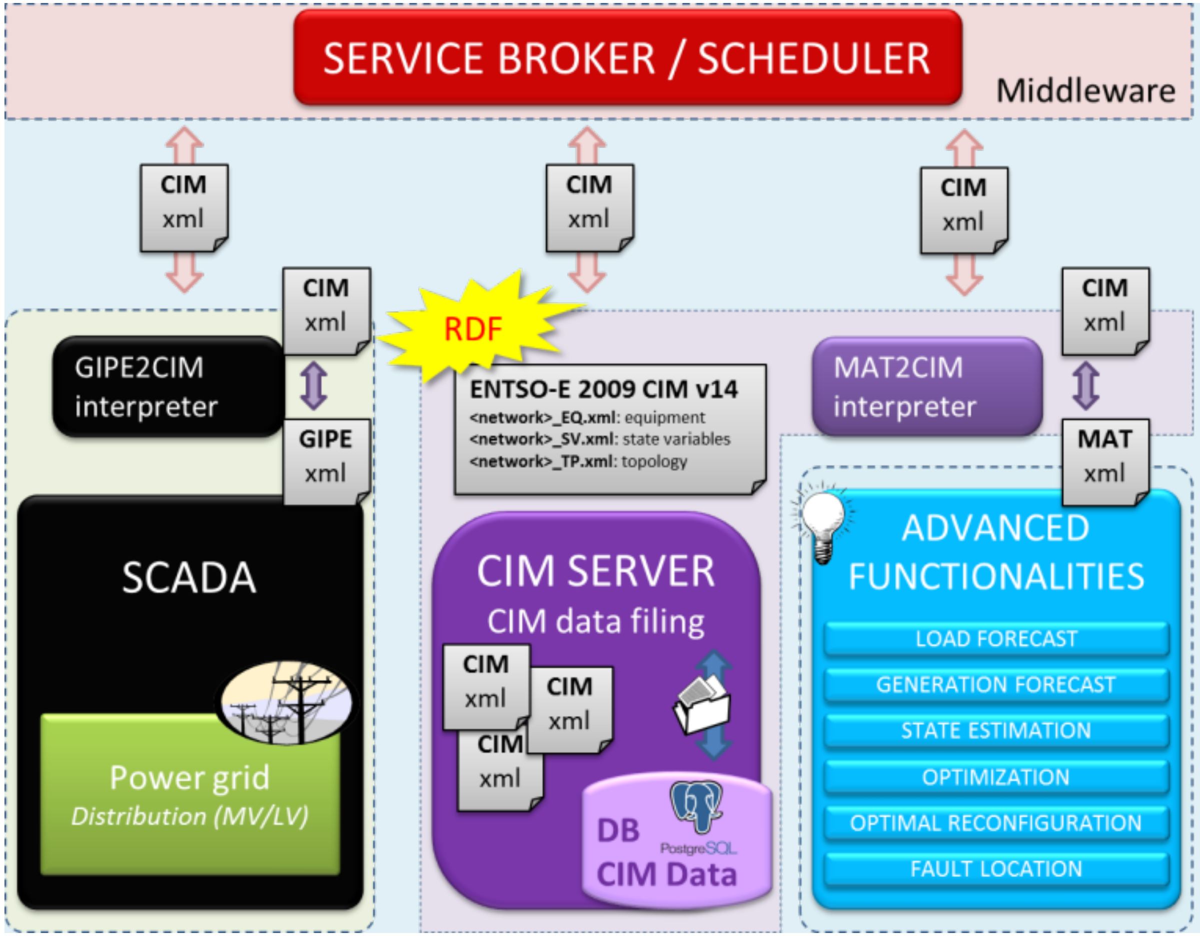
- Distribution State Estimation (ASE)
- Load Forecast (ALF)
- Generation Forecast (AGF)
- Optimal Reconfiguration (AOR)
- Working Point Optimization (APO)
- Working point Losses optimization (AWL)
- Fault Location (AFL)

Multi-level optimization


Field
Measures
State
Estimation
RES forecasting
Load forecasting
Energy Market Price
forecasting
Day-ahead
economic
optimization
Volt/Var optimization
RES forecasting
Load forecasting
Intra-day (15
min.) multi-
objective
optimization
RES controls
regulation

CIM Architecture

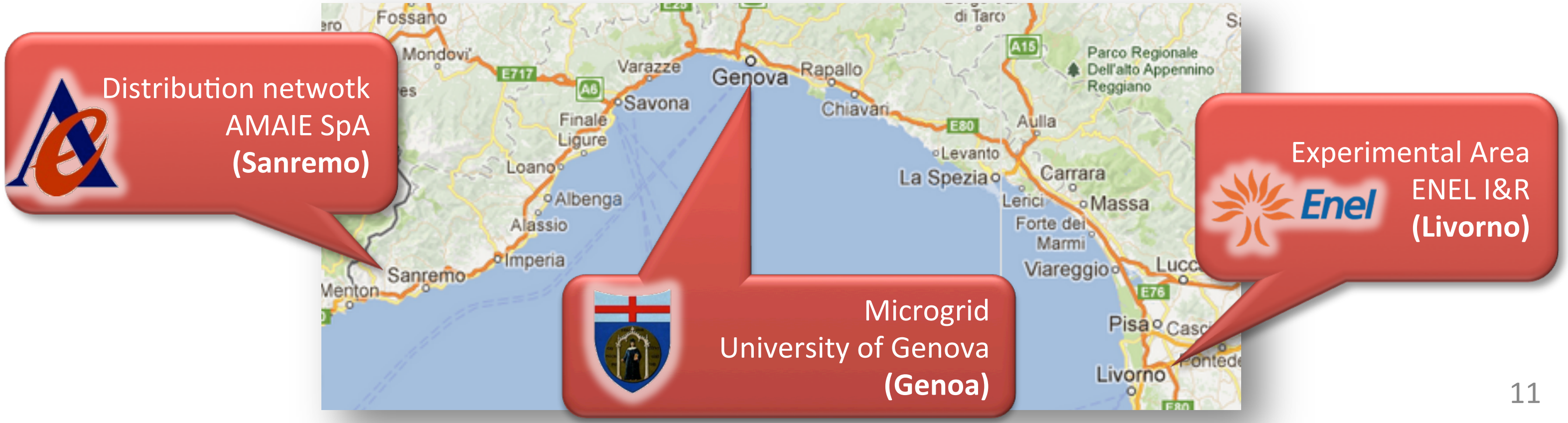
The **Common Information Model** (CIM): **a power industry standard** adopted by IEC **to allow different applications to exchange data** about the configuration and the status of a power network


SERVICE BROKER / SCHEDULER
Middleware
CIM xml
CIM xml
CIM xml
CIM xml
RDF
CIM xml
GIPE2CIM interpreter
GIPE xml
ENTSO-E 2009 CIM v14
<network>_EQ.xml: equipment
<network>_SV.xml: state variables
<network>_TP.xml: topology
MAT2CIM interpreter
MAT xml
SCADA
Power grid
Distribution (MV/LV)
CIM SERVER
CIM data filing
CIM xml
CIM xml
CIM xml
DB
PostgreSQL
CIM Data
ADVANCED FUNCTIONALITIES
LOAD FORECAST
GENERATION FORECAST
STATE ESTIMATION
OPTIMIZATION
OPTIMAL RECONFIGURATION
FAULT LOCATION

Field Testing Phase – Real Networks

- The ensemble of pilot sites was chosen in order to test (in simulated and/or in field) all the SmartGen functions:
  - State estimation
  - Load/generation forecast
  - Optimization of the working point
  - Optimal (re-)configuration
  - Fault location

- Three sites are identified sites because:
  - They allow to apply and test a comprehensive combination of the DMS functions
  - They already have a good degree of instrumentation
  - More activities aimed at the installation of additional instrumentation will be possible


Fossano
Mondovì
Varazze
Genova
Rapallo
Savona
Chiavari
Finale Ligure
Loano
Albenga
Alassio
Imperia
Sanremo
Menton
Levanto
La Spezia
Lerici
Carrara
Massa
Aulla
Forte dei Marmi
Viareggio
Pisa
Livorno
Parco Regionale Dell'alto Appennino Reggiano
Enel

Distribution netwotk
AMAIE SpA
(Sanremo)

Microgrid
University of Genova
(Genoa)

Experimental Area
ENEL I&R
(Livorno)

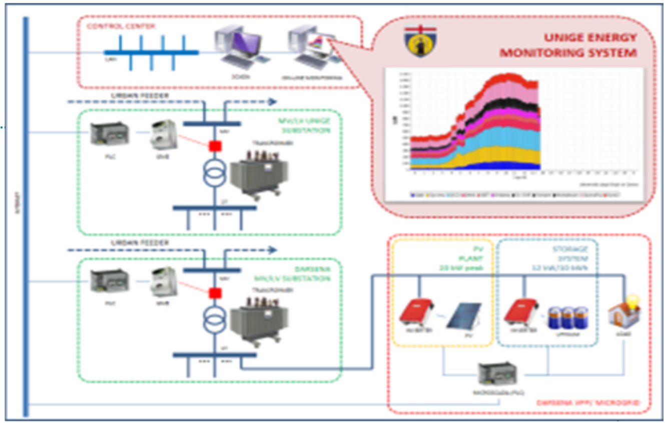
VPP – University of Genoa experimental micro-grid

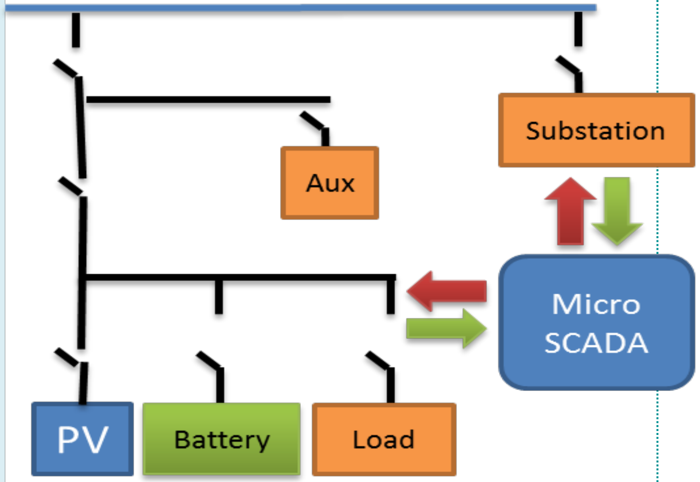
University experimental micro-grid

- Generation and network components
- 19,74 kW PV plant
- Bidirectional inverter (10kW-12kVA) with batteries control system (storage system lithium-ion battery: 4 modules (2,2 kW-48 V))
- Controllable resistive – inductive load (10 kW – 12 kVAr) for islanding scenarios (storage + PV+ load)

Data Acquisition System

- Monitoring system for generation and weather data acquisition (radiation, ambient temperature, retro-module temperature)
- Acquisition system for electrical variables (voltage, current, power, frequency, SOC) with sampling values per second
- Indipendent acquisition channels (for storage, PV and PCC) and transmission over LAN on University network.
- Development of Mixed-Integer algorithms


CONTROL CENTER
SCADA
UNIGE ENERGY MONITORING SYSTEM
URBAN FEEDER
MV/LV UNIGE SUBSTATION
PLC
TRANSFORMER
URBAN FEEDER
DARSENA MV/LV SUBSTATION
PV PLANT 20 kW peak
STORAGE SYSTEM
PV
LOAD
DARSENA VPP/ MICROGRID


Substation
Aux
Micro SCADA
PV
Battery
Load

Other significant site with PMU and smart meters installation. This site is located in Sanremo (AMAIE)

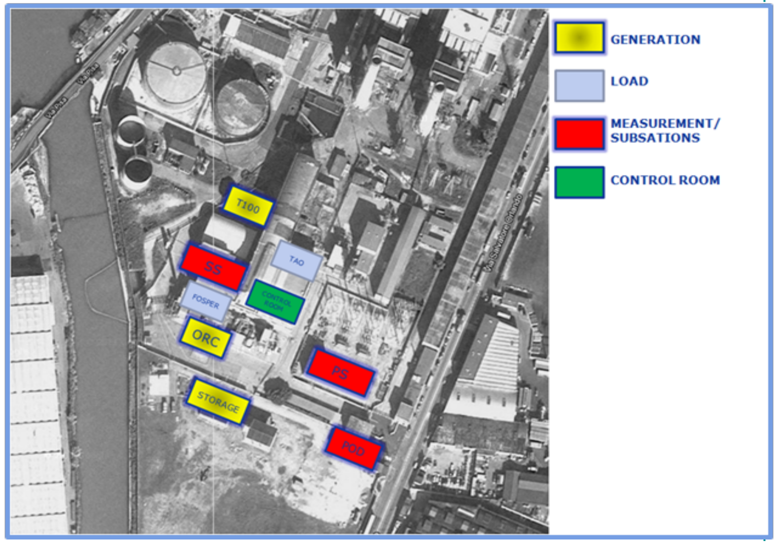
Experimental distribution network

Livorno Experimental Area

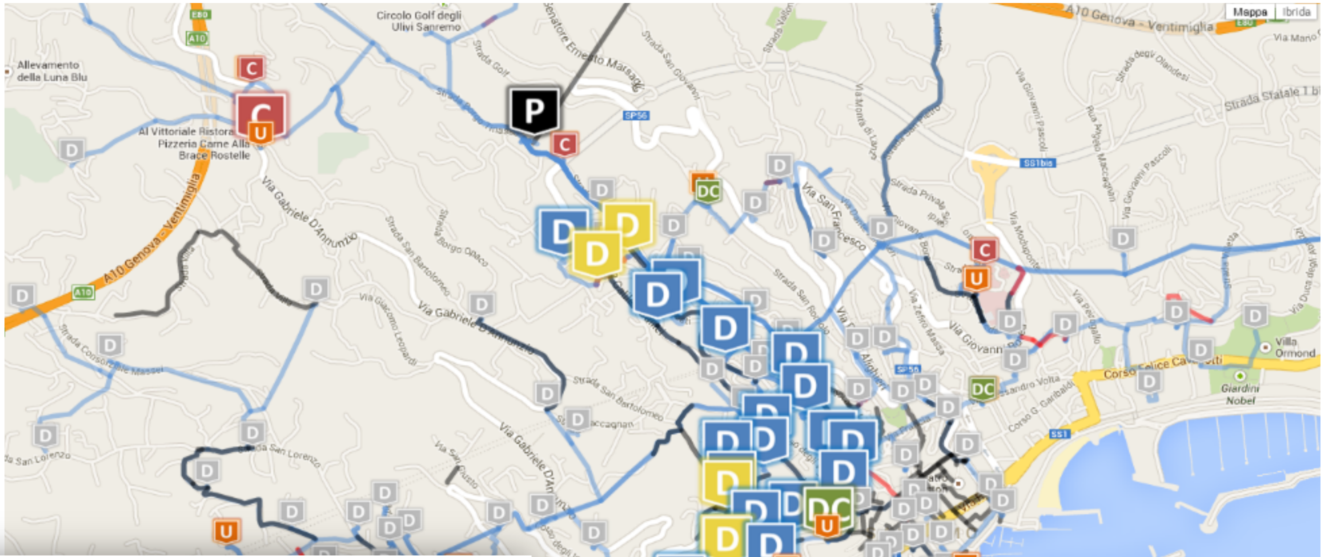
- **Main DMS SCADA functionalities**
    - Load/generation forecasting
    - Optimization of DER working point
    - Virtual islanding operations
- **Possibility of field tests with no impact on the DSO**
- **MV and LV internal network available**
- **Assets involved in SmartGen demo**

Generation	Loads and Storage
PV 20 kW	Storage systems 90 kW
ORC 500 kW	water pumps 2x50 kW
T100 100 kW	fans 2x70, 50 kW
	motors 120, 80 kW

Area overview and main SmartGen Elements


T100
SS
TAO
FOSPER
CONTROL ROOM
ORC
PS
STORAGE
POD
GENERATION
LOAD
MEASUREMENT/ SUBSATIONS
CONTROL ROOM

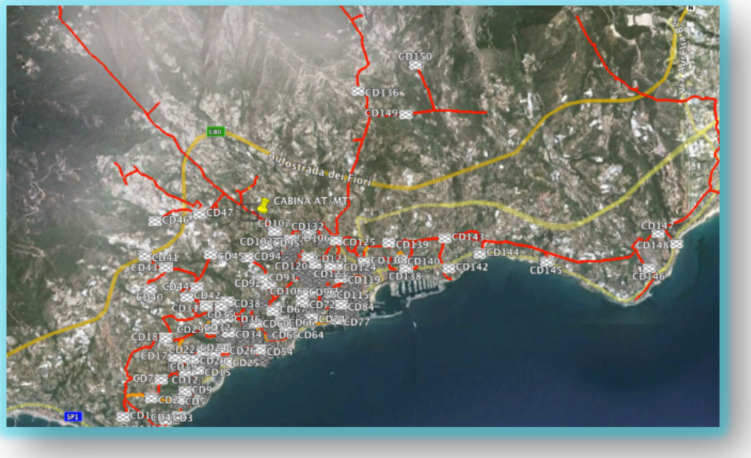
Real Distribution Network test case


Mappa
Ibrida
A10 Genova - Ventimiglia
Circolo Golf degli Ulivi Sanremo
Allevamento della Luna Blu
Al Vittoriale Ristorante Pizzeria Carne Alla Brace Rostelle
Via Gabriele D'Annunzio
Strada San Bartolomeo
Via San Francesco
Corso Felice Cavallotti
Villa Ormond
Giardini Nobel
P
C
U
D
DC

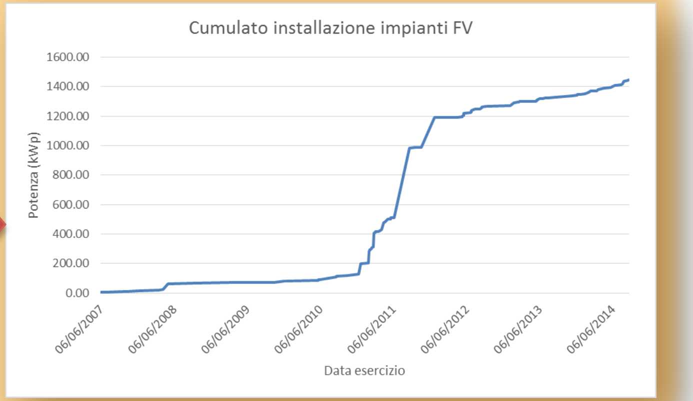
Sanremo distribution network - AMAIE

The network is composed of

- A primary substation (HV/MV 132/15 kV)
- 10 MV feeders, typically managed in a radial structure, departing from the substation
- 115 km of MV lines, both cables and overhead lines. MV network managed in compensated neutral
- ~ 200 secondary substations (MV/LV 15/0,4 kV), among public and private ones
  - Of which about 10% remotely controlled
- ~30.000 users (27.000 for domestic use, 15 for industrial use, 3.000 other)
- ~100 PV plants
  - 1 x 470 kW in MV
  - 10 x (10-100kW) in LV
  - Domestic < 6 kW

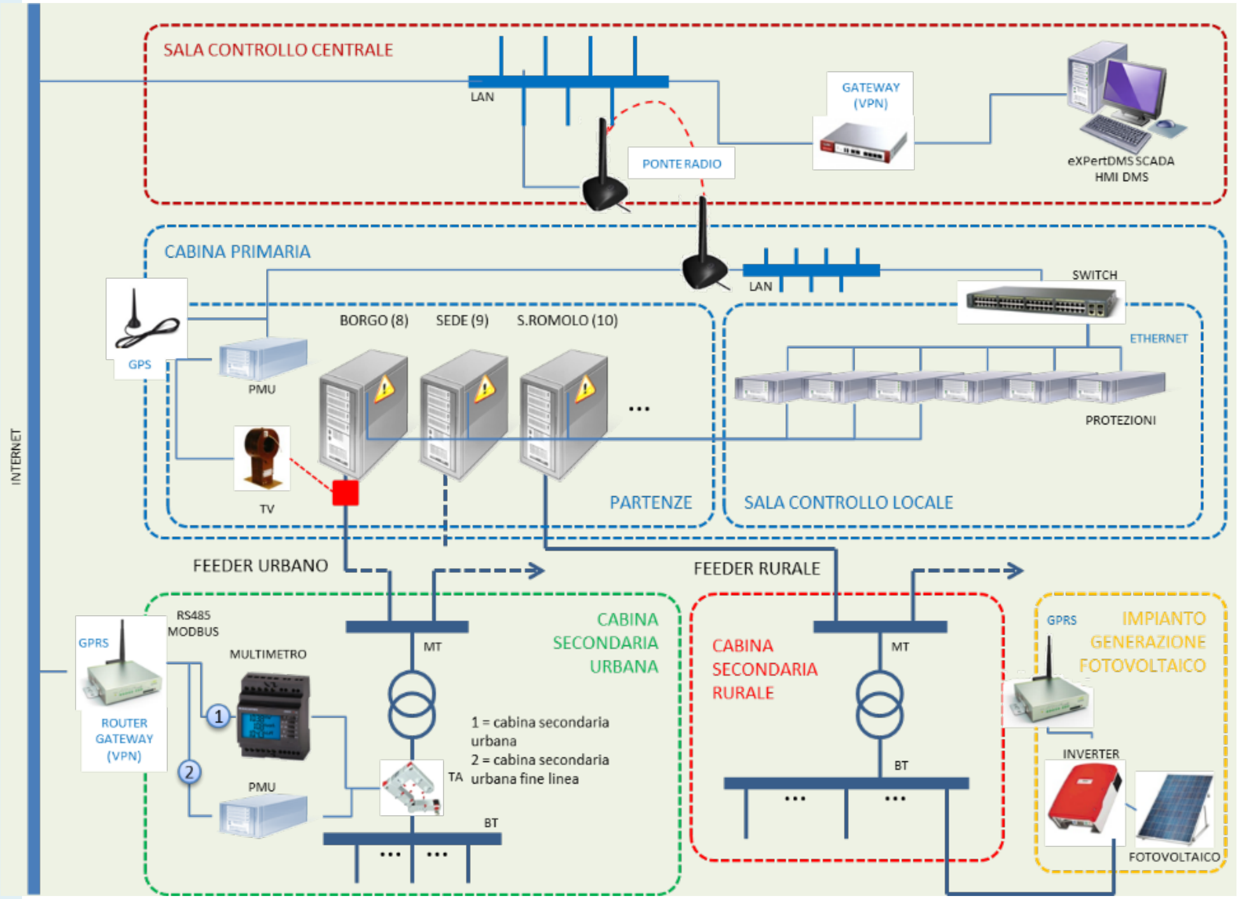

CABINA AT/MT
Autostrada dei Fiori
CD150
CD136
CD149
CD145
CD147
CD148
CD146
CD142

PV impact 2007/2014



Smartgen installations at AMAIE Sanremo

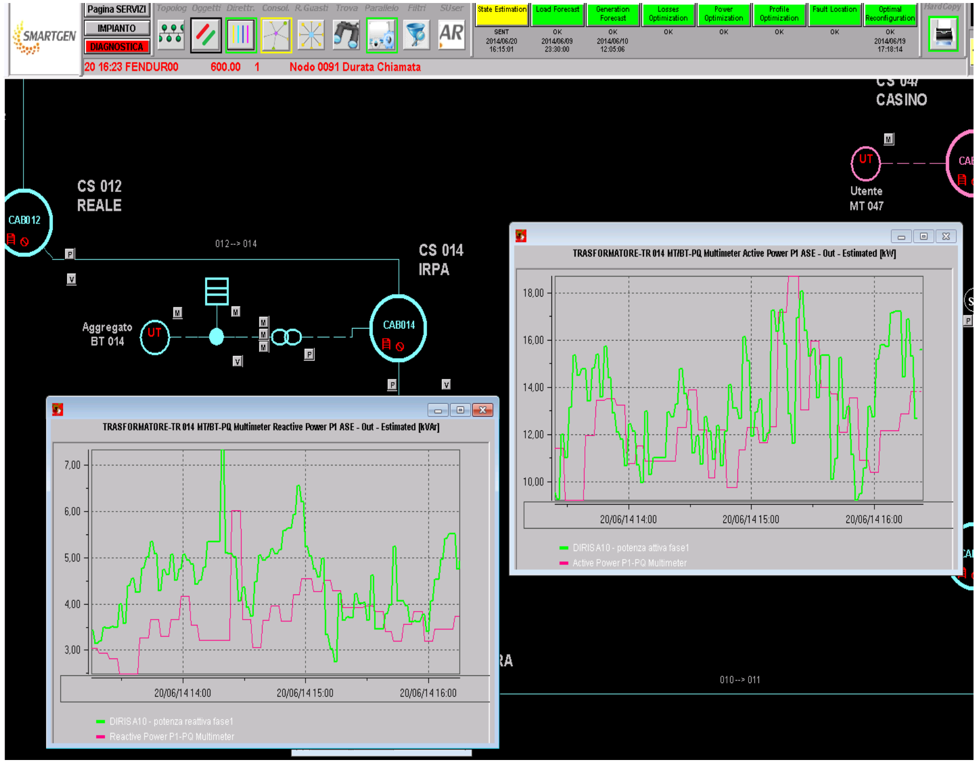
- HV/MV site full measurements
- 3 feeders fully monitored
- PV plant (470 kWp)
- 2 PMU - Power Measuring Units
- Meteo forecast

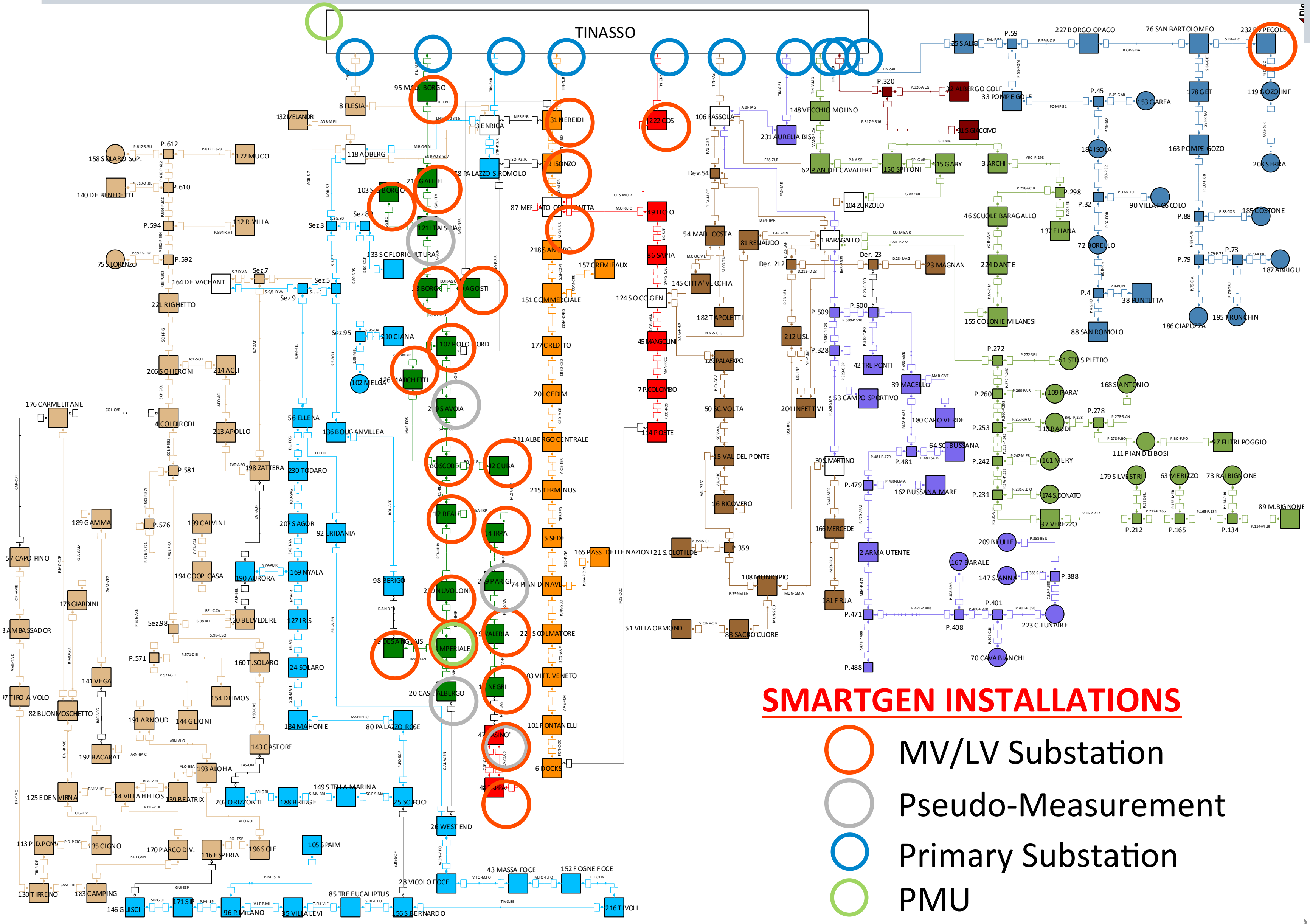

INTERNET
SALA CONTROLLO CENTRALE
LAN
PONTE RADIO
GATEWAY (VPN)
eXPertDMS SCADA
HMI DMS
CABINA PRIMARIA
LAN
SWITCH
ETHERNET
GPS
BORGO (8)
SEDE (9)
S.ROMOLO (10)
PMU
...
PROTEZIONI
TV
PARTENZE
SALA CONTROLLO LOCALE
FEEDER URBANO
FEEDER RURALE
RS485
MODBUS
GPRS
ROUTER GATEWAY (VPN)
MULTIMETRO
1
2
PMU
MT
TA
BT
... ...
CABINA SECONDARIA URBANA
1 = cabina secondaria urbana
2 = cabina secondaria urbana fine linea
CABINA SECONDARIA RURALE
MT
BT
... ...
GPRS
IMPIANTO GENERAZIONE FOTOVOLTAICO
INVERTER
FOTOVOLTAICO

AMAIE Sanremo network

the goal is to perform:

- Analysis of the **voltage profiles** and congestion in the absence and presence of PV distributed generation (connected both LV and MV)
- Study and verification of algorithms of **State Estimation** in distribution networks, load forecasting and production of photovoltaic
- In order to validate these studies, the system has been equipped with a monitoring system and remote reading of different MV/LV substations.
- Comparison measurements / simulations for other studies


SMARTGEN
Pagina SERVIZI
IMPIANTO
DIAGNOSTICA
Topolog Oggetti Direttr. Consol. R.Guasti Trova Parallelo Filtri SUser
AR
State Estimation SENT 2014/06/20 16:15:01
Load Forecast OK 2014/06/09 23:30:00
Generation Forecast OK 2014/06/10 12:05:06
Losses Optimization OK
Power Optimization OK
Profile Optimization OK
Fault Location OK
Optimal Reconfiguration OK 2014/06/19 17:18:14
HardCopy
20 16:23 FENDUR00 600.00 1 Nodo 0091 Durata Chiamata
CS 047
CASINO
UT
Utente
MT 047
CAB012
CS 012
REALE
012--> 014
CS 014
IRPA
CAB014
Aggregato
BT 014
UT
TRASFORMATORE-TR 014 MT/BT-PQ Multimeter Active Power P1 ASE - Out - Estimated [kW]
18,00
16,00
14,00
12,00
10,00
20/06/14 14:00
20/06/14 15:00
20/06/14 16:00
DIRIS A10 - potenza attiva fase1
Active Power P1-PQ Multimeter
TRASFORMATORE-TR 014 MT/BT-PQ Multimeter Reactive Power P1 ASE - Out - Estimated [kVAr]
7,00
6,00
5,00
4,00
3,00
20/06/14 14:00
20/06/14 15:00
20/06/14 16:00
DIRIS A10 - potenza reattiva fase1
Reactive Power P1-PQ Multimeter
010--> 011


TINASSO
95 MA BORGO
8 FLESIA
132 MELANDRI
22 ENRICA
31 NEREIDI
222 CDS
106 FASSOLA
148 VECCHIO MOLINO
231 AURELIA BIS
118 ABERG
158 S. CLARO SUP.
172 MUCO
P.612
P.610
140 DE BENEDETTI
103 S. BORGO
21 GALILEI
18 PALAZZO S. ROMOLO
9 ISONZO
Dev.54
62 PIAN DEI CAVALIERI
150 SPITONI
15 GABY
3 ARCHI
104 ZURZOLO
112 R.VILLA
P.594
Sez.3
Sez.8
121 ITALSIDER
87 MEL ATO
49 UCEO
75 S. LORENZO
P.592
164 DE VACHANT
Sez.7
Sez.5
Sez.9
133 S.C.FLORIO CULTURA
218 SAN ORO
54 MAD. COSTA
81 RENAUDO
1 BARAGALLO
Der. 23
23 MAGNAN
46 SCUOLE BARAGALLO
137 ELIANA
221 RIGHETTO
BORGO
AGOSTI
157 CREMIEUX
36 SAVIA
145 CITTA' VECCHIA
124 S.O.CO.GEN.
Der. 212
224 DANTE
151 COMMERCIALE
P.509
P.500
182 TAPOLETTI
155 COLONIE MILANESI
Sez.95
210 CIANA
107 POLO NORD
177 CREDITO
45 MANGOLINI
212 USL
P.328
42 TRE PONTI
P.272
206 SCHIERONI
214 ACLI
102 MELIA
126 MARCHETTI
129 PALAEXPO
39 MACELLO
53 CAMPO SPORTIVO
P.260
7 P.COLOMBO
20 CEDIM
176 CARMELITANE
4 COLDIRODI
213 APOLLO
56 ELLENA
136 BOUGANVILLEA
2 SAVOIA
50 SC.VOLTA
204 INFETTIVI
180 CAPO VERDE
P.253
14 POSTE
211 ALBERGO CENTRALE
64 SC. BUSSANA
30 S.MARTINO
P.481
P.242
P.581
198 ZATTERA
230 TODARO
BOSCOBELLO
2 CUBA
15 VAL DEL PONTE
P.479
162 BUSSANA MARE
P.231
215 TERMINUS
16 RICOVERO
189 GAMMA
P.576
199 CALVINI
207 SAGOR
92 ERIDANIA
12 REALE
14 IRPA
5 SEDE
166 MERCEDE
57 CAPO PINO
194 COOP CASA
190 AURORA
169 NYALA
98 BERIGO
165 PASS. DELLE NAZIONI
21 S. CLOTILDE
P.359
2 ARMA UTENTE
108 MUNICIPIO
178 GIARDINI
20 BELVEDERE
127 IRIS
NUVOLONI
PARIGI
74 PIAN DI NAVE
181 FRUA
AMBASSADOR
Sez.98
P.571
160 T.SOLARO
24 SOLARO
IMPERIALE
VALERIA
22 S.COLMATORE
51 VILLA ORMOND
83 SACRO CUORE
P.471
141 VEGA
154 DEIMOS
NEGRI
103 VITT. VENETO
TIRO A VOLO
82 BUONMOSCHETTO
191 ARNOUD
144 GLIONI
134 MAHONIE
80 PALAZZO ROSE
20 CASALBERGO
101 FONTANELLI
192 BACARAT
143 CASTORE
193 ALOHA
6 DOCKS
125 EDEN VIRNA
34 VILLA HELIOS
139 BEATRIX
202 ORIZZONTI
188 BRIDGE
149 STELLA MARINA
25 SC.FOCE
26 WEST END
113 P.D.PONY
135 CIGNO
170 PARCO DIV.
116 ESPERIA
96 SOLE
105 S.PAIM
43 MASSA FOCE
152 FOGNE FOCE
28 VICOLO FOCE
130 TIRRENO
183 CAMPING
146 GLISCI
171 STP
96 P.MILANO
85 TRE EUCALIPTUS
56 S.BERNARDO
216 TIVOLI
35 VILLA LEVI
255 S.ALIGI
P.59
227 BORGO OPACO
76 SAN BARTOLOMEO
232 S. PECOLLO
P.320
ALBERGO GOLF
33 POMPE GOLF
P.45
153 GAREA
178 GET
119 S.OZOINF
S.GIACOMO
181 ISOLA
163 POMPE GOZO
208 SERRA
P.298
P.32
90 VILLAFOSCOLO
P.88
185 COSTONE
72 ORELLO
P.73
P.79
187 ABRIGU
P.4
38 PUNTETTA
88 SAN ROMOLO
186 CIAPUZZA
195 TRUNCHIN
11 STR. S.PIETRO
109 PARA'
168 S.ANTONIO
P.278
110 BAUDI
111 PIAN DEI BOSI
97 FILTRI POGGIO
161 MERY
179 SILVESTRI
63 MERIZZO
73 RAIBIGNONE
174 S.DONATO
37 VEREZZO
89 M.BIGNONE
P.212
P.165
P.134
209 BULLE
167 BARALE
147 S.ANNA
P.388
P.401
P.408
223 C.LUNAIRE
70 CAVA BIANCHI
P.488

SMARTGEN INSTALLATIONS

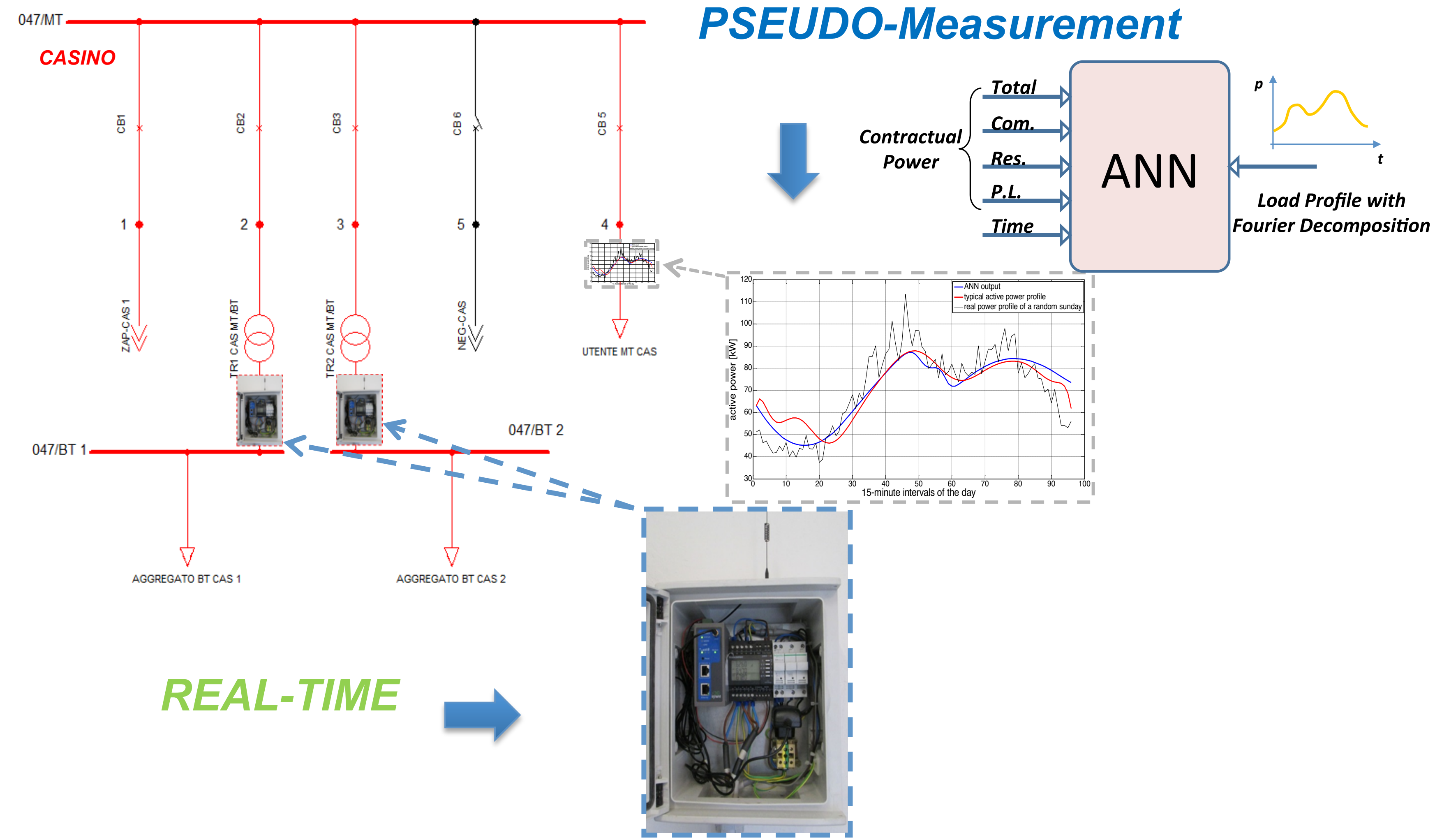
○ MV/LV Substation

○ Pseudo-Measurement

○ Primary Substation

○ PMU

Load modeling


047/MT
CASINO
CB1
CB2
CB3
CB 6
CB 5
1
2
3
5
4
ZAP-CAS 1
TR1 CAS MT/BT
TR2 CAS MT/BT
NEG-CAS
UTENTE MT CAS
047/BT 1
047/BT 2
AGGREGATO BT CAS 1
AGGREGATO BT CAS 2
p
t
ANN output
typical active power profile
real power profile of a random sunday
active power [kW]
15-minute intervals of the day
120
110
100
90
80
70
60
50
40
30
0
10
20
30
40
50
60
70
80
90
100

PSEUDO-Measurement

Contractual Power

- ***Total***
- ***Com.***
- ***Res.***
- ***P.L.***

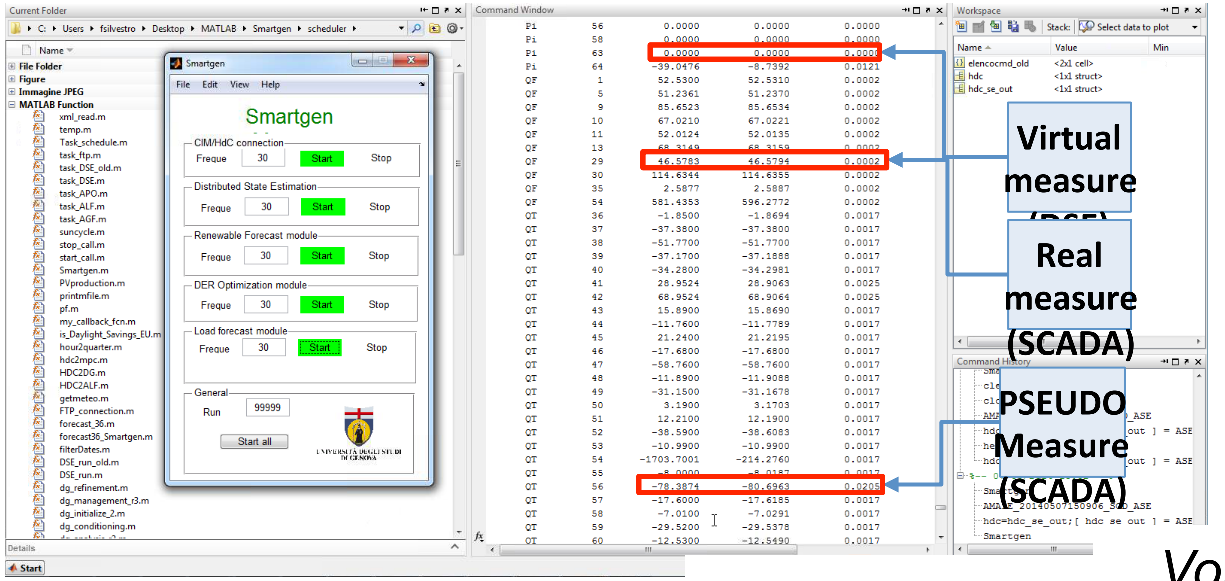
Time

ANN

Load Profile with Fourier Decomposition

REAL-TIME

Distribution State Estimation


Current Folder
C: ▸ Users ▸ fsilvestro ▸ Desktop ▸ MATLAB ▸ Smartgen ▸ scheduler ▸
Name
File Folder
Figure
Immagine JPEG
MATLAB Function
xml_read.m
temp.m
Task_schedule.m
task_ftp.m
task_DSE_old.m
task_DSE.m
task_APO.m
task_ALF.m
task_AGF.m
suncycle.m
stop_call.m
start_call.m
Smartgen.m
PVproduction.m
printmfile.m
pf.m
my_callback_fcn.m
is_Daylight_Savings_EU.m
hour2quarter.m
hdc2mpc.m
HDC2DG.m
HDC2ALF.m
getmeteo.m
FTP_connection.m
forecast_36.m
forecast36_Smartgen.m
filterDates.m
DSE_run_old.m
DSE_run.m
dg_refinement.m
dg_management_r3.m
dg_initialize_2.m
dg_conditioning.m
Details
Start
Smartgen
File
Edit
View
Help
UNIVERSITÀ DEGLI STUDI DI GENOVA
Command Window
Workspace
Stack:
Select data to plot
Command History

Smartgen

CIM/HdC connection			
Freque	30	Start	Stop

Distributed State Estimation			
Freque	30	Start	Stop

Renewable Forecast module			
Freque	30	Start	Stop

DER Optimization module			
Freque	30	Start	Stop

Load forecast module			
Freque	30	Start	Stop

General
Run 99999
Start all

```
      Pi        56         0.0000         0.0000         0.0000
      Pi        58         0.0000         0.0000         0.0000
      Pi        63         0.0000         0.0000         0.0000
      Pi        64       -39.0476        -8.7392         0.0121
      QF         1        52.5300        52.5310         0.0002
      QF         5        51.2361        51.2370         0.0002
      QF         9        85.6523        85.6534         0.0002
      QF        10        67.0210        67.0221         0.0002
      QF        11        52.0124        52.0135         0.0002
      QF        13        68.3149        68.3159         0.0002
      QF        29        46.5783        46.5794         0.0002
      QF        30       114.6344       114.6355         0.0002
      QF        35         2.5877         2.5887         0.0002
      QF        54       581.4353       596.2772         0.0002
      QT        36        -1.8500        -1.8694         0.0017
      QT        37       -37.3800       -37.3800         0.0017
      QT        38       -51.7700       -51.7700         0.0017
      QT        39       -37.1700       -37.1888         0.0017
      QT        40       -34.2800       -34.2981         0.0017
      QT        41        28.9524        28.9063         0.0025
      QT        42        68.9524        68.9064         0.0025
      QT        43        15.8900        15.8690         0.0017
      QT        44       -11.7600       -11.7789         0.0017
      QT        45        21.2400        21.2195         0.0017
      QT        46       -17.6800       -17.6800         0.0017
      QT        47       -58.7600       -58.7600         0.0017
      QT        48       -11.8900       -11.9088         0.0017
      QT        49       -31.1500       -31.1678         0.0017
      QT        50         3.1900         3.1703         0.0017
      QT        51        12.2100        12.1900         0.0017
      QT        52       -38.5900       -38.6083         0.0017
      QT        53       -10.9900       -10.9900         0.0017
      QT        54     -1703.7001      -214.2760         0.0017
      QT        55        -8.0000        -8.0187         0.0017
      QT        56       -78.3874       -80.6963         0.0205
      QT        57       -17.6000       -17.6185         0.0017
      QT        58        -7.0100        -7.0291         0.0017
      QT        59       -29.5200       -29.5378         0.0017
      QT        60       -12.5300       -12.5490         0.0017
```

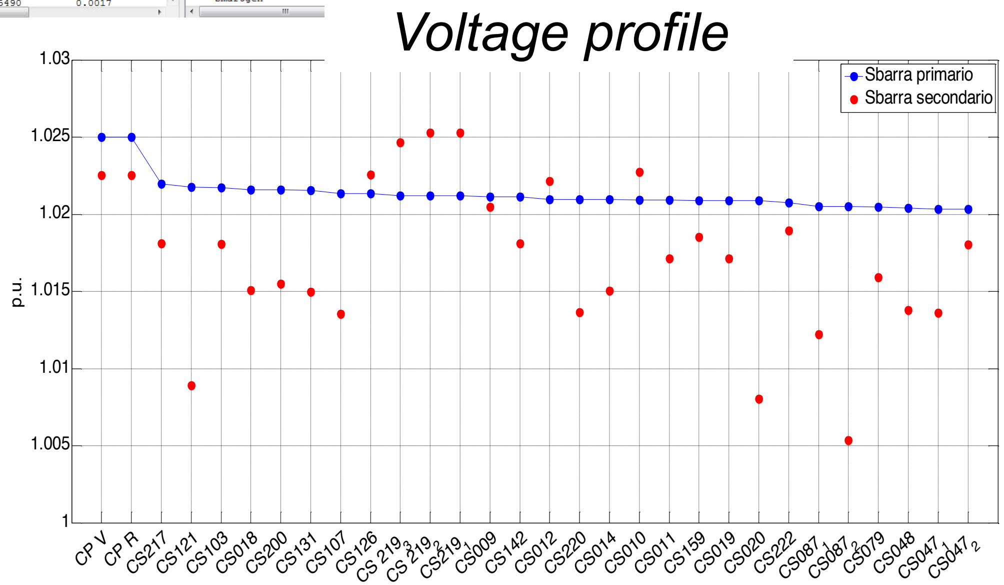
Name	Value	Min
elencocmd_old	<2x1 cell>	
hdc	<1x1 struct>	
hdc_se_out	<1x1 struct>	

```
AMAIE_20140507150906_SOD_ASE
hdc=hdc_se_out;[ hdc se out ] = ASE
Smartgen
```

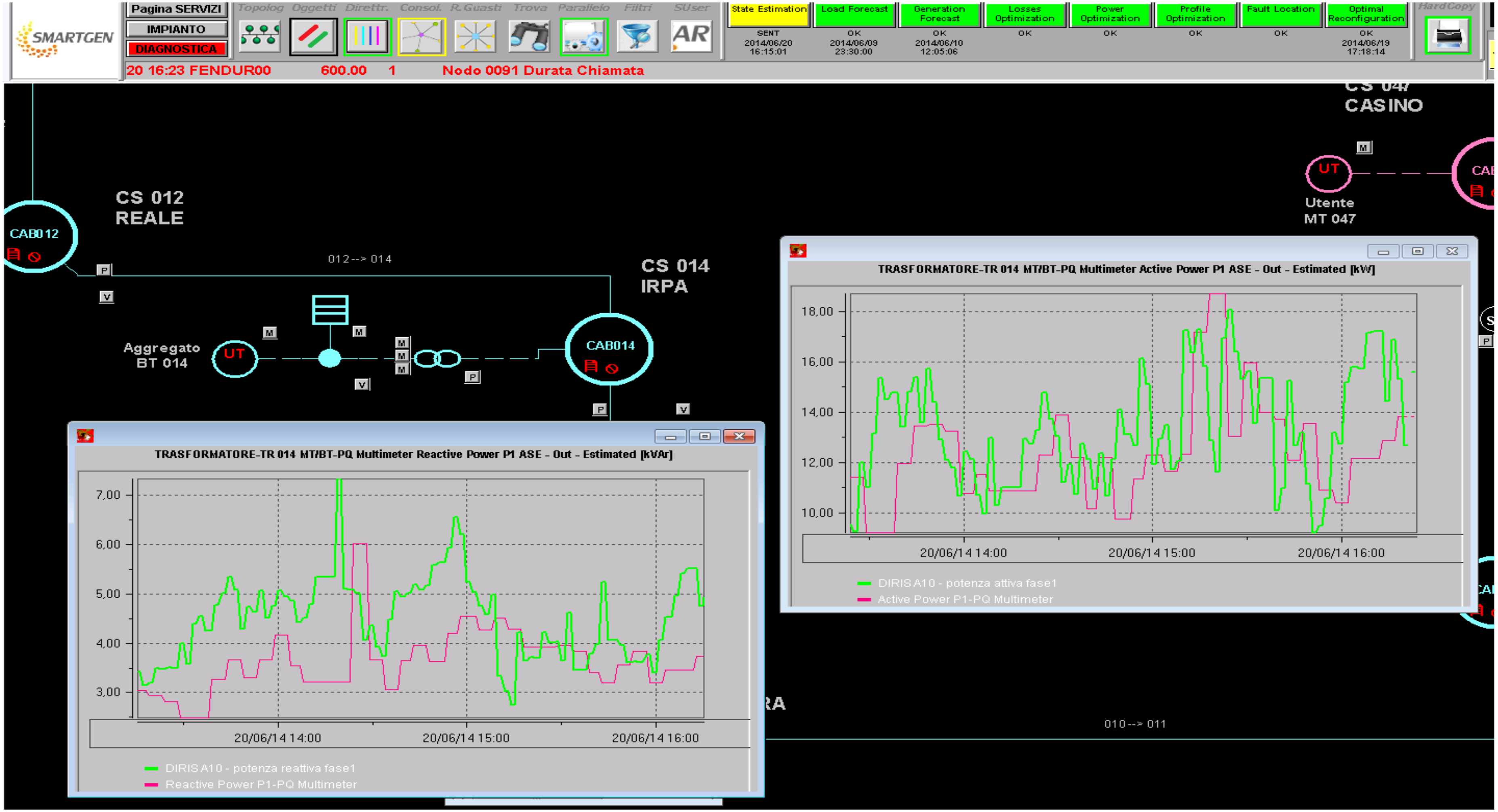
Virtual measure (DSE)

Real measure (SCADA)

PSEUDO Measure (SCADA)



DSE


SMARTGEN
Pagina SERVIZI
IMPIANTO
DIAGNOSTICA
Topolog
Oggetti
Direttr.
Consol.
R.Guasti
Trova
Parallelo
Filtri
SUser
AR
State Estimation
SENT
2014/06/20
16:15:01
Load Forecast
OK
2014/06/09
23:30:00
Generation Forecast
OK
2014/06/10
12:05:06
Losses Optimization
OK
Power Optimization
OK
Profile Optimization
OK
Fault Location
OK
Optimal Reconfiguration
OK
2014/06/19
17:18:14
HardCopy
20 16:23 FENDUR00 600.00 1 Nodo 0091 Durata Chiamata
CS 047
CASINO
UT
Utente
MT 047
CS 012
REALE
CAB012
012--> 014
CS 014
IRPA
Aggregato
BT 014
UT
CAB014
M
V
P
TRASFORMATORE-TR 014 MT/BT-PQ Multimeter Reactive Power P1 ASE - Out - Estimated [kVAr]
7,00
6,00
5,00
4,00
3,00
20/06/14 14:00
20/06/14 15:00
20/06/14 16:00
DIRIS A10 - potenza reattiva fase1
Reactive Power P1-PQ Multimeter
TRASFORMATORE-TR 014 MT/BT-PQ Multimeter Active Power P1 ASE - Out - Estimated [kW]
18,00
16,00
14,00
12,00
10,00
20/06/14 14:00
20/06/14 15:00
20/06/14 16:00
DIRIS A10 - potenza attiva fase1
Active Power P1-PQ Multimeter
010--> 011

Conclusions

- The proposed DMS architecture and prototype can constitute a solid basis for the implementation of DMSs that allow the ***real-time management of energy distribution network***, including the control of generation and load.
- The SmartGen DMS includes functionalities capable of supporting the involvement of the electric demand as a resource, including ***load forecasting, load aggregation, and generation forecasting***. These facilities will be granted as a service to DSOs, load aggregators, market operators, and single consumers.
- Through SmartGen services, those users will be enabled to optimize their business from either a technical or an economical perspective.
- The adoption of the *Common Information Model (CIM)* provides the SmartGen DMS with interoperability, allowing the interfacing with any other CIM-based system component.

Thank you for your attention

Federico Silvestro
University of Genoa, Italy
Department of Electrical, Electronic, Telecommunication
Engineering and Naval Architecture

federico.silvestro@unige.it

DITEN-IEES Intelligent Electric Energy Systems
www.iees.diten.unige.it

References

- S. Bianchi, A. Borghetti, S. Massucco, F. Napolitano, C.A. Nucci, M. Pentolini, G. Petretto, S. Scalari, F. Silvestro, G. Troglio, G. Viano, "Development and Validation of Innovative Methods and Tools for the Management of Active Distribution Networks: the SmartGen project" , Medpower 2014, Athens 2-5 November 2014
- F. Adinolfi, G. M. Burt, P. Crolla, F. D'Agostino, M. Saviozzi, F. Silvestro, "Distributed Energy Resources Management in a Low Voltage Test Facility", Industrial Electronics, IEEE Transactions on , doi: 10.1109/TIE.2014.2377133
- S. Massucco, S. Bianchi, A. Borghetti, F. Napolitano, M. Pentolini, G. Petretto, L. Poli, S. Scalari, F. Silvestro, G. Troglio, "Development and Validation of Innovative Methods and Tools for the Management of Active Distribution Networks with Renewable Generation", 2nd IEEE- International Energy Conference and Exhibition (EnergyCon2012), Firenze, 9-12 September 2012, DOI: 10.1109/EnergyCon.2012.6348245
- A. Borghetti, "Using mixed integer programming for the volt/var optimization in distribution feeders," Electr. Power Syst. Res., vol. 98, pp. 39-50, May 2013
- F. Adinolfi, F. Baccino, F. D'Agostino, S. Massucco, F. Silvestro, "An Architecture for Implementing State Estimation Application in Distribution Management System (DMS)", IEEE ISGT 2013, 6 - 9 October, Copenhagen
- S. Rahimi, M. Marinelli, F. Silvestro, "Evaluation of requirements for Volt/Var Control and Optimization function in Distribution Management Systems", 2nd IEEE- International Energy Conference and Exhibition (EnergyCon2012), Firenze, 9 - 12 September 2012, DOI:10.1109/EnergyCon.2012.6347777
- F. Adinolfi, F. D'Agostino, M. Saviozzi, F. Silvestro, "Pseudo-Measures Modeling Using Neural Network and Fourier Decomposition for Distribution State Estimation" IEEE ISGT 2014 Europe,Istanbul, October 2011

pscc2016
GENOA
June 20-24, 2016
Genoa, Italy
www.pscc2016.net

Welcome to PSCC 2016 in GENOVA

20-24 June 2016

www.pscc2016.net