• IDE4L-project is a 3 year demonstration project (Sep. 2013 – Aug. 2016) funded by European Commission (total budget is 8 M€)

• The main aim is to
  • Develop novel distribution automation architecture and solutions to integrate RES and fulfills the reliability requirements of distribution networks
  • Demonstrate developed system and solutions in the laboratories and real distribution networks
Breakthroughs

WP7 Demonstrations

WP2
Planning tools for distribution network management
- ANM concept
- Target and expansion planning including ANM
- Operational planning including DER uncertainty

WP3
Distribution network automation architecture
- Automation concept
- Smart meter as a sensor
- Testing Platform for monitoring & control systems
- Hierarchical and decentralized automation

WP4
Fault location, isolation and supply restoration
- Decentralized FLISR
- IEC 61850 Distribution Protection System Reconfiguration
- Microgrid interconnection switch

WP5
Congestion management
- Decentralized state estimation and state forecast
- Tertiary control – Network reconfiguration
- Secondary control – Coordination of voltage controllers
- Dynamic tariff

WP6
Distribution networks dynamics
- Aggregator concept
- Optimal scheduling of flexibility
- Transmitting synchro-phasors & real-time model syntheses
- Improved microgrid operation

WP7
Demonstrations
- IDEA4L Symposium, Brescia
Vision of future smart grid

Market design
Smart charging of EV
Smart homes and PV
System management and design

Microgrids
Energy communities
Aggregator

Grid infrastructure
Controllable loads and energy efficiency
Renewable energy resources

Storage
Balancing
Power to gas
Distribution automation
Advanced monitoring
Policies of electricity network

- Today networks are always over-dimensioned due to quality of supply obligations and missing possibility to control DERs
- Some companies are already forced to utilize production curtailment to manage their networks
- In future more flexibility is needed to integrate more RES and DERs in power system
  - Controllability of distribution network via advanced ICT
  - Decentralization of network management due to scale of the system
IDE4L automation architecture
Roles of grid operators and aggregator

1. **DSO/TSO**
   - Validates the submitted offers:
     - Off-line validation
     - Real-Time validation
   - Purchases flexibility services for avoiding network constraints
   - Calculates and provides the Flexibility Table (Limits for each Load Area)

2. **Aggregator**
   - Forecasting of consumption, production, price, etc.
   - Flexibility estimation of customers
   - Commercial optimal planning

\[\begin{align*}
\text{Determination of market bids} & \\
\text{Maximization of aggregator profit} & 
\end{align*}\]
Monitoring, protection and control system

- **Complete network will be monitored and controlled**
  - Intelligent Electronic Devices (IEDs)
  - Coordination and merging of information and decisions at substations
- **DA applies variety of communication technologies**
  - Primary substations - SCADA and possibly other IT systems (fibre optics, wireless)
  - Secondary substations and MV switching stations (wireless)
  - Smart meters (PLC or wireless)
- **Ethernet is becoming the prevalent communication standard for all automation devices**
  - IEC 61850 GOOSE and MMS
  - DLMS/COSEM
  - IEC 60870-5-104
  - Modbus/TCP over LAN/WAN
Control of DERs from DSO’s viewpoint

• Regulation
  • Connection requirements \(\rightarrow\) technical capabilities for the control of DERs
  • Dynamic tariffs to incentivize load shifting
    • Retail \(\rightarrow\) off-peak day-ahead prices
    • Grid \(\rightarrow\) off-peak network load

• Direct control
  • DSO’s own resources (OLTC, Reactive power compensation and FACTS)
  • Contracted non-market based control, e.g. voltage control of DG units
  • Emergency control to act just before protection

• Flexibility services from Commercial Aggregator
  • Scheduled re-profiling of flexible DERs
  • Conditional re-profiling of flexible DERs
Active network planning

- **Active network becomes alternative for network reinforcement**
  - Postponing investments of physical infrastructure by ANM
  - Replacing network reinforcement with smart functionalities

- **Traditionally worst case design principle**
  - Firm connection capacity always available for all customers
  - DG impact $\rightarrow$ maximum production – minimum loading condition
  - Leads to over-dimensioning of network and the evaluation of smart functionalities is limited to peak conditions

- **Stochastic planning of active network**
  - Non-firm connection (based on dedicated contract) increase network hosting capacity remarkably
  - Enable full utilization of ANM
Benefits of congestion management

Secondary control

- DG reactive power as primary control variable
- Substation voltage as primary control variable
- Substation voltage only

Primary control

- Substation voltage 1.0 and DG power factor 0.92ind.
- Substation voltage 1.0 and DG unity power factor
- DG power factor 0.92ind.
- DG unity power factor
- No production

Reference cases

Example of rural MV grid in Finland with 3 MW of DG and 1 MW of peak load

Secondary control is utilizing OLTC, reactive power control of DG and production curtailment if needed.
Thank you!

www.ide4l.eu