Making the Smartgrid real

Medium Voltage Grid Supervision and Automation

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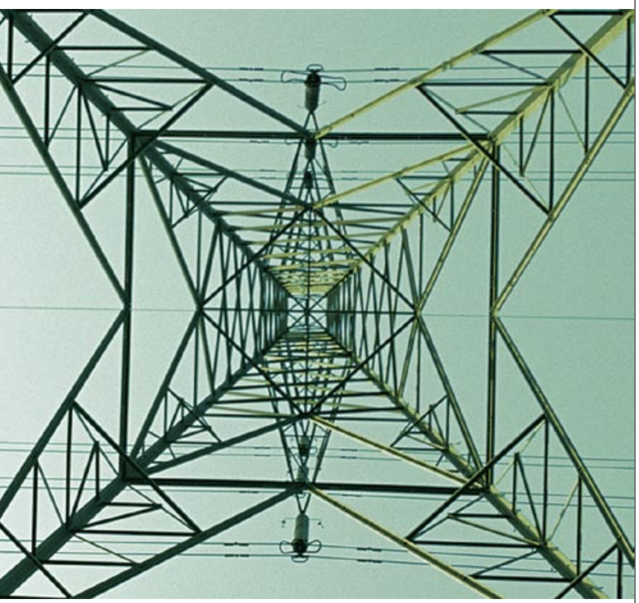
The question of what makes a power grid intelligent or which steps are to be taken to be able to frame it correctly within the SmartGrid concept, has as many answers as the number of experts to whom the question is addressed. However, nearly all will agree on the need to incorporate or encourage a number of features that are already a part of the SmartGrid concept itself and, sometimes, define it.

Many of these features have already been incorporated, though partially, into existing grids and, in any case, they represent technical targets that have always been sought after. What makes the present situation different is the technical availability (sensors, communications, digital processes, power electronics...), which makes massive implementation, at feasible cost, into medium voltage distribution grids possible.

The distribution grid is the boundary between the power system and the users, both as consumers and producers. As consumers, they constitute a group more and more demanding in terms of service quality and the grid must be able to satisfy said demand. As producers, the grid must constitute the technical space to increase their share in the power market. For both purposes, the distribution grid must be a robust, flexible and reliable support with technological means to quickly and efficiently respond and solve the problems that might occur, in a user transparent manner.



· Remote supervision.

· Remote operation (Automation).

· Minimise outage time:
  - Rapid location of malfunctions.
  - Reconfiguration.
  - Resetting.

· Incorporate distributed power generation resources and their exploitation for grid sustainability.

· Flexible grid topologies.

· Assets management optimisation.

· Predictive maintenance.

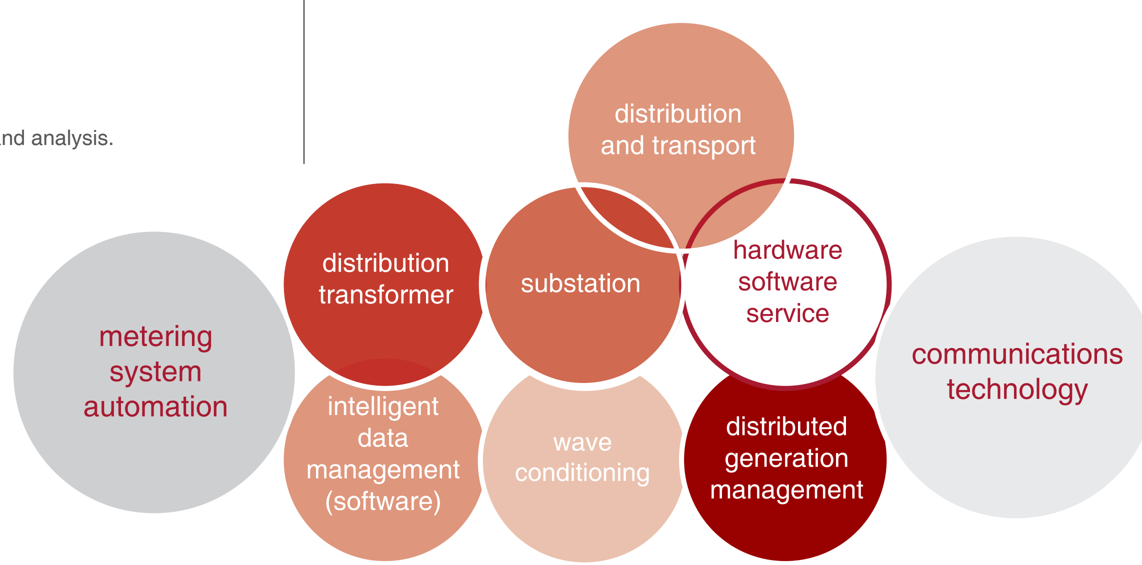
· Minimise losses.

· Wave quality.

· Voltage control.

· Incident management and analysis.

This catalogue includes a number of ZIV SOLUTIONS for the whole range of required applications, including the substation and distribution transformers, to furnish the operator with all technical means needed to deploy intelligence across the grid turning it into a system able to anticipate the problems thus preventing them from occurring and removing them rapidly when they occur.



At the Substation

System Automation

HV/MV substations are the points from where medium voltage distribution grids originate and where automation starts. These installations have long history of intelligent devices to control, protect and monitor the electrical power system, both at local level and from control rooms. Said devices allow for automatic and reliable response, in real time, upon incidents or changes in the exploitation conditions, and support programming and file management.

Process architecture used is based on the distribution of devices and functions into levels, applying the general principle that functions rest on the level in which enough information is available for execution and decision making.

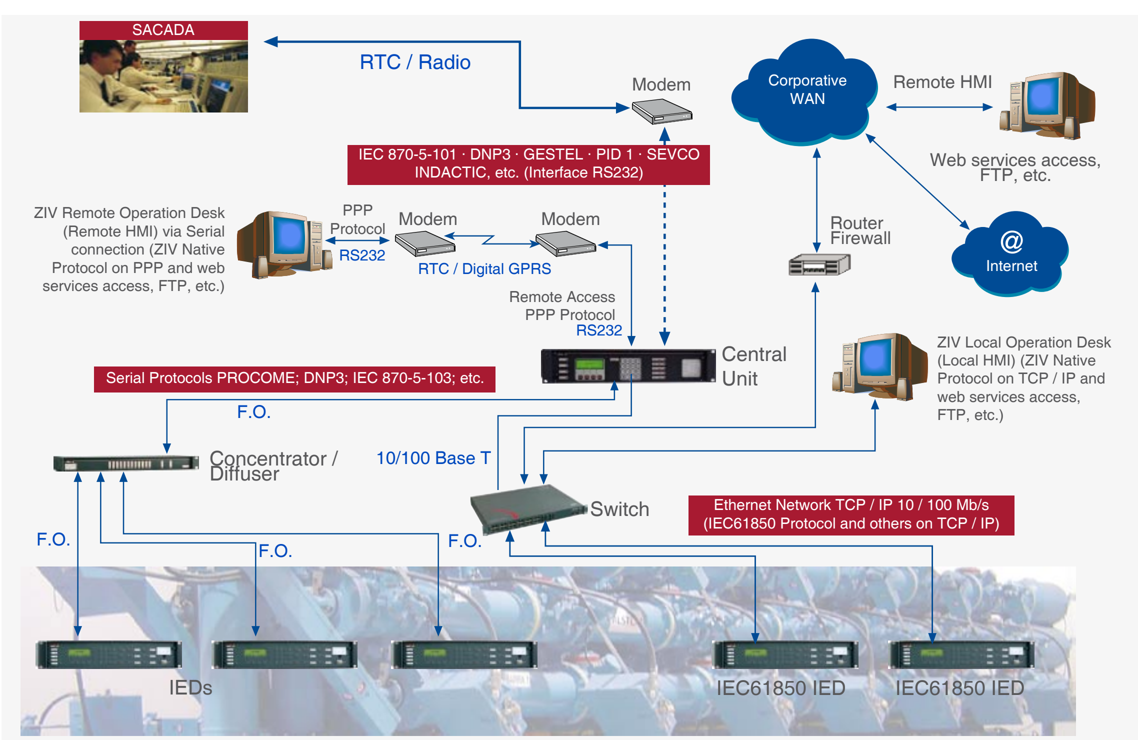
Automation, which has been based on the application of formal or D2, de facto D3, standards of communications between devices and between levels, is fully installed in two high levels (level 1 or bay level, level 2 or substation level) and thanks to the standardisation efforts over the last years (IEC61850) is reaching Level 0 devices (or process devices).

These functions are based on a wide range of protection and control devices, with different degrees of functional integration, which allow users to apply their technical criteria with full flexibility and automate their substations to the level and pace deemed appropriate, concentrating or laying out the devices in the manner that best suits the application.

Automation solutions are always provided with a set of software tools to configure and personalize devices and systems to user needs. In this field, friendly and flexible ZI software solutions (ZIVERCOM, ZIVERGRAPH, ZIVERCID...) are available to solve any substation automation application.

ZIV counts on vast experience as provider of substation solutions, using Integrated Protection and Control Systems (SIPCO) that house all types of supervision and automation functions.

- Protection.
- Bay and substation automation (Reclosers, load shading, reset, voltage control, fault location, logic selectivity, interlocks, load transfer…).
- Data recording and saving.
- Redundancy.
- Local operation post.
- SCADA gateway.
- Local and remote signalling.
- Operation and maintenance interface (HMI).



Outside the Substation Intelligent Distribution Transformers

Beyond the substation boundary there extends what constitutes the medium voltage distribution grid proper, with very different topologies not only between different utilities but between areas belonging to the same utility.

It is this area the one that underwent the least technical changes, they being the most complex and diverse, and where, at a great extent, grid and user interact. Thus, this is the area where the incorporation of intelligence and automation is needed most.

No matter the meaning of SmartGrids, it will only be a reality if distribution grids turn into intelligent systems.

Outside the substation, the grid extends through power distribution centres, reclosers and sectionalizers (surface or underground) and distribution transformers; users being connected to these latter installations. In order for operation centres (SCADA) to detect these installations and implement automation functions, said installations must be automated, linked to the communications infrastructure and provided with sensors, supervision, monitoring and operating devices:

- Remote supervision and operation: metering; status; switchgear and transformer life span management; alarms and safety; sectionalizing.
- Fault location.
- Reconfiguration.
- Reset.
- Voltage control.

…

TCA

- Sensor inputs, both of conventional transformers and non conventional sensors (Rogowsky and capacitive couplers).
- Digital inputs for switchgear status supervision.
- Outputs for switchgear operation.
- Communications.
- Close onto fault detector able to operate in bidirectional power flow environments.
- Programmable logic (automation implementation).
- Service quality functions.
- Fault recording.
- Web Server for data parameterisation and access.

TCA provides all functions required by intelligence centres implanted into distribution grid nodes on which automation functions operate. Communications functions allow it to be inserted into the deployed grid exchanging data with the substation and operations room to implement automatic functions.

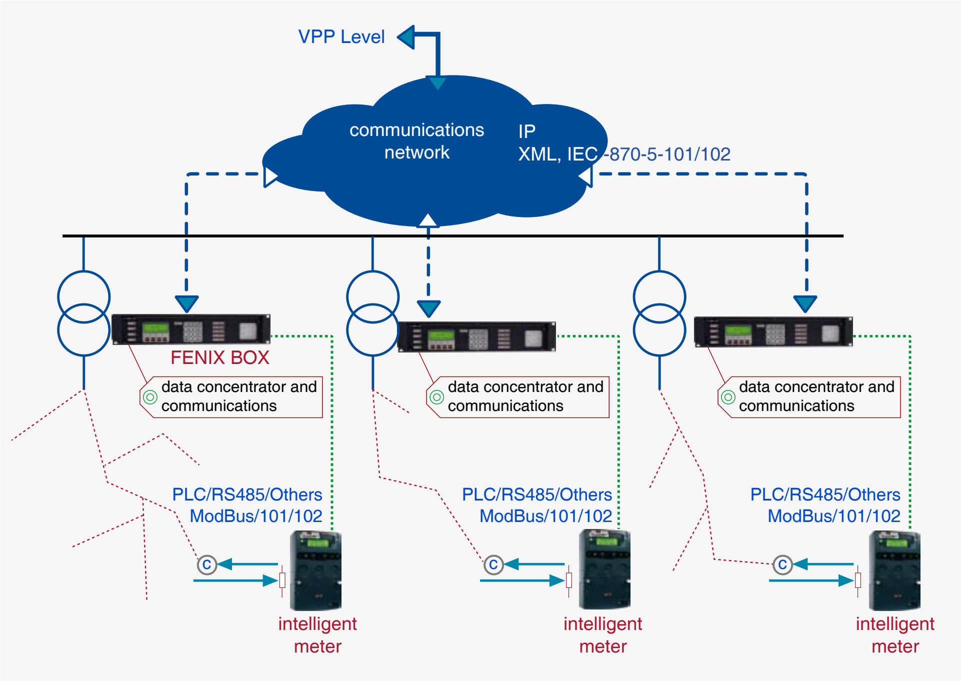
In MV. Connection of dispersed Generation Sources

The incorporation of distributed generation resources is one of the issues enforcing the need to equip MV distribution grids with intelligence. Such resources come, to a great extent, from renewable energy sources, and thus count on the institutional and social support of citizens concerned about climatic change, who feel responsible for the environment. This leads to think that their deployment will continue to increase and the medium voltage grid will have to be furnished with proper means not only to take up said intelligence, without posing any problems, but, on the contrary, to support grid technical sustainability.

One of the problems derived from distributed generation is atomisation and dispersion, which render it invisible to the electrical system, hampering it to take advantage of its benefits at the same level than for conventional plants.

This brings up the Virtual Generation Plant (VPP) concept, which adds up the capacity of several dispersed generators, creating, from them, a single operating profile, as if only one generator were involved, allowing its contribution to the energy market, the provision of additional services and the approach to a deterministic behaviour. The virtual plant is established by means of software tools (Distribution Energy Management Systems – DEMS) connected to the different generators that constitute its energy portfolio.

In order to facilitate the connection between generation sources we have developed (as part of the FENIX project, framed into the European Union's FP6 programme) FENIX Box (FB) device representing the intelligence at local level, namely, at load and generator level.



Fenix box functions:

- Data concentrator supported by a real time database, for intelligent meters (SmartMeters) and distributed generation resources.
- Standardisation of data exchange and commands or instructions between the DEMS system and the different types of generators and loads.
- Housing of local agents for local automatic operation, by means of MSMQ and WEB Services.
- Support of standard protocols for communications with higher hierarchy levels (e.g. IEC 870-5-104) and with intelligent meters and distributed generation resources (e.g. IEC 870-5-102, MODBUS, SNMP).
- Support of multiple communications interfaces such as PLC, ETHERNET, RS232 or fibre optic serial ports, allowing at the same time wireless communications using GPRS or 3G technologies.

At the Decision Making Centres. Intelligent Data Management

Along the path of any electrical utility company towards intelligent distribution grids, conventional systems coexist with more intelligent systems. Data management systems able to capture, manage and process relevant multipurpose data must be provided. Said systems must assist in timely decision making.

Thanks to the standardisation of communications protocols in the control area, SCADA systems are able to capture essential data in real time and contribute to proper Grid operation. However, the protection area underwent a historical delay because of the complexity of data management derived from the use of multiple communications protocols. This fact will be markedly mitigated with the extensive use of standard, IEC 61850, although, bearing in mind that a great number of conventional substations must also be managed.

ZIV has developed a single-platform Remote Protection System to capture, standardise, classify and store protection data from relays of many manufacturers thanks to the emulation of their specific communications protocol.

This repository stores data from all devices in a single format (on Oracle BD) and is the necessary base to provide essential data for off-line analysis and decision making. Its task is to provide data for specific applications to support decision making on:

- incident analysis
- settings management
- predictive maintenance

Protection Management System, SGP software v.2.0, is a multiuser Web application for remote protection management and incident analysis.

· unified inventory management,

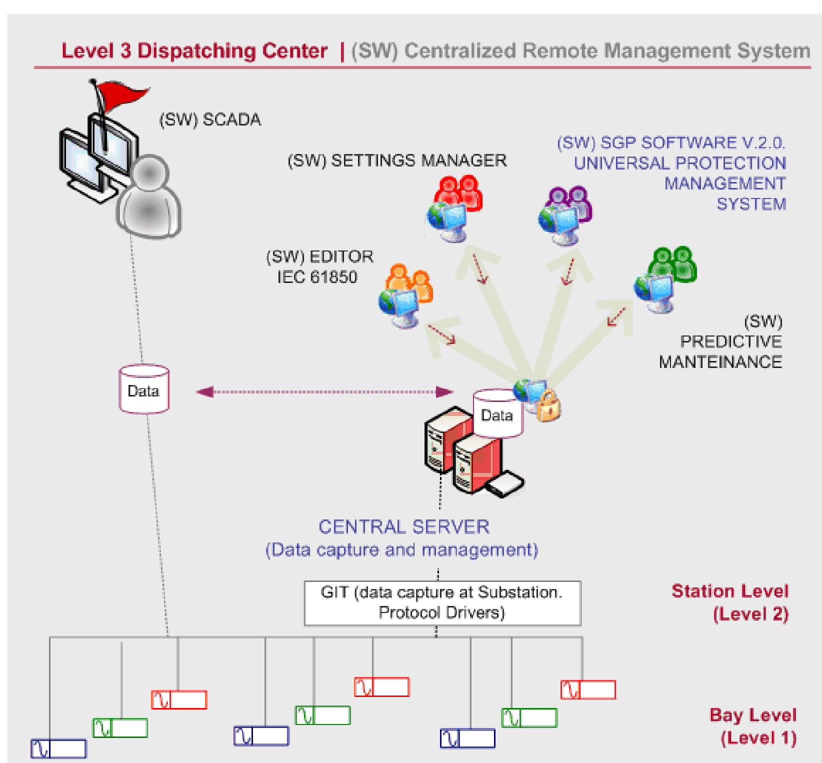
· remote capture (programmed and on request) of: events, fault reports, oscillograph records and settings

· alarm management and automatic transmission of reports via e-mail

· incident documents, statistics generation, reports, work orders, associated file repository, etc.

GIT

As an addition to the data capturing system, in substations, GIT centralises cyclic data capture, such that only new data are transmitted to the office for the Database.

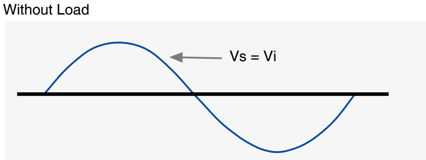


At the GRID proper

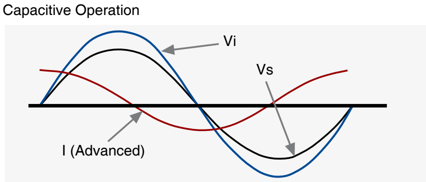
In a distribution grid, the possibilities for intelligence deployment do not depend only on the grid itself but on the energy conveyed and carrying waves. A target of distribution grid automation is service quality, but digital economics also needs energy efficiency and wave quality. In order to cover for the latter two targets, power electronics is applied, the capacity of which to recover the properties of a distorted wave are derived both from the ability to control voltages and powers and from the intelligence and the ability to control algorithms implanted into the controllers.

ZIV power electronics solutions, applied on low voltage grid loads, are able to manage the energy keeping it within the quality parameters required by grid users, with high energy efficiency.

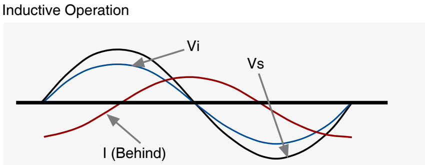
Without Load



Capacitive Operation



Inductive Operation



CPF relays correct the grid power factor and provides flexible voltage control, at the load connection point, by means of active power exchange, both inductive and capacitive. Apart from controlling voltage and power factor, properties defining grid voltage wave quality can also be recovered.

CPF wave conditioning

- Mitigates voltage gap effects on sensitive loads.
- Compensates for harmonic frequencies derived from non linear loads.
- Mitigates voltage flicker reducing its effects on lighting.
- When linked to a storage device it helps maintain continuous energy supply.
- Equalises phase to phase currents, and reduce unbalance.

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