Custom power equipment to facilitate the penetration of embedded generation in distribution networks

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1. Introduction

The European challenge to produce 20% of primary energy from renewable sources before 2020 implies the need to facilitate the integration of embedded generation on the grid in order to achieve and even exceed this goal. The rapid development of wind energy is a clear example of the benefits of integrating embedded generation into the grid. With an installed power in Spain above 16GW, the record of providing 26% of daily production has been achieved.

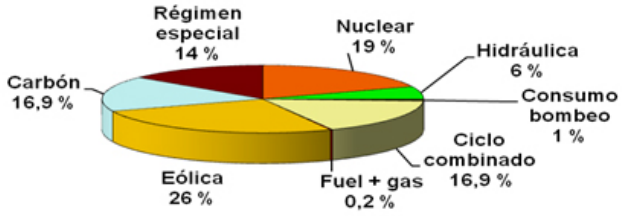

Fig.1 Electricity generation sources in Spain 22/01/09

The devices that better allow penetrating the generation of active distribution networks of medium and low voltage are known as Custom Power (CUPS), which are a modified version but adapted to distribution networks of the FACTS (Flexible AC Transmission Systems) devices used in transport networks.

	CUPS	FACTS
Shunt	D-Statcom, Active filter	Statcom
Series	DVR	SSSC
Combined	UPQC	UPFC

Table 1: Custom Power and FACTS devices.

CUPS are used with the main objective of contributing to the decrease or the compensation of the influence of electrical disturbances in the network, because these installations connected to the distribution network are vulnerable to these problems, especially in the case of plants susceptible to voltage dips.

Key words: Custom Power, Embedded generation, Renewable Sources, DGfacts, Power Quality

2. Custom Power Devices

The *Custom Power* term was proposed to designate a new generation of semiconductor devices based on power electronics, designed to operate at medium and low voltage levels, and whose main objective is to improve the service quality of distribution networks. Recent advances in controllable semiconductors, micro-controllers, signal processors, and energy storage technologies have enabled the design of new devices. They can present faster responses and a more accurate setting in basic and important functions such as voltage regulation, reactive power compensation, reduction in the rate of harmonic distortion, or the limitation of short-circuit currents.

The first installation of a D-STATCOM used to compensate reactive power and to prevent the voltage 'flickers' was installed at a sawmill in British Columbia, Canada. The D-STATCOM ± 2MVAr was installed for a load of 2.6MVA with a typical power factor of approximately 0.85.

The boom that wind generation is presenting offers the possibility of adapting these devices for supervision and correction of anomalies or distortions in the electricity network by improving the quality of supply in the wind farms. The addition of these equipments in the wind farms are having a great importance as can be appreciated in Rejsby Hede wind farm, in Denmark, which has an advanced static compensator for reactive power (ASVC) to improve the wave quality, and withstand voltage dips.

3. Analysis scenario

The strategy of implementation of Custom Power Devices for facilitating the use of embedded generation in distribution networks of medium and low voltage, implies the deepening of key aspects of FACTS technology, adapted to the most demanding requirements of installations sensitive to disturbances in the network, which ensure a high supply quality. The development areas in the adaptation to the distribution networks are:

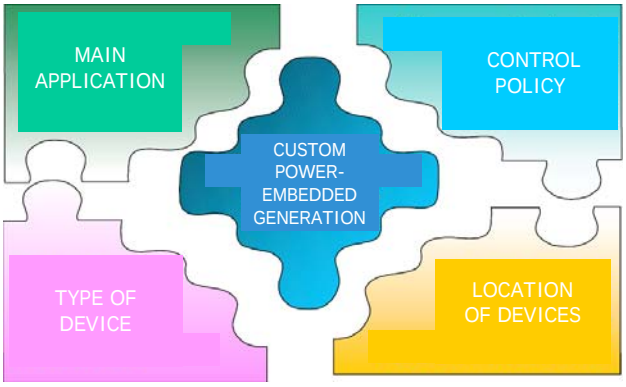

Fig. 2. Development areas of CUPS- GD

A. Most suitable type of device. Devices based on Voltage Source Converters (VSC), such as:
• Active power filters designed to improve the quality of supply of electricity and more specifically the waveform quality
• D-STATCOM (Distribution Static Synchronous Compensator) is a parallel compensator that allows the tension acting on a line by injection of reactive power.
• DVR (Dynamic Voltage Restorer) is a compensator connected in series that injects voltage with a fixed angle between the supply and load.
• UPQC (Unified Power Quality Conditioner) is a combined compensator (series-parallel), which takes advantage of the benefits provided by each type of compensator.

B. The topology of the converters. Based on the VSC, there exist many configurations. The most basic is the three-phase inverter bridge, base of multipulse converters (n-three-phase inverters). Within the multilevel converters, there are various types:
• Diode-Clamp Converter: converter with a fixed level for diodes
• Flying-Capacitor Converter: converter with floating capabilities
• Full-Bridge Cascaded Converter: converter with cascade monophasic bridges

C. The basic and global control strategies so that converters operate as FACTS devices in distribution networks.

D. Applications of the devices, such as reactive compensation, voltage control, voltage dips and power control.

The simulation of DGFACTS models under the new considerations of distribution networks with embedded generation is fundamental for deepening in these areas. Among the digital tools available, the most used are the software package of MATLAB (SimPowerSystems), the software for transients ATP/EMTP (Electromagnetic Transients Program) and the application PowerFactory of DigSilent.

4. Conclusions

The globalization of society and industry has increased awareness of the differences in the quality of electricity supply in different countries. This can be an important point in determining the maintenance of production plants or in finding new locations, becoming to be considered the electricity product quality as an issue of crucial importance.

The interest in the industries to have devices that guarantee an adequate supply quality can be understood taking into account that, according to estimates made by the Leonardo Power Quality Initiative (LPQI) organization, quality problems of electric power to industry and commerce in the European Union around 10,000 million euros a year, while expenditure on preventative measures is less than 5% of this amount. This highlights the importance of accelerating the introduction of Custom Power devices in distribution networks.

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