The evolution towards a Smart Distribution and impact on Electric Power Systems: CIGRE strategy and undertaken actions

E. Navarro Spanish representative of CIGRE SC C6 "Distribution Systems and Dispersed Generation"



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CIGRE: the International Council on Large Electric Systems is a worldwide association (founded in 1921) with members in over 80 countries







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(OPAWS)

To-day key driving factors affecting development and operation of Power Electric Systems (PES)

- Contribution of PES to the Global Climate Change
- High prices, physical and political constraints in the acquisition of primary energy sources
- Interaction, at a continent level, among regional or national PES and among energy vectors (today: electricity and gas; tomorrow: electricity, gas and hydrogen)





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CIGRE SC C6 Distribution Systems and Dispersed Generation

Scope

- Assessment of the technical impacts and requirements which a more widespread adoption of DG could impose on the structure and operation of the system
- Issues like rural electrification, Demand Side Management, use of storage are included



..... it is therefore assumed that the application of the DG concept means "The development of a set of sources of electric power connected to the distribution network or on the customer side of the meter"



AC-Bus AC-Bus Ac-Bus Ac-Bus Ac-Bus Ac-Bus Inverter y Island Battery Consumers

Diese

Generator Set

230 V or 3 ~/400 V 50 Hz/60 Hz

"Why a new SC dealing with Distribution and Dispersed Generation?"

Use of small size generators is considered one of the main options to face:

Climate change

•Concern toward security of energy acquisition and of PES operation.

Factors that motivate the development of the DG concept

- Capability of higher efficiencies from primary energy sources (CHP)
- Low environmental impact (RES)
- No additional transmission costs and savings in distribution costs (depending on DG location)
- Improvement on reliability and quality of supply
- Adoption of targets and provision of subsidies for RES and CHP
- Open and competitive markets (DG participation to be solved)

But constraints exist

- High technology costs
- Distribution networks not designed for DG.
- Criteria and rules to operation distribution networks to be modified.
- Capacity to provide ancillary services and contribution to system security are not fully recognized.

"Connect and Forget" versus "Integration"

"Connect and Forget": Consider possible impact, connect, no more communication with the devices, negative load

"Integration": Consider possible contribution in planning and operation of the grid, continuous communication, demand response

B. Buchholz -MVVEnergie CIGRE Conference 2006

Strategy applied by the SC

Actions to be undertaken in a short term perspective

- Get detailed information about DG
- Investigate integration issues

Problems that can be foreseen in a longer term perspective

- Rural electrification
- Management of electricity consumption and demand (DSM)
- Storage

Key factors affecting the choices and priorities of the SC

- Exchange of information with the aim of identify and share the "best practices",
- Exchange of information on research projects,
- Support the development of internationally accepted:
 - rules and standards,
 - models and benchmarks,

Identify the requirements for DG component manufacturers and provide recommendations for the technical content of Distribution Codes and Grid Access Rules.

Work made by SC C6 (I)

WG C6.01: "Development of dispersed generation and consequences for power systems"

- Present status of DG penetration (technologies)
- Influence of DG on the power system and
- Impact of DG on power systems
- Topics to be further investigated (revision of standards, data management, technology development)
- "Development of dispersed generation and consequences for power system" (Summary on ELECTRA, August 2004)

Work made by SC C6: DG integration issues (I)

WG C6.02: "Connection of generators and Other Customers"

- Definition of connection, procedures of connection, ownership, tariffs and contractual agreements
- Major developments in DG but industry is not yet mature
- Changes in legislation and standards to assure DG does not negatively impact the grid rather than integrating.
- Technical Brochure, Ref 271, 2005, "Connection of Generators and other Customers - rules and practices". Summary on ELECTRA, April 2005

Work made by SC C6: DG integration issues (II)

- TF C6.04.01: "Connection Criteria at the Distribution Network for Distributed Generation"
- Current connection criteria (international standards)
- Protection practices (methods applied to DG connection)
- Recommendation for further standardization activities (procedure for determining DG install capacity, operation of Active Distribution Networks,...).
- Technical Brochure, Ref 313, 2007, "Connection criteria at the distribution network for distributed generation" Summary on ELECTRA, February 2007

Work made by SC C6: DG integration issues (III)

- TF C6.04.02: "Computational tools and Techniques for Analysis, Design and Validation of DG systems"
- Examine computational tools for dynamic simulation
- Evaluate the significance of the tools for DG systems design
- Develop some benchmarks.
- (Expected publication early 2009)

Work made by SC C6: DG integration issues (IV)



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Work made by SC C6: DG integration issues (V)

- WG C6.08: "Integration of Large Share of Fluctuating Generation"
- Share system operation experience gained
- Study conditions and generators design requirements

Face experienced drawbacks

Allow growing fluctuating power penetration.

(Expected publication end of the year)

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Work made by SC C6: ICT role (I)

WG C6.03: "Operating Dispersed Generation with ICT"

- ICT in use but communication networks not fully installed
- Obstacles: Cost of constructing the networks and absence of definition of the structure supporting the cost and responsibility for network operation
- Important for prevalence of DG
- Added value: Voltage control, automated operation of distribution system,...

Transition towards Active Distribution Networks

Work made by SC C6: ICT role (II)

- Suggestions to promote dissemination of DG through the use of ICT:
 - Communication infrastructure
 - Standardization
 - > Information security
- Technical Brochure, Ref. 311, 2007, "Operating dispersed generation with ICT" Summary on ELECTRA, February 2007

Work made by SC C6: Active Distribution Grids (I)

WG C6.10: "Technical and Commercial Standardization of DER/micro-grid components"

- New DG concept based on integration of small size generators, storage devices and controllable loads.
- New technical standard & commercial protocols key for:
 - > the integration of DER.
 - > Avoid negative impact on network reliability and safety

Work made by SC C6: Active Distribution Grids (II)

- Objective to propose guidelines for easy installation of micro-sources for integration in micro-grids:
 - Standardization of interfaces
 - > Harmonisation of standards
 - Protocols for sale and purchase of electrical energy and ancillary services, access to network,...
 - Standardised tests for installation, evaluation and review

Work made by SC C6: Active Distribution Grids (III)



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Work made by SC C6: Active Distribution Grids (IV)

WG C6.11: "Development and Operation of Active Distribution Networks"

- Assessment from DSO of requirements (control, protection, communication,...)
- Strict co-operation among manufacturers, ICT solution providers and DSO to identify enabling technologies
- Definition of limits/barriers
- Evaluation of cost/benefit analysis methods
- Identification of evolution requirements in regulatory
 aspects



Work made by SC C6: Interaction with Electricity Consumptions. DMI (II)

Scope:

- Identification of drivers for demand-side integration
- Investigate the role of DSI for impacting identified drivers
- Assessment of the forms of implementation of DSI
- Customer value of reliability and reliability preferences
- Identification of roles, responsibilities and economic drivers to support implementation of DSI
- Improvements to better integrate demand-side resources
- (Expected publication end of the year)

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Work made by SC C6: Rural Electrification

WG C6.13 ·Rural Electrification"

- Considered a key challenge by CIGRÉ community.
- Aimed to address problems, difficulties and opportunities to extend electricity supply to rural and remote areas.
- Colloquium on "Electrification and Dispersed Generation" organised in South Africa in 2005
- 2nd colloquium in Malaysia "Electricity for Rural Socio-Economic Development"; development impact
- A paper is now circulating and will be issued in ELECTRA by the end of the year with possible additional actions.

Work made by SC C6: Others

WG C6.15: "Electric Energy Storage Systems"

- Important with growing renewable generation
- Evaluate storage technologies and their commercial background
- Scenarios with high penetration of uncertain generation

Joint WG C3/C6.05, "Environmental Impact of Dispersed Generation"

Joint C1/C2/C6.18, "Coping with limits for very high penetrations of renewable energy"

A look into the future (I)

Search for new subjects shall take into account

- Additional aspects related to connection and integration of dispersed generators and of other devices as storage, electronic interfaces and systems
- DG concept as a part of the medium long term evolution of distribution system
- Evolution of distribution networks not strictly related to DG concept but to the role itself of electric distribution systems within PES

A look into the future (II)

Subjects:

- Analysis of demand evolution (DG and DSI requirements)
- Contribution of distributed energy resources to energy policy objectives. Market rules and business models for DG implementation and exploitation.
- Methods applied in many countries to develop benchmarks for the evaluation of distribution systems
- Distribution utilities/operators requirements for the integration of DER
- New role of distribution networks with DER and DSI

A look into the future (III)

- Plug & play distributed energy resources: functions, technical characteristics and requirements
- Distributed intelligent technology to develop advanced management and control systems of active distribution networks integrating DER and micro-grids.
- Technical, economical and organisational issues relevant to electrification extension or to electricity supply in areas with very low pro-capita consumption (WG C6.13)
- In 2008, more than half population will be living in urban areas consuming more than 75% of the world energy. "Urban electrification" specially mega-cities



August 29, 2008, Friday Tech. Session of SC C6 Distribution Systems and Dispersed Generation

- 1. Development and operation of power systems incorporating Dispersed and Renewable Energy Resources (DER/RES)
- 2. Concepts and technologies for active distribution networks

3. Storage to support DER and RES integration in distribution grids and standalone systems

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http://www.cigre.org

Assesment of cost and benefits of distributed energy resources options and business models in Spain at Iberdrola

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IBERDROLA DISTRIBUCIÓN ELÉCTRICA S.A.U.



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Improving position in the utility sector:

from the 19th in 2001.....to become one of the five largest utilities



Iberdrola's organization structure dealing with DER&RES



AREA	TASK	HHRR	
RENEWABLES	Wind, Mini-hydro, Solar, Biomass.	1,039 in 2007	
ENGINEERING & CONSULTANCY	Engineering of the group developing renewable facilities	No data	
COGENERATION	Completly commited to CHP; building and managing	83 (96) in 2007	
RETAILING	Seeking new ways of trading energy in the liberalized market (Green Energy)	No data	
DISTRIBUTION	Managing the system for efficiency and reliability of supply	85 in 2005	

Renewable energies are one of the basic pillars of Iberdrola's growth strategy



First electric company having a stake in renewable energies as a fundamental strategic plan ...

... which made Iberdrola world leader of the sector ...

... opting for the most developed renewable energies ...

... developing emerging technologies ...

... being pioneer in integrating renewable energies within the system and improving their efficiency...

... opting for the international expantion to the rest of the EU, USA and Latin America.

Iberdrola, sustainable growth



Contributing to the energy policy objectives







Iberdrola already complies with Spain's 2010 environmental targets



Iberdrola is one of the world leaders in renewable energies.





Iberdrola's Renewable Energies Operations Centre, in Toledo, is designed to help bring these energies onto the electricity grid and to improve their efficiency





- Iberdrolas's renewable energy operations centre (CORE) is a pioneer initiative in the industry due to its technology and scope.
- It allows Iberdrola to improve the management and operation of renewable energy installations.
- The centre helps to bring these energies into the system and to eliminate possible obstacles to their development

Energy Production in Spain



SPECIAL REGIME

PRODUCTION

TOTAL PRODUCTION

Year 2007: 274.518 GWh Year 2007: 56.831 GWh Others_ 4% Cogeneratio Nuclear Solar n 19% 1% **Hydro** 30% 7% Renewables. 31% Wind Coal 47% 25% Petrol, Prod 1% Waste 11% Natural Gas 20% **Biomass** 4%

SPECIAL REGIME SALES WERE 22,4 % IN AUGUST 2007.

IN SEPTEMBER 2007 95% OF WIND POWER WAS ON MARKET

Installed Power in Spain



INSTALLED POWER

Year 2007: 90.309 MW



INSTALLED POWER RENEWABLES AND WASTE

Year 2007: 33.829 MW



Grid connected solar photovoltaic installations in Spain



	2005		2006			2007			% en 2007			
Distribution company	Energy (GWh)	Installed Power (MW)	Number Installation s									
Iberdrola	30	33	3.990	77	102	7.432	300	401	13.941	68	74	78
Endesa	6	6	642	17	26	1.128	96	87	1.887	22	16	11
Unión Fenosa	4	3	405	8	7	640	32	23	1.390	7	4	8
Viesgo	0	1	69	1	1	122	2	2	159	0	0	1
Cantábrico	0	0	31	3	0	40	1	1	55	0	0	0
Distribuidoras DT 11	1	1	133		4	220	12	31	403	3	6	2
Fevasa									1	0	0	0
TOTAL	42	44	5.270	106	140	9.582	443	545	17.836	100	100	100



(Source: CNE - Inf. January 2008. Information for Iberdrola 2007 comes from Iberdrola's Special Regime department



Units and Installed Installations and Annual Evolution in Iberdrola Distribution

Тира	Generation Units (cumulative)							
туре	31/12/2006	31/12/2007	Increase	Anual %				
Cogeneration	482	499	17	3,53%				
Solar (Photovoltaic, Thermal)	7.432	13.941	6.509	87,58%				
Wind (+tidal, erc)	295	320	25	8,47%				
Hydro	415	420	5	1,20%				
Biomas	39	40	1	2,56%				
Waste	24	24	-	0,00%				
TOTAL Units	8.687	15.244	6.557	75,48%				

Total facilities 8.270 14.796 6.526 78,91%





Installed Power and Annual Evolution in Iberdrola Distribution



Тиро	Cumulative Installed Power (MW)							
туре	31/12/2006 31/12/2007		Increase	Anual %				
Cogeneration	2.240	2.287	47	2,10%				
Solar (Photovoltaic, Thermal)	102	401	299	293,14%				
Wind (+tidal, erc)	5.606	6.029	423	7,55%				
Hydro	537	540	3	0,56%				
Biomas	101	101	0	0,00%				
Waste	325	325	0	0,00%				
TOTAL Units	8.911	9.683	772	8,66%				



Energy distributed by Iberdrola



	Total 2002	Total 2006	Total 2007	% of distr.	<u>∧</u> %2002-
				Energy 2007	2007
Customers in 400 or 220 kV	4.120	5.037	5.369	5,2%	30,3%
From Transport	64.268	72.603	71.821	70,1%	11,8%
Balance with other distributors	399	520	762	0,7%	91,0%
Generation (< 220 kV)	2.593	2.744	2.864	2,8%	10,5%
Gen. in special regime	10.850	18.562	21.679	21,2%	99,8%
Total Energy	82.230	99.466	102.495	100,0%	24,6%

Millions of kWh

Energy distributed by Iberdrola









A clear stake is needed (State and Companies)

Whenever exists good regulatory support we can achieve great developments (Example of Iberdrola Renewables)

Regulatory support must be focused in all areas related to DER&RES otherwise a stopover could arise

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