SC C6 - Distribution Systems and Dispersed Generation

GROUP DISCUSSION MEETING SUMMARY

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The session was opened by the Chairman with a presentation of the activities of the Study Committee C6. The list of the working forces and of the publications is attached at the end of the session summary.
The main conclusions achieved in debating the three preferential subjects are hereunder given.

Preferential Subject 1: Operating systems with Dispersed Energy Resources (DER) or Renewable Energy Resources (RES).

Preferential Subject 1 received 12 papers addressing various aspects of the operation of power systems with renewable energy resources connected either to transmission or distribution networks. Authors were drawn from 10 countries reflecting the international interest in the topic.

1.1 Operating systems with DER

Existing technical barriers may be overcome by defining shared technical requirements for DG, by stating clear rules and procedures for network operation, by developing suitable SCADA and protection systems.
The concept of Virtual Power Plant may optimise electric distribution jointly with thermal generation just achieving efficient use of resources.
European and national directives are supporting in Europe an impressing development of renewables' deployment; in some cases DNO have to accept all DG/RES generation at fixed rates. New regulatory schemes must be considered taking into account all market players.
These results have to be achieved by providing to regulators results of studies and researches and developing with them a collaborative approach.

1.2 Ancillary services provision from Distributed/Renewable Energy Resources

This topic attracted very considerable interest with excellent answers to the 2 questions.
Ancillary services as frequency and voltage control, power balancing, restoration of supply should be, in the future, also provided by distribution networks integrating DG and RES. Technologies are available and in principle all power plants connected to the power systems (independently on energy sources) should face the same requirements.
Mandatory requirements have not to exclude market mechanisms: appropriate combinations could provide a solution, therefore there is the need for an adaptation of the economic and regulatory framework. Fault ride through capability of wind generators is highly recommended in the case of high wind power penetration.
Integration of DG/RES is providing new challenges for the European TSO to harmonise grid codes, but taking care of specific grid structures; responsibility of national TSO on system stability and other additional national guidelines has to be respected.
Technical consistency (common grid codes and standards) as well as economic consistency (common market models and rules) are important for system security, for manufacturers, for market operators and to foster competition.

1.3 Power System Communications for Dispersed Generation

The project "Network for energy and communications" was reported and the communication requirements for DER quantified. This German project is analysing communication requirements for distribution energy resources management and dispatchability. Data to be

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exchanged and latency requirements are individuated for different size and types of DER and for different microgrid structures.
Standardisation of communication protocols and standards has to be developed.

1.4 Wind Forecasting

In the case of high wind power penetration, forecasting tools have to be integrated in the control procedures of power system operation. Methods and tools have been already developed and utilised. Accuracy depends on how much time in advance forecasting is performed; comparisons between forecast and online measures of wind generators have been reported. The need to indicate confidence limits was stressed.

1.5 National Experience

Interesting experience was reported from 3 countries. Interventions addressed both technical and commercial issues. A contribution provided an overview of strategies applied in Malaysia to exploit renewables; a suitable distribution code is now developed.
It has been stressed that CIGRÉ is a platform for a global exchange of information and experience; in Brazil the actions of CIGRÉ committees, in particular C6, have been creating a favourable environment for networking with different organizations and utilities.

1.6 Hydrogen Energy Storage

A study for the utilisation of hydrogen to compensate fluctuations of wind power was reported. A method to optimise the design and the size of the components has been developed. It was stressed that technology is expensive, further development is needed and, overall, a new infrastructure for production and distribution of hydrogen has to be realised.

1.7 Impact of Distributed Generation on reliability worth

Three interventions were made addressing the question what computational tools are required for the study of DER/RES.
Significant DG penetration needs the impact on the reliability of customer supply be quantified.
Probabilistic methods have to be used and computing tools are already available for studies at the planning and operation stage. Improvements are needed especially to model particular features of DG sources (as described in paper 107), as well as the development of benchmarks; this is within the scope of the CIGRÉ task force C6.04.02 which will conclude its activity by the end of the year by publishing a technical brochure reporting models and benchmarks.

Preferential Subject 2: Demand Management (DM) and Demand Response (DR)

This preferential subject was introduced by Study Committee SC C6 with a view to support the activities of WG C6.09 Demand Side Response that has been established by SC C6.
Four papers were submitted in this area: One from Australia, one jointly between Australia and Germany, one from Italy and one from Sweden.

In introducing the subject, a video produced by MVV Energy of Germany as part of the Dispower Project titled "Smart Grids – Energy Management in Distribution Grids" was presented. This demonstrated the outcome of establishment of a smart grid that allows for load levelling through storage and integration of various renewable energy sources.

Nine formal contributions were submitted to the questions raised in the Special Report, the majority of which came from Germany reflecting both German and European activities. To complement these contributions, there were a large number of spontaneous contributions that raised further questions and suggestions.

In raising the question as to the correct terminology (Demand Management (DM) Demand Side Management (DSM), Demand Response (DR) or Demand Side Response (DSR)) the alternative term of Demand Side Initiatives (DSI) and Demand Side Integrations (also DSI) were proposed as being better terms.

Although many questions were put forward in the Special Report it is clear that many of these questions are still support open with development work and investigations being undertaken in Europe, USA and Australia in particular.

2.1 DM and DR as capacity and energy source

Same experience was already achieved with individual response of a small number of large generators and loads, in performing peak shaving and activating a Virtual Power Plant to participate to the market. The next action will be to involve large numbers of small generators and loads to achieve energy efficiency and supply security.
The impact of price signals was already experienced in Germany where ecological incentives (the program “Washing with the sun”) and hourly tariffs for families were introduced. Customers tended to respond positively to ecologically beneficial behaviour even if it does not necessarily result in commercial benefit.
It was noted that there was a need for development of an open communication protocol right down to the customer and appliance level. Additionally, it is becoming increasingly clearer that the customer needs to be able to make the ultimate decision as to the level of automation and pattern of usage that is acceptable to the customer.

2.3 Role, willingness and approach of Distribution Network Operators in implementing DSM and DSR projects

Role and willingness of DNO depends on market conditions, current level of distributed generation in own networks and availability of suitable technologies. Experimentations are already in progress in some countries with the contribution of the European Union.
Studies (as presented in paper 204) enable evaluating benefits provided by DSM and DSR actions and to compare them with the relevant implementation costs. These studies have also to be performed in planning the long term system development just to ensure a network secure operation.

2.4 Role of regulators

Today there are several barriers (network constraints, equipment cost, lack of market rules and suitable legislation, not sufficient technology) that are constraining the adoption of demand side initiatives. Regulatory support is required to support standardisation, establish suitable market mechanisms and establish financial incentives.

Preferential Subject 3: Innovative distribution systems facilitating widespread deployment of DER

3.1 Innovative Distribution System Structures

There are several innovative Distribution system structures proposed in order to make efficient utilization of DER. For example, the integration of small DER into wholesale markets aggregated as Virtual Power Plants of a significant size provides a number of advantages concerning portfolio imbalance management and risk analysis. The Greenfield structure is another economically justified approach based on the integration of converters and storage devices and the combined transmission of different energy carriers (electricity and gaseous) in one device. Microgrids provide another approach offering several benefits to power system operation (reliability, losses, congestions, environmental effects) and planning (deferral of investments for reinforcement and replacement). These need to be quantified and incorporated into an appropriate commercial and regulatory framework so that a level playing field for all energy technologies can be established.

3.2 Microgrids – Control Issues

Microgrids control is a key feature for their participation in Electricity Markets, especially coupled to Demand Side Management. In order to operate a Microgrid in a coordinated manner, there are several decision making approaches varying from a centralized to a fully decentralized approach. Centralized approaches in which the main responsibility for optimised operation lies with the Microgrid Central Controller have been presented, including two decoupled optimisation cycles including sophisticated forecasting and state estimation techniques. These are clearly suitable only when there is control over all DER and interruptible loads, as is the case of an industrial microgrid. On the other hand, decentralized control giving the main responsibility to the controllers of the microgenerators, based on distributed multi-agent technology, is clearly more suitable in residential microgrids with different DER ownerships. Wide customer participation to ensure seamless transition from interconnected to islanded operation seems critical.

3.3 Pilot Installations

Pilot installations are very important to prove innovative distribution structures. A number of pilot installations are currently under development within EU projects; a demonstrative project has been realised in Japan integrating a regional power grid with renewable energy resources.

Studies are also being performed to quantify the benefits vs. costs for upgrading the operation of individual DERs to coordinated DER control. Laboratory installations are also developed and their work is considered very important, especially regarding standardization and testing.

3.4 Coordinated FACTS Control to increase the Transfer of Wind Power on Transmission Networks

A number of FACTS solutions has been applied worldwide and proven to increase transfer capability of existing transmission systems. These solutions can be also applied to increase wind power transfer with good economic results.

An investment performance index has been proposed to quantify the cost/benefits of FACTS utilisation.

WORKING BODIES

Working Groups - Task Forces			
Ref	**Title**	**Convenor**	**Dates**
AG C6.01	Strategic Advisory Group	A. INVERNIZZI (Italy)	2002-Perm.
AG C6.12	Tutorial Advisory Group	Trevor GAUNT (South Africa)	2006-Perm.
WG C6.01	Development of dispersed generation technologies and consequences for the power systems	Makoto YAGI (Japan)	2000-2004
WG C6.02	Connection of generators and customers	Wil KLING (The Netherlands)	2000-2004
WG C6.03	Operating DG with ICT (Information & Communication Technology)	Shiro ODAGIRI (Japan)	2003-2005
WG C6.04	Connection and Protection Practices for Dispersed Generation	Nikolaos HATZIARGYRIOU (Greece)	2003-2005
TF C6.04.01	Connection Criteria at the Distribution Network for Distributed Generation	Nikolaos HATZIARGYRIOU (Greece)	2003-2005
TF C6.04.02	Computational Tools and Techniques for Analysis, Design and Validation of Distributed Generation Systems	Kai STRUNZ (USA)	2003-2005
WG C6.05	Technical and Economic impact of DG on Transmission and Generation Systems	Goran STRBACK (UK)	2003-2005
WG C6.08	Integration of large share of fluctuating generation	Harald WEBER (Germany)	2004-2006
WG C6.09	Demand side response	Alex BAITCH (Australia)	2004-2007
WG C6.10	Technical and commercial standardisation of DER/microgrids components	Jose María OYARZABAL (Spain)	2006-2009
WG C6.11	Development and operation of active distribution networks	Christian D'ADAMO (Italy)	2006-2009
WG C6.13	Rural elecrification	Gudni DAGBJARTSSON (Switzerland)	2006-2008

PUBLICATIONS

Issued

- ELECTRA, April 2004,"Distribution Systems and Dispersed Generation: a New Focus for CIGRE"
- ELECTRA, August 2004 "Development of Dispersed Generation and Consequences for Power Systems"
- Technical Brochure, Ref 271, 2005, "Connection of Generators and other Customers - rules and practices" . Summary on ELECTRA, April 2005
- Athens Symposium, April 2005, " Connection of Generators and other Customers"
- ELECTRA, June 2006, "Electrification and dispersed generation: a debate between local and international professional". Main conclusion of 2005 South Africa C6 Colloquium

Coming soon

- ELECTRA report on conclusions of WG C6.03, "Operating dispersed generation with ICT"
- Technical brochure and summary for ELECTRA on results of TF C6.04.01, "Connection criteria at the distribution network for dispersed generation"