SC C6 - Distribution Systems and Dispersed Generation

GROUP DISCUSSION MEETING SUMMARY

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Preferential Subject 1: Distribution and transmission network development in a dispersed generation environment.

- **Rules for system planning and DG designing to maximise benefits and minimise impact.**
- **Impact of large scale of non-dispatchable DG.**

The responses to the ten papers in this PS were discussed under four headings: DG development and integration in the liberalised market, planning issues, wind farm integration: techniques and system impact, advanced power supply systems with DG

DG development and integration in the liberalised market

An extended methodology to support the integration of DG/RES into a liberalised market has been developed in the EC funded BUSMOD project. The methodology does not address technical aspects; it assures the transparent process to evaluate the economical worth of DG/RES. An important aspect is the access to data relevant to DG/RES production and to customers; the data can be more easily collected using advanced communication technologies.

The impact of DG/RES on the electric market depends on the type of the primary energy sources. Conformity, reliability and dispatchability are strictly required: conformity guidelines already exist, supplementary rules are required for reliability and dispatchability as well as the development and utilisation of a decentralised energy management system.

Rules for DG/RES connection and integration depend on the characteristics of the electric power system. The experience so far gained in Spain is positive; the definition of common rules and regulation might be necessary at an over-national level (e.g. at the EU level) in the case of very high degree of penetration.

Profitability of DG/RES depends on technological development, availability of the energy sources, national rules stated to control the environmental impact, the model adopted for the liberalised electricity market. Various options may be used for the allocation of connection costs: variable shallow connection tariff, deep connection tariff, real cost. The Dutch Office for Energy Regulation is in favour of the real cost option. The new EUDEEP EC funded project started the activity in January 2004 with the aim to create a European Distributed Energy Partnership to help the large-scale implementation of DER in Europe by overcoming the existing technical and non-technical barriers (market integration, regulation adaptation, connection technologies, grid impact, DER systems).

Planning issues

Planning methodologies specifically developed for DG/RES integration are required; very important steps are the analysis of energy sources data, territories and generator characteristics. Profitability analysis has to take into account all the relevant costs including all the internal and external civil and grid costs as well as energy or investment subsidies available. Profitability depends also on the costs related to the modification of distribution operation procedures (passive vs. active distribution networks, development and use of ICT systems). The impact on network losses and investment deferral strongly depends on the penetration level and the local concentration degree.

DG benefits may be improved by developing the “virtual power plant” concept. This solution has to respect the market rules about unbundling and requires significant organisational effort and economic analysis; the application of this concept should be easier for smaller network operators with lower unbundling requirements.

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Wind farm integration: techniques and system impact
DC technology is suggested for grid connection of large power wind farms by using either HVDC-VSC schemes or HVDC line commutated systems to be compared with HVAC transmission systems.

Correlation between wind speed and load is very low; power system "net" load curve is very much affected by wind power and it becomes more uncertain and less smooth. "Capacity credit" of wind power depends on many factors but tends to be low.

Increased wind energy infeed in the transmission network (today already experimented in Germany) requires new rules for connection of wind power plants to the HV and EHV networks: a change of paradigm in case of network failure is necessary, a substantial change in wind turbine design is needed (including protection and control), wind turbines must contribute to network stability like conventional power plants. New guidelines have been stated in Germany; they are available on www.vdn-berlin.de.

Advanced power supply systems with DG
The new concept of "Autonomous Demand Area Power System" (ADAPS) has been introduced; it seems to be a particular example of Microgrids. The comparison with the conventional substation reinforcement in a small distribution network demonstrates the economical validity of the proposed solution; the relevant communication system also permits customers to receive real time price information allowing them to draw up a purchase plan of electric power.

A new voltage control scheme has been also proposed to improve voltage profile on distribution feeders integrating DG. The solution based on the diffused utilisation of sensors and the control of transformer taps allows to reduce the effect of DG on voltage variations along the feeders, so far improving electric power quality. This solution, as well the conventional compounding technique, causes an increase of the number of transformer tap changes but this does not seem a significant drawback.

The alive free discussion that followed the prepared and spontaneous contributions raised some significant issues:

- there is some concern about the effect of availability and reliability of DG/RES plants;
- grid rules stated for DG/RES integration in distribution networks have to be also approved by system operators;
- the increasing diffusion of wind power generation is stressing the need for wind data availability;
- DGs are a disaggregated power source that has to be in some way centrally managed by system operators and regulators. The assessment of rules and procedures has to be supported by CIGRE' activity;
- the widespread integration of DG into distribution systems might require the utilisation of meshed distribution networks, so far allowing the development of the active distribution concept;
- penalties stated by regulators on unbalances of DG production (with respect to the predefined generation schedules) may significantly reduce DG profitability.

Preferential Subject 2: Role of dispersed generation in power system reliability, security and quality of power supply.

- **Capability of DG in facing network disturbances.**
- **Capability of DG in providing ancillary services.**

The responses to the seven papers in this PS were discussed under four headings: reliability and security, power quality, ancillary services and fault performance, and modelling of DG

Reliability and security
Frequency excursion indicates the loss of power capacity, which depends on the inertia of the sources and the spinning reserves. General rules of reserve cannot be simplified to simple

percentages or indices, because several factors contribute. The reliability problem needs dynamic security assessment based on decision trees or ANNs, which can be used for scheduling and monitoring.

DG represents a new situation in the network. The power generated depends on the character of primer power sources and long-term statistics are not available. Reliability and dispatchability need to be expressed in terms useful for stochastic analysis. Although having many small DG units, and therefore higher single-contingency reliability, the system reliability depends on the reliability of the DG sources. DG has been proposed as an alternative to network reinforcement, but in practice some DG requires network reinforcement to maintain stability or to cope with DG output exceeding the local load. Good wind conditions lead to development of WG, but the concentration is not really dispersed.

Power quality

Converters generate harmonics, which must be managed within acceptable limits, by installing filters if necessary.

The flicker problems relates to visual perception, with limits based on health effects. Wind power fluctuation at 8Hz over 100 min is not a problem in strong networks, but on weak rural networks (for example 1MW over 5km of 10kV line) advanced pitch control is needed to damp the oscillations.

Power systems with eigenvalues in low frequency range can indicate susceptibility to oscillation. Wind turbines can be the source of excitation of the system.

Ancillary services and fault performance

It is necessary to distinguish between fault contribution and the post-fault recovery. Need better rules for fault contribution. Performance depends on the source, especially for induction generators, but can be improved by FACTS devices.

While the share of DG was small, it could be tripped off the system when faults occurred, but then could not contribute to post-fault recovery. Different problems occur in weak and strong networks, affecting protection co-ordination and reactive power deficiency leading to voltage collapse. Load shedding (especially of induction machines) is possible to assist recovery, or power electronic devices can be used to supply reactive power, or SVCs for voltage control.

The large capacity of wind generation in Germany, and the scope for more, suggests alternative generator technologies are needed for the fault power contribution. A technical and economic comparison of heavier (synchronous) generators or the application or FACTS needs to consider the whole system.

Ancillary services are not taken into account because (a) DG is in the lower voltage systems, so reactive power not suitable for voltage control, (b) unbundling of the power system has changed the responsibilities for stability and control, and generators are not responsible for stability, for which there is a limited functional market. In some cases there is no payment for reactive power, but a regulator can instruct reactive power supply.

Modelling of DG

DG analysis requires benchmark models for comparing different types of studies, identifying the simulations required, and identifying suitable simulation techniques.

Wind power provides about 10% of the Nordel system described in one paper. A detailed model would have too many discrete wind turbines, so a reduced model of the dynamic response with stochastic aspects is needed appropriate for the problem being simulated.

In considering applications for new DG (wind) connections, it is easy to make complex models, but most applicants do not yet have the details of their technology, so models with minimum parameters are needed.

Some people prefer existing software, using suitable detailed or reduced models, but others consider that different simulation tools are needed because most existing software does not allow for the typical conditions on distribution networks with DG. In several cases, it appears that existing software is being updated to meet the new needs. Also, there is a need to test the equivalence of the reduced models or new physical units (eg fuses or demand side management) that have been proposed. Attention is needed to the compatibility of data for use in different software models.

In the classical approach to simulate large systems, assumptions were debated about 30 years ago. Implicitly, we are building and working with those approaches. The assumptions may no longer be accurate of new energy systems.

Much of the discussion has been about wind generators, but there are other technologies that should also be included. NY Power Authority has 12 fuel cells already in operation using natural or anaerobic gas, with diverse benefits. They are small systems with small impact at present, but there is potential for growth. Simulation tools should be kept adequately general and not limited only to a specific technology.

DG introduces new problems on networks, so practical testing must validate computer studies.

Preferential Subject 3: Electrification of rural areas.

Factors limiting the use of the low cost technologies include community perceptions of "second class electricity", conservative utility engineer thinking about load growth and concern about finance for future reinforcement, and the need for new parameters, design software and staff training.

The low cost of the SWS allows electrification to be extended. The SWS can only serve a limited corridor along the HV line route and short circuit levels are low. Different materials are used for SWS, compared with conventional HV lines, but the performance very little altered. When loads grow, intermediate sources can be introduced.

Load parameters and standard system voltages differ in different countries, requiring different line designs, system planning and performance indicators.

Household electrification contributes to evening peak demand and may change the utilisation of generation and transmission assets. Considering electricity as both a commodity and a public service requires new tariff approaches, power quality standards, and processes of investment approval.

SC-C1 is considering related electrification planning issues for newly industrialised countries.