



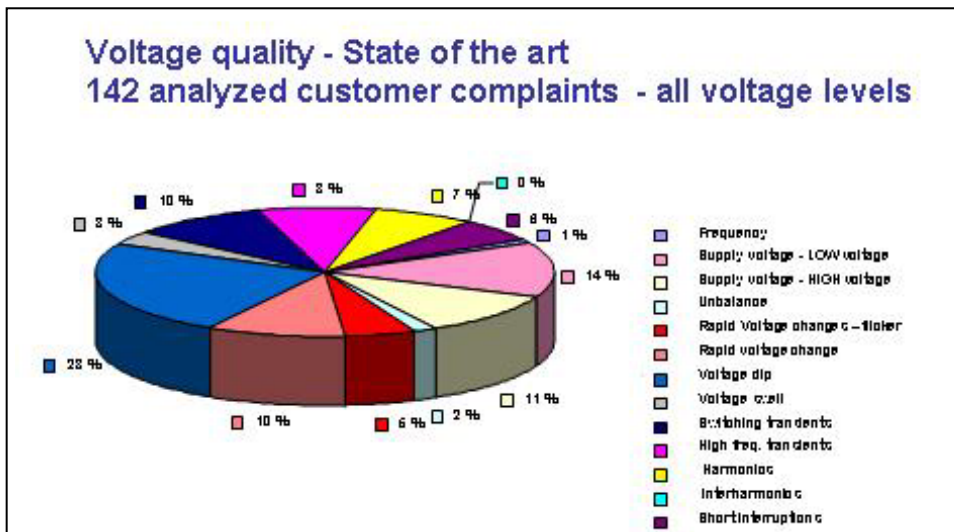
**IEA Implementing Agreement on
Electricity Networks Analysis, Research and Development (ENARD)**

Annex I Workshop Profile

“Distribution Systems and End User Aspects”

Annex I: Information Collation and Dissemination

**Annex I Workshop held CESI Ricerca, Milan, Italy,
28th September 2006**



[from the presentation given by Kjell Sand, SINTEF Energy Research, Norway]

Summary:

Some 22 delegates from 10 countries participated in this meeting, with five expert presentations preceding open discussion and debate on key areas of interest. Two key themes and priority areas were identified in relation to:

- *“here and now” – today’s networks;*
- *“new systems” – tomorrow’s networks*

Consensus was reached in relation to a range of priority areas for future distribution related activities to be further developed, within ENARD, in line with the overall Annex I work programme.

This workshop forms one of a series of ENARD Annex I workshops organised and delivered by EA Technology in its capacity as ENARD Annex I Operating Agent



Workshop profile

1 Introduction

The workshop was convened as the inaugural meeting in the series of topical experts' meetings and workshops of the International Energy Agency (IEA) Implementing Agreement on Electricity Networks Analysis, Research and Development (ENARD). ENARD has been established to address a wide range of issues associated with electricity transmission and distribution (T&D) systems. Annex I is the central information collation and dissemination Annex and also contributes to the definition of future priorities for the Implementing Agreement as a whole.

Annex I is essentially led by a series of topical experts' meetings and workshops, each addressing particular areas of interest that act as the foundation for the development of future collaborative research and development (R&D) Annexes. Further details may be found on the ENARD web-site at www.iea-enard.org or e:mail enquiries@iea-enard.org.

2 Workshop Aim and Objectives

The meeting objectives were to focus on:

- distribution system aspects, noting different approaches, research projects and teams;
- associated transmission system interface issues;
- considerations in relation to localised connection requests.

Participants were welcomed by John Baker, ENARD Annex I Operating Agent (EA Technology, UK), who commented that the meeting should aim to identify:

- key challenges;
- information requirements;
- opportunities for future collaborative R&D;
- complementarities with other initiatives and programmes;
- opportunities to develop a dedicated distribution systems (R&D) Annex.

3 Expert Presentations

Distribution system asset management: the present situation in Norway and future challenges

(Dr Kjell Sand, SINTEF Energiforskning AS, Norway)

Dr Sand's presentation gave an insight into the Norwegian perspective, where electricity distribution acts as a major driver in asset management. The distribution industry manages increasingly ageing assets, with reduced manpower, whilst also managing technical issues (e.g. over-voltage) caused by reduced capital investment.

Current and anticipated trends include:

- regulatory and political drivers, e.g. promotion of distributed generation;

- "professional" ownership within the distribution industry demanding performance and returns;
- environmental consequences, from toxicological / carcinogenic to visual amenity factors;
- increasing electricity prices impacting on an increase in heat pumps and local generation, with consequent impacts on distribution system loads;
- increase in urban district heating and cooling;
- advanced metering techniques, including smart meters and automated meter reading;
- external risk elements, e.g. climate change and severe weather effects;
- some inadequacy in IT systems source data required to respond to more stringent regulation.

Such regulatory, governmental, environmental and market related trends are complemented by technological developments, including smart grids and advances in sensors and communications systems. These trends are combining to create clear requirements for new business and management tools, information systems, methodologies and technologies and R&D needs, including:

- developments in regulatory benchmarking;
- consolidation of utility information systems;
- accommodation of data sets and key performance indicators (KPIs) within IT systems;
- managing an ageing asset base via, for example:
 - network risk management methodologies;
 - complementary condition monitoring;
- managing multiple diverse energy sources within the distribution system, e.g. smart grids;
- managing the convergence of communications and distribution systems infra-structures.

Smart and active distribution network operation

(Alberto Cerretti, Enel Distribuzione, Italy)

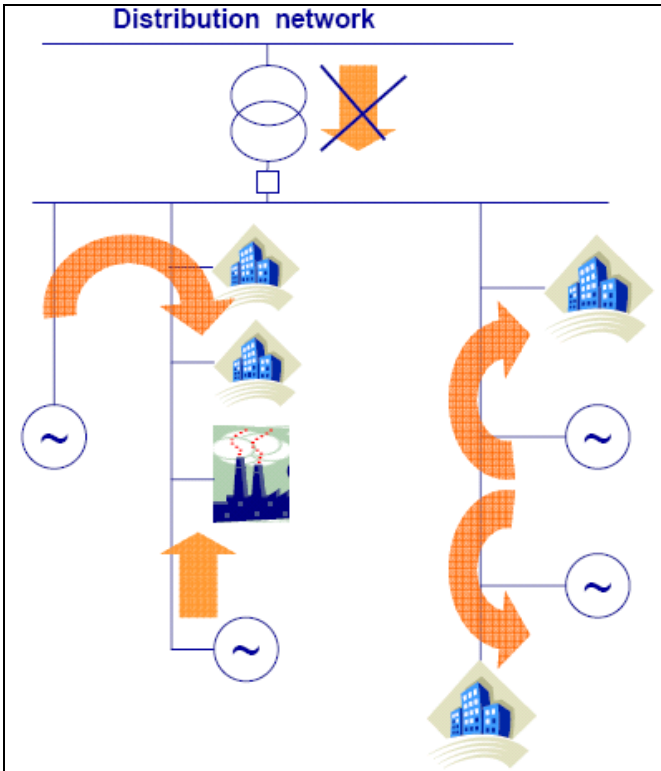
Mr Cerretti commented that the advent of distributed generation and renewables presents various challenges to the power distribution sector, including:

- cost and efficiency aspects;
- integration difficulties;
- automation, protection and control problems.

ENEL's approach to such problems is the Smart Distribution Network Operation (SDNO) concept, which is expected to deliver significant improvements in network performance in terms of automation, protection and control, together with quality-of-supply benefits.

With the SDNO concept, the basic network "building block" or "atomic network" would be the MV network supplied by a single HV/MV transformer. The principal objectives of SDNO include independence from the HV network, both in terms of supply disturbances and outages and also from an energy perspective, with the HV network only supplying energy at times of insufficient localised MV generation.

It is envisaged that islanding operation will be a distinct possibility, complemented by advances in automation, protection and control, to facilitate automated network operation, with consequent benefits in terms of quality and security of supply.



[*Smart Distribution Network Operation* - from the presentation given by A Cerretti, Enel Distribuzione, Italy]

The incorporation of Petersen coil controller technology to provide a centralised MV earth fault protection function, together with complementary developments in network automation, are intended to allow automated switching between faulty and healthy network branches.

However, the biggest challenge is a communications system infra-structure able to reach every sub-station, irrespective of the MV network status. Two principal options are under consideration, namely power line carriers with multi-carrier modulation and the WiMax Wireless technology.

Distribution systems issues – a Swedish perspective (Stig Goethe, Power Circle, Sweden)

Mr Goethe provided a thought-provoking perspective on a range of distribution system issues from the perspective of Power Circle, which acts as an electro-technical cluster within Sweden. He commented on the two categories of business and market drivers, namely “administrative”, embracing such facets as utility structuring, business separation and regulation, and “technical”, embracing quality of supply, network modelling and metering. Customers now expect close to 100% security of supply, so a blackout in 2003 followed by a hurricane in 2005 triggered major political debate in Sweden, leading to significant changes in the structure, regulation and management of the distribution base. The regulatory framework for network businesses is now performance based, rather than opex/capex based.

Regulation is an essential pre-requisite for any natural monopoly such as a distribution system, but a stable regulatory framework is required for the efficient

development and management of long term distribution businesses. Ultimately society must decide on the appropriate balance between quality and security of supply and the cost that this entails, with the regulatory régime then providing the necessary incentives and penalties. The decisions then permeate through to technical considerations, e.g. more undergrounding, and enhanced diagnostics/management/operational/ maintenance techniques.

The Energinet.dk Cell Controller Pilot Project (Per Lund, Energinet.dk, Denmark)

Mr Lund was the first of two presenters reporting on the development of the transmission system infra-structure in Western Denmark, in the context of a very significant growth in distributed generation from the late 1980s. Generation capacity is now approximately equivalent to twice the peak demand level, with wind and CHP alone being capable of supplying peak demand since 2002.

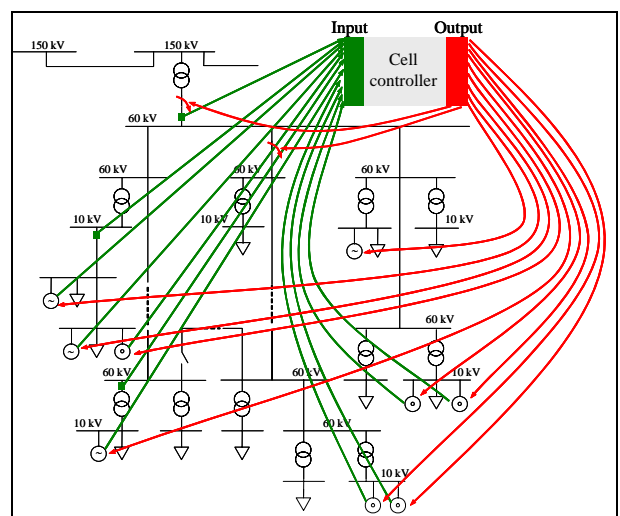
Associated challenges include the inability of local grids to maintain normal (n-1) security standards, security analyses becoming less accurate, the tripping of local generation as a result of remote faults on the HV transmission system and increasingly complex post fault restoration procedures.

Energinet.dk initiated its cell controller pilot project to investigate the feasibility of developing utility scale micro-grids (or cells), with the objectives of:

- ultimately, under emergency voltage collapse conditions on the HV grid, such cells being able to disconnect themselves from the HV grid and assuming island mode operation;
- in the event of a total system collapse, individual cells being able to black-start themselves to a state of controlled island operation.

The project was initiated late 2004 and is expected to run through to end 2011, in various stages, including:

- information gathering and specification phases;
- measurements in candidate network(s);
- development, commissioning and evaluation of a full scale pilot cell demonstration in Jutland.



[Cell Controller Functionalities. Diagram provided by P Lund, Energinet.dk, Denmark]

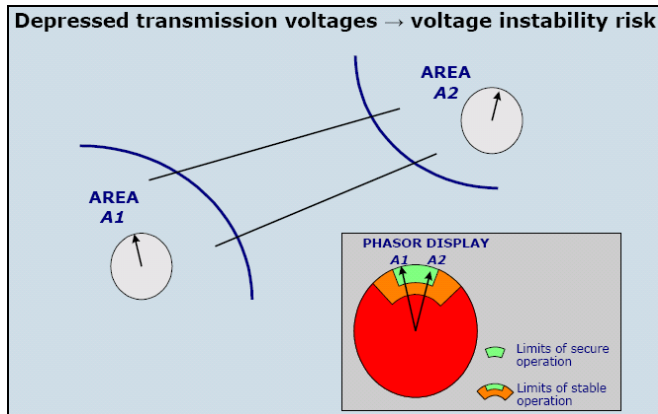
The diagram above shows the Cell Controller functionalities. Measuring and monitoring of load and production is indicated by the green arrows and Control actions on generators, load feeders and main power circuit breakers are indicated by the red arrows.

Advanced Usage of on-Line Measurements from Phasor Measurement Units

(Carsten Strunge, Energinet.dk, Denmark)

Mr Strunge described the advanced applications of phasor measurement units for provision of early warning of imminent voltage collapse and on-line detection of low frequency oscillations in the Nordic Transmission System Operator area. Secondary objectives of the project included:

- generator monitoring;
- determination of corridor loadings;
- islanding detection;
- SCADA support;
- model/parameter identification;
- validation of simulation tools.



[from the presentation given by C Strunge, Energinet.dk]

Mr Strunge commented that there is no unique voltage/reactive power (V/Q) curve available to warn of imminent voltage collapse, thus the V/Q curve having to be continually updated in real time.

4 Expert Discussion

A wide ranging expert discussion followed, with the objective of identifying the key requirements for future collaborative R&D activities and, specifically, the most effective role for ENARD in relation to distribution system developments. Two principal themes, recorded in table 4.1 and linked by some common work areas, were:

- Ongoing management, operation, maintenance and evolutionary development of today's "here and now" networks, which will exist for the next 10+ years;

- Opportunities to contribute to the development of future network architectures and R&D requirements.

Table 4.1: Distribution System Priority Areas

"Here and now" – today's networks	"New" Systems – tomorrow's networks
<p>Characteristics</p> <ul style="list-style-type: none"> • 30 to 40 years old • will still be very much in existence and operation for next 10 plus years 	<p>Characteristics</p> <ul style="list-style-type: none"> • penetration of DG routinely up to circa 30% level • active networks • network automation
<p>Aim: Management of the effective transition from today's networks to tomorrow's</p>	
<p>Priorities</p> <ul style="list-style-type: none"> • management of an ageing infra-structure • condition monitoring • lifetime estimation/indicators • development/application of risk based methodologies • safe operation • network management and control, with incomplete/imperfect data sets 	<p>Priorities</p> <ul style="list-style-type: none"> • active network management • measurements, control and communications aspects • standards development • definition of developing market needs • management of inter-utility system dependencies
<p>Common themes/activities</p> <ul style="list-style-type: none"> • contribution to the development of appropriate regulatory frameworks ("educating the regulator") • definition of developing market needs • quality/security of supply considerations • development of the distribution system and associated DG databases (including identification of data requirements) • network management and control, with incomplete and imperfect data sets • development of DG charging and pricing mechanisms • dynamic modelling of loads and DG identification of barriers and response mechanisms 	

5 Future Activities

This inaugural meeting provided an invaluable opportunity for ENARD participants to discuss a wide range of distribution system issues, preceded by topical presentations, and to identify priorities for future activities.

ENARD, the IEA Implementing Agreement on Electricity Networks Analysis, Research and Development, functions within a framework created by the International Energy Agency (IEA). The views, findings and publications of ENARD do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

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