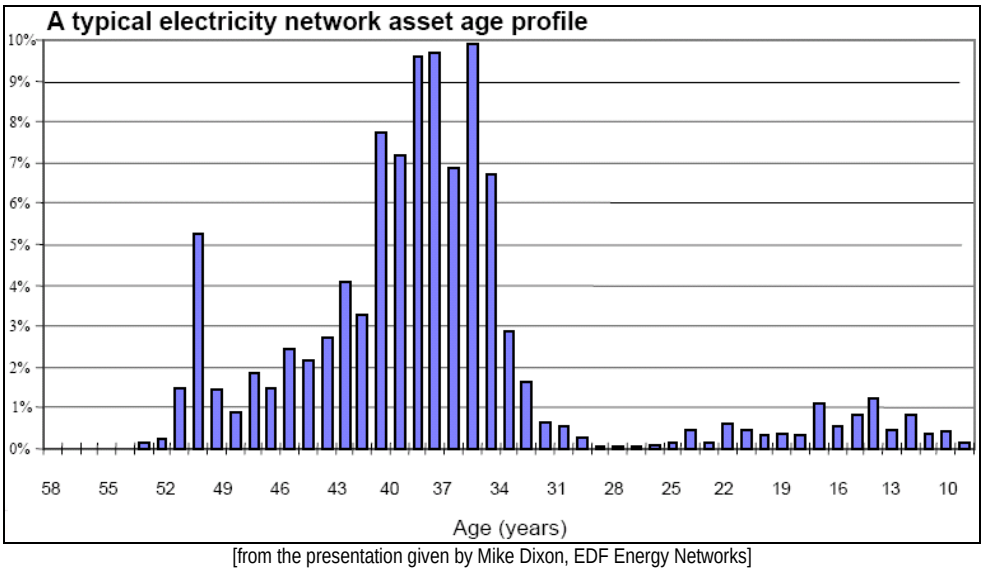
IEA Implementing Agreement on
Electricity Networks Analysis, Research and Development (ENARD)

Annex I Workshop Profile

"Managing an Ageing Infrastructure"

Annex I: Information Collation and Dissemination

Joint Annex I / CIRED Workshop held Reed Messe, Vienna, Austria 21st May 2007



[from the presentation given by Mike Dixon, EDF Energy Networks]

Summary:

The workshop drew the support of 33 participants from 16 countries and comprised a series of expert presentations, open discussion and dialogue. The presentations and subsequent discussion identified the clear potential for a dedicated ENARD Annex to advance the current state-of-the-art in distribution systems' asset management.

The development of an authoritative international information and data base relating to the degradation and failure characteristics of distribution systems' assets was noted as a clear priority, supported by an enhanced understanding of such information, case study material and of the risk and consequence aspects.

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 the third in a 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 developed to address a wide range of issues associated with electricity transmission and distribution (T&D) systems. Annex I, which serves as the central information collation and dissemination Annex, 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 workshop was convened as a direct result of the ENARD Annex I experts' meeting in Milan, September 2006 and aimed to share experiences and to identify a range of key issues in relation to the management of ageing T&D asset bases. This would help identify the requirements for future actions in this area.

Specific workshop objectives included:

- review state-of-the-art in terms of the effective management of ageing T&D asset bases;
- identify principal methodologies and tools in current use, their applications, merits and limitations (asset specific and whole system);
- review techniques available to make full use of asset remanent life;
- learn from industry "best practice";
- assess implications of the above for network operation & performance and regulatory régimes;
- identify the requirements for future international collaborative R&D.

3 Workshop Structure and Programme

The workshop, organised in conjunction with the CIRED 19th International Conference and Exhibition on Electricity Distribution, was opened and chaired by John Baker, ENARD Annex I Operating Agent (EA Technology, UK).

The workshop comprised a series of expert presentations, followed by an open discussion aimed to elicit the key requirements for future developments in the area, which could potentially be addressed by ENARD.

4 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, generating a number of future scenarios for electricity distribution, including:

- a focus exclusively on core infrastructure business;
- the development of multi-utility service provider companies;
- smart/active networks;
- regulation to protect perceived customer interests.

Priorities for asset management related research in the distribution systems area were noted as:

- diagnostic and condition monitoring techniques, for lifetime estimation;
- risk based management techniques, including decision support methodologies, the role and contribution of KPIs, contribution to vulnerability assessments and development of support tools to handle incomplete data sets.

Investing in an Ageing Infrastructure
(Mr Mike Dixon, EDF Energy Networks, UK)

Mr Dixon introduced EDF Energy as a major player in the UK, with extensive electricity generation, energy supply and electricity distribution interests. EDF Energy Networks is the UK's largest Distribution Network Operator, servicing some 7.5 million customers and operating within Ofgem (the UK's regulatory regime) and the Department of Trade and Industry licence conditions. EDF Energy has an extensive asset portfolio. In common with large scale investment in the UK electricity industry in the 1960s and early 1970s, its distribution asset age profile is such that many of the assets are some 35 to 40 years old. Even with substantial current investments, a 30 year peak will remain. Examples of the asset management process were described in relation to 33 kV and 11 kV switchgear.

A series of generic risk areas were noted:

- Asset utilisation;
- Overhead line vulnerability;
- Ofgem's Information and Incentives Project (IIP);
- Asset condition;
- The environment;
- Protection Integrity; and
- Asset security.

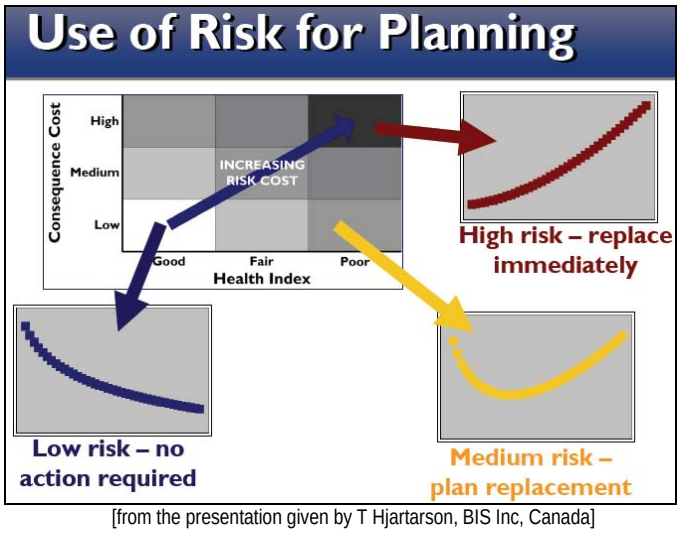
The Network Asset Management Plan is EDF Energy Network's essential document linking work programmes to business objectives. The plan includes both a 12 year forward projection and a rolling two yearly forward projection annual production plan, revised on an annual basis. Asset condition reports provide an essential contribution, with any deviations being managed via a rigorous change control process.

Asset risk management capabilities are being developed, including modelling and simulation methodologies, information systems and the accommodation of technological developments in network design strategy. Mr. Dixon particularly commended the 2004 British Standard PAS 55 (Specification for the Optimised Management of Physical Infrastructure Assets) as a yardstick for the establishment of "best practice" in the management of complex infrastructural asset bases, including those in the power distribution sector.

In closing, Mr Dixon noted that information was the key to successful asset management.

Program Planning Using Health and Risk
(Thor Hjartarson, BIS Inc., Canada)

Mr Hjartarson summarised his experiences, from a Hydro One Networks study with Dr Hughes, EA Technology in 2003, through to establishing his own business in January 2007. The Hydro One study covered the whole business planning process, based on a risk/impact methodology. Mr Hjartarson had since enacted some 20-30 projects based on the evolutionary development of a risk based approach to life cycle analysis.



[from the presentation given by T Hjartarson, BIS Inc, Canada]

He described three key elements in the process as below.

- *Stage 1: Health Indexing* - Determination of measurable End-of-Life criteria is an essential precursor to the derivation of Health Indices (HIs) for the various components of the asset base. Typical asset life curves, based on industry experience, manufacturers' data and specific experience can then be used to relate the HIs to probabilities of failure.

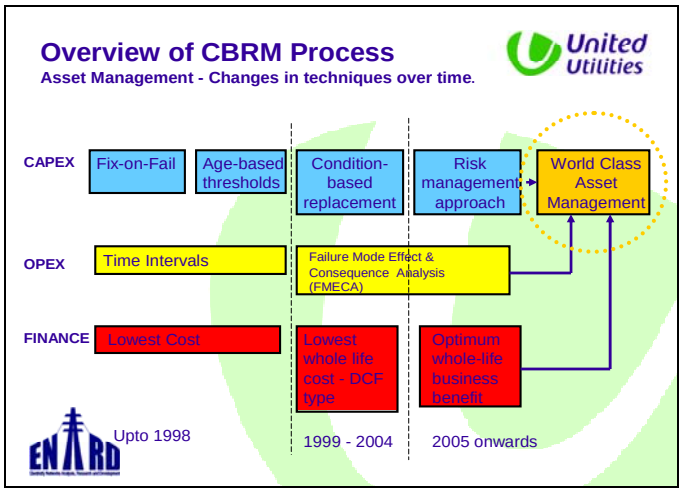
- *Stage 2: Consequence Cost* - The criticality of assets within a population, in relation to their consequences of failure, can be quantified in terms of costs. System reliability is an important consideration, with strict regulatory incentive and penalty measures in terms of overall system performance. The HIs can be mapped against the consequence cost of failure for the various asset types, to produce a risk matrix.

- *Stage 3: Risk Based Planning Process* - Optimised solutions can be developed, based on avoiding consequences by replacing assets just ahead of their impending failures. The overall forward expenditure programme for the distribution asset base can then be developed on a well-defined cost-benefit basis.

Results of a transformer case study and application of the technique in practice were also described.

Addressing the Challenge of Infrastructural Renewal
(Eddie Hamilton, United Utilities, UK)

Mr Hamilton summarised previous presentations, then introduced United Utilities which serves 2.3 million customers in the electricity distribution sector. The transition to risk based asset management progressed from a fixed life/fix-on-failure approach through to a CAPEX, OPEX and corporate finance-based approach.



[from the presentation given by E Hamilton, United Utilities, UK]

The evolution of the CBRM technique within UU was described, from a 2003 project with EA Technology involving the estimation of asset failure rates, together with the replacement and refurbishment requirement to maintain an acceptable failure level. CBRM was then developed and adopted into the company's business-as-usual operations, with enhanced asset information and data sets, field service personnel fully briefed on specific aspects of data collections and an overall increased understanding and quantification of the consequences of failure. This has delivered a series of benefits, including:

- A more robust and rigorous methodology;
- In-depth understanding of present and future asset base condition, performance and risk;
- Development of investment programmes;
- A systematic risk management philosophy.

Application of CBRM to painting and refurbishment of overhead tower lines was described, and the contribution of CBRM to the understanding of the asset base and its consequential management was recognised.

Understanding the Assets: Information, knowledge, experience – the key to successful asset management? (Dr David Hughes, EA Technology, UK)

Dr Hughes described EA Technology's 40 years of experience in electricity T&D systems and, in particular, the accumulated in-house knowledge and experience in degradation and failure characteristics of network asset groups. This led to the development of the CBRM technique which provides a methodology to quantify the current and future condition of network assets and their performance and risk, with different levels of investment. It has been extensively applied to the management of ageing asset bases, with some 20 implementations within Europe, North America, the Middle and Far East. The significant added value to be obtained through shared knowledge and experiences in the performance, degradation and ageing of the principal distribution asset categories was noted, with a significant pooling of information in such areas having already been achieved within the UK. In conclusion, the potential role of ENARD in extending this information base on an international basis was noted, addressing such facets as:

- Collation of End-of-Life (EoL) experience, and definition of EoL, for distribution assets;
- Determination of critical factors in relation to degradation and ageing;
- Typical asset lifetimes
- Availability of condition assessment techniques
- Identification of key ageing/failure indicators.

5 Open Discussion and Conclusion

A wide ranging open discussion followed, in relation to the opportunities available under ENARD for future collaborative work, with a view to advancing the state-of-the-art for asset management aspects of electricity networks. The discussion is summarised in table 5.1.

Table 5.1: Priority Areas for Future Collaborative Work

- Clear focus on distribution systems asset management aspects;
- Aim to develop a larger and more robust information base in relation to the ageing, degradation, failure and EoL characteristics of distribution systems assets ("quality data");
- Develop detailed understanding of (a) risk based definitions and methodologies, and (b) appropriate "key performance indicators" and their application between strategic and component level;
- Develop a complementary understanding of consequence cost and its evaluation, including the application of "net present value" methodologies;
- Source, collate and analyse case studies for regulated and un-regulated operational scenarios;
- Cross reference and compare the above with transmission system assets (e.g. ITOMS, Nordel);
- Distil all the above into a comprehensive and in-depth understanding of cost effective distribution systems asset management, to apply in practice.

The workshop concluded by reaching consensus on the value of a future collaborative work programme addressing the above considerations.