

Smarter Electricity Grids for Competitive Markets

An interview with

John Baker, Annex I Operating Agent, IEA Implementing Agreement on Electricity Networks Analysis, Research and Development (ENARD)¹

Barely six months since it officially joined the ranks of IEA international collaborative energy technology R&D programmes, ENARD is contributing energetically to the knowledge and solutions essential for modern, equitable, resilient electricity transmission and distribution (T&D) networks. Operators and governments around the globe face some tough challenges, calling for innovative operating procedures, architecture, methodologies and technologies to serve citizens around the world with reliable, affordable electricity.

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Many of us have memories of recent major power blackouts. How could smarter technology in transmission and distribution have limited the damage?

John Baker

Clearly, the provision of enhanced security of supply is consistent with the IEA's core policy objectives and ENARD's remit to address the 3Rs of power systems development, namely network renewal, renewables integration and network resilience.

On network resilience, we have already heard from our early experts' meetings, workshops and associated sources that innovative developments are possible to limit the spread and impact of major blackouts.

Technology certainly has a big part to play in mitigating the impact of blackouts. However, technology can only contribute effectively if it is deployed and utilised appropriately; the provision of meaningful, reliable and timely information and data is an essential prerequisite for any substantial investments in purely technological solutions.



John Baker
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¹ ENARD is one of some forty international IEA Implementing Agreement energy technology R&D programmes operating within the IEA's collaborative framework.

Developments in the information and communication technology infrastructures (ICT) are therefore required to accommodate changing scenarios in terms of electricity trading, long-distance power flows, increasing competition and the accommodation of increasing penetrations of distributed resource.

Wide Area Management Systems (WAMS) represents one such supporting ICT which is likely to enhance the reliability of extended power transmission networks, via their provision of phasor measurements over a wide area to provide advance warning of instabilities and incipient voltage collapse.

As for other technological contributors, complementing developments in the ICT infrastructure, the role and potential of microgrids – or cells – in providing a degree of autonomy from the T&D infrastructure is being studied with interest in a number of countries. Under normal operation, microgrids could offer the potential for matching supply and demand on a localised basis and thereby facilitate the integration of renewables and other distributed resources. Under abnormal operating conditions, and in the event of total or partial collapse of the main transmission system, such microgrids could disconnect from the main T&D infrastructure and maintain security of supply on a localised basis.

Developments in the core power engineering technologies themselves will also have a key role to play in enhancing the reliability and resilience of T&D networks. Here, we are watching developments in such key technological areas as energy storage, superconductivity, FACTS (flexible AC transmission systems) and HVDC (high voltage DC) with keen interest.

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What about the human factor? Can we say that the liberalisation of electricity markets has changed the way that people operate the system? In what ways can better technology improve crisis management?

John Baker

Certainly, even the best technologies in the world are unlikely to be effective unless we also consider human factors. Indeed, some of the key lessons learnt from the blackouts in more recent times relate to the interaction between control room operators and their information and data inputs and, in particular, the interpretation by the operators of the events happening around them.

More generally, however, electricity market liberalisation has fundamentally impacted on the operation of electricity systems, to the extent that systems are now routinely expected to operate far closer to their design limits, whilst also producing a meaningful financial return to their owners, and within the prevalent regulatory frameworks.

Almost without exception, we have seen manning levels reduce very significantly amongst the T&D owners and operators, in parallel with market liberalisation and privatisation. We are also seeing a steadily ageing workforce, in which smaller teams are increasingly required to

cope with the very considerable challenges in the sector, not least of which is the accommodation of growing amounts of renewable and distributed resources. Active network management and network automation are two current measures to enhance the performance of distribution systems in this respect, along with the necessary improvements I have already mentioned in ICT infrastructures and systems to enhance crisis management.

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Existing grid infrastructure often dates back several decades, pointing to the acute need for investment. What do you regard as the major challenges faced in making investment decisions, notably for integrating new automation and control arrangements into existing grid structures?

John Baker

Investment is certainly very important since T&D infrastructures in many of the OECD member countries are typically some 40 to 50 years old.

Our inaugural ENARD distribution systems experts' meeting, held in Milan in September 2006, identified two key themes in relation to power distribution systems: first "here and now" issues in relation to today's networks; and, second, issues in relation to "new" systems, or tomorrow's networks.

The management of an ageing infrastructure was identified as a priority area for today's networks. Key supporting elements here include condition monitoring, lifetime estimation and the application of risk-based methodologies. We picked up on these themes at our workshop on this subject held in conjunction with the CIRED international conference in Vienna on 21st May 2007.

Similarly, the development and integration of active network management measures, control and automation have all emerged as key priorities for tomorrow's networks; the present ageing infrastructure provides the opportunity to adopt such measures as part of overall network renewal strategies. Our workshop on Distributed Generation (DG) System Integration, held in Vienna, March 2007, succeeded in establishing the basis for a proposed new Annex in this area.

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

ENARD was established in 2006 to address issues involved in the development, design, operation and performance of electricity networks at the integrated system level. ENARD's vision is to facilitate the uptake of new operating procedures, architectures, methodologies and technologies in electricity T&D networks that can enhance their overall performance in relation to the developing challenges of network renewal, renewables integration and network resilience.

The ENARD programme brings together: Austria, Belgium, Denmark, Finland, Italy, Netherlands, Norway, Sweden, Switzerland and the United Kingdom.

The new ENARD Annex will address a range of complementary technological, market and regulatory issues and elicit the key lessons learnt from a series of international case studies. The increased penetration of distributed generation and the consequential requirement to accommodate, and preferably to integrate, such smaller and distributed power sources within the network clearly presents a whole series of challenges to the distribution engineer. This will undoubtedly require a transition from today's passive distribution networks to future active networks in which advanced automation and control measurements will contribute increasingly to network performance and to realising the potential of distributed generation in terms of system support and network development. The March 2007 workshop in Vienna noted that key enabling technologies to advance such developments would include energy storage, demand-side management, dynamic operation of electrical plant, FACTS, current limiters and solid state substations. The distributed generation issue will be addressed once again at the 13-14 June workshop in Leuven, Belgium, on Economic Regulatory and Market Issues Associated with the Incorporation of Variable Generation. We are organising this event jointly with the IEA Renewable Energy Technology Deployment Implementing Agreement programme (RETD).

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Now that energy markets are more liberalised, the trend is towards increasing cross-border flows of electricity. How does this affect service to customers and what measures might prove necessary to maintain high standards?

John Baker

Increases in cross-border power flows constitute another emerging trend in today's electricity markets that is increasingly exercising the minds of Transmission System Operators (TSOs). To a growing extent, TSOs are having to cope with long-distance power trades and also with the scenario where reserve plant may be more and more remote from the principal demand centres. Transmission over such long distances can lead to excessive voltage drops, especially where grid capacity and reactive power reserves are limited. Furthermore, the greater inter-connection observed between national transmission systems means that causal events in one country can impact across national boundaries and affect customers far removed from the original event.

Accurate security analyses are therefore increasingly required, as transmission networks are operated far closer to their design limits. Advances in the ICT infrastructure are also needed, to provide system operators with accurate and timely information and data. We have already noted the potential in this latter area of WAMS, which can provide enhanced wide-scale situational awareness. Further attention needs also to be focused on enhanced provision of reactive power for system stability and the early damping of low frequency oscillations in inter-connected power systems. Our forthcoming transmission systems workshop, to be held in Trondheim, Norway in September 2007, will aim to address these and related considerations, with a view to identifying the requirements for collaborative R&D in this area, via a dedicated ENARD Annex.

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Is there a danger that technical incompatibility between network equipment and practices might stand in the way of the free play of market forces in network technology purchases? If so, what do you see as the solutions.

John Baker

This could certainly be a very real issue and it is an area in which international collaboration via the IEA can make a real contribution. If we generalise in terms of three principal economic regions (Europe, North America and Asia-Pacific), then we clearly have the potential to compare, contrast and learn from international best practice. We would aim to complement - and contribute to - the work of the relevant standards-making organisations here, including the International Standards Organisation (ISO).

ENARD has also identified its potential contribution in terms of electricity networks in developing countries and would hope to support the IEA in pursuit of its Gleneagles G8 objectives in this area.

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Can system operators help customers to be more energy efficient, or are they too remote from the actual point of use?

John Baker

Electricity market unbundling has effectively served to separate out the generation, transmission, distribution and supply functions of the overall electricity supply chain. The promotion and delivery of customer end-use energy efficiency measures falls principally in the remit of the supply side functionality, since T&D operators are somewhat removed from this side of the business.

However, the converse can yield significant benefits to T&D network operators, with demand management measures having a clear role to play in relieving network capacity constraints and integrating variable renewables resource. We would envisage working closely with our colleagues in the IEA Demand-Side Management Implementing Agreement in these and related areas.

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Thank you, John Baker, for sharing your views with us.

John Baker

It has been my pleasure.