

Planning and Optimization Methods for Active Distribution Systems

This Technical Insight article is based on the 2014 publication of WG C6.19 Technical Brochure 591.

Background

Distribution Network Operators (DNOs) have started to evolve their traditional passive networks towards more actively controlled systems. This is driven by a number of factors including the increasing penetration of distributed energy resources (DERs); load growth; the requirement for improved efficiency, security and quality of power supply; and the liberalisation of the electricity market. A shared global definition of Active Distribution Systems (ADSs) has been developed by CIGRE:

ADSs are distribution networks that have systems in place to control a combination of generators, loads and storage (collectively termed DERs). DNOs have the possibility of managing electricity flows using a flexible system topology. DERs take some degree of responsibility for system support and this is facilitated by a suitable regulatory environment and connection agreements.

Overview of CIGRÉ Working Group (WG) C6.19

The objective of this WG was to assess the various requirements to facilitate the transition towards active distribution systems, specifically focusing on planning and optimisation methods for ADSs. The following taskforces were created and their outputs are summarised:

Taskforce 1: A survey was conducted to review planning and optimization tools used by different DNOs around the world. It was found that current planning processes rely heavily on data related to customers' usage and city planning to form accurate load forecasts. Demand-side integration and ADS concepts are not yet being rolled out within Business-as-Usual operations by utilities.

Taskforce 2: Its aim was to illustrate how the traditional approaches used in distribution planning are arguably no longer fit for the present purposes. Business cases were used to highlight the bottlenecks and limitations in existing planning procedures and the future needs.

Taskforce 3: A general framework for modern planning tools was defined. This integrates ADS solutions in the set of feasible alternatives in order to identify the best balance with traditional network reinforcement.

Taskforce 4: It was identified that ADSs will be more complex to plan and operate in comparison to traditional networks, mainly due to the integration of information and communication technology (ICT). Therefore, system planners will need adequate resources to properly design and evaluate ADSs to achieve maximum exploitation of existing assets.

Taskforce 5: The aim was to understand the impact of Demand-side Integration and storage on the planning of ADSs. It is necessary to include these options as possible solutions for network optimization to make better use of network capacity and gain better reliability.

In addition, the business case for the transition from passive to active distribution systems was presented. This process considers the reasons for ADS transition, business options, expected benefits and drawbacks for different stakeholders, timescales for the transition and for realising the benefits delivered by ADSs.

Conclusions and Recommendations

Planning and operation can no longer be considered as separate tasks and need to be interactive. Planning engineers need to develop tools with time-dependent and probabilistic models to deal with the uncertainties during operation. To meet network planning requirements, risk-oriented methodologies need to be developed, which move beyond current deterministic most-onerous cases.

ICT is becoming an integral part of power system planning processes. Co-simulation of both power and ICT system components needs to be integrated into reliability and risk studies. Data analytic techniques need to be developed to support network operators in their efforts to manage and extract value from volumes of 'big data'.

Relevance to UK

Due to environmental pressures and in order to meet the target of an 80% reduction in greenhouse gas emissions by 2050, the UK is integrating increased numbers of low-carbon technologies (LCTs) into its electricity networks.

Research, Development and Demonstration:

Through government and regulatory funding incentives, many research, development and demonstration (RD&D) projects are underway to facilitate the integration of LCTs:

- The Department for Energy and Climate Change (DECC) is promoting this innovation through mechanisms such as the [Low Carbon Innovation Co-ordination Group](#). In addition, the Government and Ofgem are supporting the transition to smart meters through a [Smart meter roll-out programme](#) (incorporating the installation of 53 million smart meter devices in households by the end of 2020).
- The [Smart Grid Forum](#) was created by the DECC and Ofgem to support the UK's transition to a secure, safe, low carbon, affordable energy system.
- In Distribution Price Control Review Period DPCR5 (2010 – 2015) the [Low Carbon Networks Fund](#) (LCN Fund) has provided up to £500m to support projects sponsored by the DNOs, to demonstrate new ADS technologies.
- The Energy Networks Association (ENA) [Smart Networks Portal](#) acts as a repository for innovation projects, promoting the sharing of knowledge and experience. This encompasses electricity and gas sector innovation projects at both transmission and distribution levels.
- Moving forwards into RII0-ED1 (2015 – 2023), Ofgem has introduced a number of innovation mechanisms, including the [Network Innovation Competition](#) for electricity companies to compete for funding and demonstrate new technologies, operating and commercial arrangements.

CIGRÉ: A bilateral knowledge exchange forum

The utilisation of LCTs is paving the way for a low carbon economy in the UK. However, a number of challenges need to be addressed by network operators, policy makers, regulators and energy business.

Technical Brochure 591 provides interested parties with tools and international case studies to address the challenges faced by DNOs in their efforts to integrate increased numbers of LCTs. ADSs allow DNOs to accommodate LCTs in a cost-effective way by deferring, or even avoiding, significant network reinforcement, thereby overcoming barriers (such as obtaining planning consents for new electricity infrastructure). The planning tools and optimization techniques could be of interest to Transmission System Operators (TSOs) too, when dealing with the integration of LCTs.

CIGRÉ provides a forum for disseminating to the international community the wealth of knowledge and experience (being accrued in the UK through the 'hands on' delivery of innovation). Moreover, the UK can benefit greatly from the knowledge and experience gained by other countries, where LCTs and ADSs have already been successfully developed and demonstrated.

Further Reading

CIGRÉ: [Electricity supply systems of the future](#) (2010) and WG C6.11 TB 457: [Development and operation of Active Distribution Networks](#) (2011)

ENA: [Assessing the Impact of Low Carbon Technologies on GB's Distribution Networks](#) (2012)

IET: [Electricity networks - handling a shock to the system](#) (2013) and [What is a Smart Grid?](#) (2013)

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Find out more...

Founded in 1921, CIGRÉ, the Council on Large Electric Systems, is an international non-profit association for promoting collaboration with experts from all around the world by sharing knowledge and joining forces to improve the electric power systems of today and tomorrow.

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