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An Overview of the Smart Grid in Great Britain

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1. Introduction

The consensus among climate scientists is clear that human-made greenhouse gases (GHGs) are leading to dangerous climate change. Hence, ways of using energy more effectively and generating electricity without, or with limited, production of GHG must be found [1].

In the United Kingdom (UK), the power sector is currently the single largest source of GHG emissions, accounting for 27% of the total [2]. By 2050, emissions from the power sector need to be reduced to close to zero. In Great Britain (GB), the anticipated future decarbonized electrical power system is likely to rely on generation from a combination of renewables, nuclear generators, and fossil-fueled plants with carbon capture and storage (CCS) [2]. This combination of generation is difficult to manage as it consists of variable renewable generation, and large central generators that run at a constant output for both technical and commercial reasons. Meanwhile, the demand for electricity, with the potential electrification of heating and transport, will become more variable. As a result, the power system will need to become smarter at balancing demand and supply. Smart grid is widely recognized as the future of modern electrical power systems. It involves modernizing existing networks, changing the way they operate, facilitating changes in the behavior of energy consumers, providing new services, and supporting the transition to a sustainable low-carbon economy [3].

The UK has made significant progress to date in deploying smart grids and has made a considerable investment in smart grid research and demonstration projects. These projects have been delivered through a range of initiatives, including the Office of Gas and Electricity Markets (Ofgem) price control model, which places great emphasis on supporting network innovation; and the creation of the £500 million Low Carbon Networks Fund (LCNF) and its successor, the Electricity Network Innovation Competition (ENIC). These competitions provide funding for network companies to undertake innovation projects and try out new smart grid technologies and solutions. More limited funding for innovation is available to network companies through the Network Innovation Allowance (NIA) [4] and the previous Innovation Funding Incentive (IFI). GB has also begun the nationwide installations of smart meters, which will help to improve network management and facilitate demand reduction and shifting.

Various actors are involved in the development of the smart grid in GB, including the government (Department of Energy and Climate Change, DECC), a national regulatory authority (Ofgem), network companies, equipment manufacturers, and academia. This paper presents the current status of the development of the smart grid, the roles these actors have played in the past few years, the focus areas and achievements to date, and future work that needs to be undertaken to deliver a low-carbon smart grid. The learning from this work will provide valuable guidelines for future smart grid development in GB and other countries.

Smart grid definitions

The future power system is expected to make extensive use of modern information and communication technologies (ICT) to support a flexible, secure, and cost-effective decarbonized electrical power system. A smart grid is capable of controlling active networks intelligently to facilitate the integration of renewable energy into the power system [5].

Various definitions of the smart grid have been used by different countries across the globe and no single universal concept has been agreed on. This paper presents two definitions that are often used in GB.

The concept of the smart grid, developed in 2006 by the European Technology Platform, is:

A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic