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# Sources of risk and uncertainty in UK smart grid deployment: An expert stakeholder analysis

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ABSTRACT

The shift to increasingly smarter grids will require preparation and planning on the part of a diverse selection of current and future stakeholders. There are substantive sources of uncertainty that will impact on the adoption of smarter grid solutions. Risks and uncertainties are placed in one of seven categories: markets, users, data and information, supply mix, policy, investment conditions, and networks. Each of these has the potential to add risk to the planning profiles of the stakeholders involved. Here, UK stakeholders drawn from industry, government, regulators, and academia are canvassed about potential sources of uncertainty within the UK's electricity sector and the attendant risks that might be engendered by them.



## 1. Introduction

This paper is concerned with a qualitative discussion of the many sources of uncertainty concerning the development of a smart grid (SG) provision within the UK's electricity industry. It builds on previous work to identify key issues likely to impact the need for a smarter grid, the most likely influencing factors for demand and to set out concerns arising from industry stakeholders. We use the definition of SG suggested by the Smart Grids European Technology Platform: "electricity networks that can intelligently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies" [1].

This work synthesises knowledge from in-depth expert interviews and online surveys forming part of a UKERC funded project to produce scenarios for the development of SG in the UK. The scenarios [2] are the culmination of a multi-stage process and have been used to inform the national debate about drivers, barriers, and uncertainty of SG deployment. A key area of the process was the identification of the principal elements of uncertainty and attendant risk arising from the many variables inherent to SG which will be, to a lesser or greater degree, emergent. Questions have been raised about the uncertainty of the potential benefits and risks of unforeseen issues for SG [3]. It was clear from the interviews in particular that an extended discussion of these risks was warranted, and that risk and uncertainty need to explicitly inform the considerations that underlie development and application of energy policy and regulation. This paper aims to fulfil this gap by analyzing previously unpublished data from this project with a particular focus on risk and uncertainties arising from the UK context.

There have been very few broad assessments of the risks for the development and deployment of SG. For example, although Rossebø et al. [4]; assessed many sources of risk, their analysis concentrated on operational parameters expected to be important. In their modelling, Zio and Aven [5] explicitly recognized investment, environmental and energy policy, and technical issues. Digmayer and Jakobs [6] conducted a study of experts and laymen into the risks associated with innovation in direct current grids. The risk categories identified by Digmayer and Jakobs were technical, health-related, economic, environmental, privacy, infrastructure,

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and landscape-related, approximately 80% of the risks referenced were technical. Lastly, Tuballa and Abundo [7] review some elements of the deployment of SG.

The UK energy policy environment relating to carbon reduction and renewable energy deployment is strongly influenced by EU commitments, though selection of instruments rests with the UK. Security is primarily a national concern, while social issues such as fuel poverty have both national and wider influences. Security of supply has become significant in shaping the UK generation mix and this significance will continue to grow while old coal and nuclear capacity are removed from the mix and the Government attempts to incentivise sufficient new capacity to meet demand. This will be partially met by new renewable capacity. EU policy requires 20% of energy consumption to come from renewables by 2020 and the UK agreed an ambitious and legally obligatory target of 15%. It is not clear what happens if any Member State fails to achieve their target [8] though substantial fines cannot be ruled out. Clearly the negotiated exit of the UK from the EU is likely to impact substantially on the UK's commitments and any consequences. A newer EU wide goal of 27% for 2030 is not a legal obligation but may pressure continuing increases at the national level [9]. It is not currently clear how the result of the UK referendum on leaving the EU will impact the UK's position. The UK has seen steady growth in generation from renewable energy sources of electricity (RES-E), particularly onshore and offshore wind and solar [10] and this is expected to continue, with a widening diversity of sources over time. Decarbonisation of heat and transport via electrification may require a shift to greater electrical demand, impacting on overall demand and demand volatility. The government and regulator have acknowledged the challenges of integrating these technologies into networks and markets and the need for new approaches to network management.

All GB distribution networks are owned by six distribution network operators (DNOs). UK DNO R&D expenditure declined steadily following privatisation in 1990. The continued evolution of policy and the emergence of a requirement for decarbonisation saw Government and Ofgem come to view this as unacceptable in the face of the challenges now faced for continued provision of reliable, secure and low carbon energy delivery [11–14]. This has led to a number of policy initiatives to provide new incentives for investment.

The need to adopt new technologies and new approaches, potentially in different locations for generation, network management and supply and provided by existing companies and perhaps new market entrants creates substantial new sources of uncertainty for all stakeholders. This paper explores these uncertainties with a view to identifying the most important concerning future risk relating to solving the energy trilemma via smart methodologies.

## 2. Methodology

We used a multi-step process as part of a wider programme of work carried out to inform the development of SG scenarios for the UK [2]. An extensive initial literature review highlighted many areas of uncertainty and the specific issues arising from them [15]. A list of UK stakeholder institutions was derived representing regulators, consumers, and network operators. Eighteen semi-structured interviews were conducted with experts representing these key organisations to identify emerging issues and those factors thought to be the most important in shaping UK SG development. The interviews fed development of a two-stage stakeholder online survey ($n = 77$, $n = 44$); broad characteristics of the participants are given in Appendix A. We used a ranking system to identify the factors considered to be most important in characterising UK SG development. A Delphi Policy process [16] identified the key transition points, with results checked for credibility at an expert workshop with fifteen participants [17]. The entire programme was overseen by an expert advisory group comprising ten participants.

The interviews inform the writing throughout this paper and their content was added to during the following stages of the applied methodology. The nature of the process, drawing on additional information to add to a larger model, means more quantitative assessments using tools such as NVivo is less appropriate since it would tend to militate against factors emergent in the latter part of the process. The quantity and scope of the data collected means that we focused on the main points arising from the whole process, with the later elements of the method enabling us to select for perceived importance from expert stakeholders.

While there it is always possible to overlook or misunderstand important information, considerable effort was made to capture the widest possible information set, with stakeholders asked to add to the list of considered factors at every stage. A framework to organise the information was required as part of the scenario development process [2] following the interview stage. Using information from our literature review and the interviewees, and the views of our expert advisory group, we developed a classification system as follows: markets, users, data and information, supply mix, policy, investment conditions, and networks. This represents the most important categories identified by the stakeholders. These seven groups were a convenient way of ensuring consistency through the whole programme and we use them here for categorisation. Many issues overlap categories and the categories should not be seen as silos in this approach. Four cross-cutting issues emerged, and these are introduced first to assist with laying out the evolving situation in the UK electricity sector.

While our method identified and ranked the areas considered most important for dictating the likely direction of UK SG development to 2050, we qualitatively describe the wider range of possible sources of uncertainty and the potential risk arising from them.

## 3. Risks raised by stakeholders

Independent of whether the interviewees and survey respondents considered an issue to be a driver/barrier or benefit/pitfall of SG development, each has associated uncertainty. This implies risk when companies are making decisions about investing in new capacity, management or in bringing new services or technologies to market. The meanings of our seven groups, whilst widely applicable, are conceived in the context of the SG scenarios developed by Balta-Ozkan et al. [2]. We discuss the cross-cutting issues first, then summarise the key risks, and their associated uncertainties and drivers in Table 1.

## 4. Cross-cutting issues

Four issues were mentioned in multiple risk groups and warrant being discussed separately from the categories discussed below.

### 4.1. The broken value chain

The potential costs and value of smarter energy systems may be distributed across many stakeholders. However, it is not always clear which stakeholders will benefit from which actions and how value might be assigned [18]. This is a type of 'split-incentive' problem with the UK smart meter (SM) roll-out a prime example. Suppliers are bearing the cost for SM, but the usefulness to suppliers is largely limited to automated collection of consumption