Energy Policy 115 (2018) 397–408

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Do energy scenarios pay sufficient attention to the environment? Lessons from the UK to support improved policy outcomes

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ARTICLE INFO

Keywords:
Energy
Environment
Scenarios
Policy
UK

ABSTRACT

Scenario development is widely used to support the formation of energy policy, but many energy scenarios consider environmental interactions only in terms of climate change. We suggest that efforts to develop more holistic energy pathways, going beyond *post hoc* analysis of environmental and social implications, can usefully draw on environmental scenarios. A detailed content analysis of UK energy and environmental scenarios was therefore undertaken, with energy scenarios selected on the basis that they were recent, had a direct link to energy policy, and covered a range of scenario types. The energy scenarios rarely considered societal drivers beyond decarbonisation and focused on quantifiable parameters such as GDP, while the environmental scenarios provided a richer narrative on human behaviour and social change. As socio-economic issues remain fundamental to the success of energy policies, this is a key area which should be better addressed within energy scenarios. The environmental impacts of energy scenarios were rarely considered, but could have a significant bearing on the likelihood of pathway outcomes being realised. Fuller evaluation of the environmental interactions of energy systems is therefore required. Although the analysis focuses on the UK, some international scenarios show similar limitations, suggesting that the conclusions are more widely applicable.

1. Introduction

There is growing international momentum to reduce carbon emissions and mitigate the effects of climate change, with the Paris Agreement enshrining the aspiration to limit global temperature increase to 1.5 °C above pre-industrial levels (UNFCC, 2015). In parallel, the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) and initiatives such as the Aichi Biodiversity Targets (Convention on Biological Diversity, 2012) and the Millennium Ecosystem Assessment (MEA, 2005) seek to mainstream the importance of biodiversity and ecosystem services within policy at international, national and regional levels. The UK has been a global leader across these domains by establishing a legally binding set of carbon budgets and targets (Committee on Climate Change, 2015a), and in the integration of ecosystem services within policy development informed by the UK National Ecosystem Assessment (2011). As such we focus on the UK as an exemplar to explore integration of energy and environmental scenarios in policy development. Therefore, whilst the focus of this paper is on the UK, there is an important opportunity to learn lessons for scenarios that focus on other countries.

National policy decisions are commonly informed by energy scenarios (Berntsen and Trutnevyte, 2017), and this has been particularly the case in the UK over the past decade. The 2008 Climate Change Act established a long-term target for the decarbonisation of the UK economy, to be achieved by a set of diminishing five-year 'carbon budgets' between 2008 and 2050. This statutory combination of long-term change and step-wise progression has encouraged the proliferation of quantitative energy scenarios in the UK since 2008, with energy policy development informed particularly by scenarios produced by the government's official advisory body, the UK Committee on Climate Change (CCC) (Winskel, 2016).

Scenarios are defined as a postulated sequence or development of events, and can be either explorative (considering the evolution of possible futures from a pre-set storyline) or normative (exploring ways to achieve a specific future objective), with intermediate approaches also possible (van Vuuren et al., 2015). Scenario development allows

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https://doi.org/10.1016/j.enpol.2018.01.028
Received 12 June 2017; Received in revised form 9 January 2018; Accepted 12 January 2018

for the consideration of alternative futures and their evolution from the present, and thus provides insights into the decisions required in the near-term (Hughes, 2009). UK energy scenarios typically focus on decarbonisation, energy security, investment requirements and affordability (the 'pillars' of the energy trilemma) (DECC, 2014); they consider the whole energy system or discrete elements of it; they have been commissioned by academia, industry, the Government and Non-Governmental Organisations; and they use qualitative and quantitative approaches (Trutnevyte et al., 2016; McDowall et al., 2014; Holland et al., 2016a; Skea et al., 2011). Fulfilling these combined objectives set by multiple actors presents an enormous challenge, not least as there is considerable uncertainty about energy futures, particularly for the longer-term time horizons to 2050 and beyond.

However, despite this range, almost all energy scenarios considered in recent reviews (Trutnevyte et al., 2016; McDowall et al., 2014; Holland et al., 2016a) have in common (by the nature of the questions they have been conceived to address) a relatively narrow consideration of environmental consequences beyond those associated with greenhouse gas emissions. The *post hoc* evaluation of the environmental implications of energy pathways does take place both in the UK and internationally, for example for pollutant emissions and water use (Howard et al., 2011), in terms of effects on biodiversity (BIO by Deloitte, IEEP and CEH, 2014) and through Life Cycle Assessment (Hammond et al., 2013). However, this is rarely an integral component of the scenario development itself. Limitation of energy scenarios to considering one environmental externality, greenhouse gas emissions, seems short-sighted especially in light of other legal obligations and international commitments on, for example, biodiversity.

Also, failure to consider the broader environmental consequences of energy futures brings the risk that the pathways described may have negative environmental consequences or may miss opportunities to deliver ancillary environmental and social benefits (Holland et al., 2016a). Thus, the credibility of the pathways produced may be undermined, the underlying assumptions of the energy models may be brought into question, or pathways may be generated that are unrealistic in practice. A recent example of the unintended impacts of narrowly defined, decarbonisation-focused energy policy was the UK Government's prioritisation of carbon emissions reduction as the primary mechanism for sustainable mobility, which incentivised the purchase of diesel vehicles and led to increases in air pollution (Brand, 2016; Skeete, 2017).

A further limitation of *post hoc* assessment is that the analysis is almost invariably undertaken later, and by a separate agency. This means that the two-way interactions between energy systems and environmental systems are not taken fully into account in such cases; *post hoc* analysis considers the impact of energy systems on the environment but not how environmental factors enable or constrain the future development of energy systems. *Post hoc* analysis many not be comprehensive and is likely to have weaker policy impact than a more holistic approach in which wider environmental and social concerns are addressed directly during the development of energy pathways.

An 'energy only' approach may also not reflect emerging governance practices. Already within the UK, the Government's industrial strategy green paper (HM Government, 2017) is explicit on the need to reconsider its approach to the energy 'trilemma' and to place greater emphasis on the affordability of energy and the economic growth potential of the low carbon sector in developing its policies for addressing climate change. In addition, UK energy policy does not reflect the rise of integrative and holistic policy and research framings which bridge across food, water and climate (Cairns and Krzywoszynska, 2016). This concept of nexus thinking has emerged as a means of building synergies across different sectors and transcending traditional policy silos (Sharmina et al., 2016). Water, energy, and food have been at the core of nexus concepts (e.g. United Nations, 2014), with increasing calls for wider environmental and socio-ecological considerations to be incorporated within the paradigm (de Grenade et al., 2016).

Closer integration of energy and environmental scenarios has been proposed as one route to ensuring that energy strategies take account of broader environmental, economic and social objectives (Holland et al., 2016b). In order to explore the potential of such integration in the development of energy policy, we have undertaken a detailed analysis of UK energy and environment scenarios encompassing a broad range from those based on quantitative modelling through to qualitative studies. We have focussed primarily on the development of 'whole systems' pathways, as these are most appropriate in the context of the development of national energy policy. We examine the key features of the scenarios and assess their commonalities, differences and the consistency between them. In particular, we discuss the lessons that can be learned from the environmental scenarios, and conclude with recommendations for the development of future energy scenarios.

2. Method

2.1. Scenario selection

The analysis considered eight scenario sets: three of which explored the possible response of the natural environment to broad societal change, while five focused on the future energy landscape (Table 1). A 'scenario set' is defined here as the overarching study, within which there may be multiple individual scenarios. There are many scenario sets that propose relevant scenarios; Holland et al. (2016a), for example, identified six environmental and 13 energy scenario sets for the UK. In this analysis, only a subset of these were considered in order to permit detailed assessment to be carried out.

Three environmental scenario sets were selected, those prepared by the UK National Ecosystem Assessment (UKNEA; Haines-Young et al., 2011), UK Climate Impacts Programme (2001), and Natural England (Creedy et al., 2009). These were chosen because they scored most highly in Holland et al. (2016a) in terms of the level of detail of their coverage of environmental issues and energy systems, as well as the broader definition, scope and robustness of the approach (with the most robust approaches defined as those with a clearly documented method likely to produce rigorous outputs and representing best practice).

The priority in selecting UK scenario sets for energy was to include the most recent scenarios, and particularly those with a direct link to UK policy development. Within this overarching aim, additional criteria were to include a range of scenario types, and to ensure representation from three different sectors whose work can influence energy policy: agencies who advise the UK Government directly, the energy industry, and academia. The scenarios selected to represent these three sectors were: i) the Fifth Carbon Budget (Committee on Climate Change, 2015a, 2015b) produced by the UK's statutory advisor to government on carbon emissions in relation to the possible means of achieving legally binding targets; ii) the National Grid (2015) scenario set developed by the national system operator to consider the future demands on electricity and gas transmission networks; and iii) scenarios produced by the UK's national academic centre for energy research (the UK Energy Research Centre) that explore options for the future of natural gas (McGlade et al., 2016).

Holland et al. (2016a) identified additional UK energy scenarios (ETI, 2015; Tran et al., 2014; Ekins et al., 2013; Foxon and Pearson, 2013; DECC, 2011; Ofgem, 2009; and Foresight, 2008). These were not selected for this analysis, as they generally pre-dated our chosen scenario sets. ETI (2015) is also a recent scenario set produced by the industry sector, but the National Grid scenarios were selected in preference due to their more comprehensive coverage of the whole energy system and their closer links to investment decision making in the UK energy sector.

A further objective of the analysis presented in this paper was to consider a broad range of energy scenario types, and so two further sets of scenarios have been analysed. The three scenario sets described above (the Fifth Carbon Budget, National Grid and UK Energy Research