Futures 55 (2014) 41–57

Contents lists available at ScienceDirect

Futures

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

Integrated scenarios for energy: A methodology for the short term

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ARTICLE INFO

Article history:
Available online 22 November 2013

Keywords:
Scenario
Forecast
Energy
Carbon emissions
Short-term
Integrated

ABSTRACT

Quantitative point forecasts of energy and carbon emissions have experienced difficulty with responding to uncertainty. Accuracy issues arise even in the short term with consequences for policy. The technique of scenario analysis is increasingly applied in scientific inquiry on the long term but it also has utility in the short term. This paper presents a discussion of the use of forecasts for prediction and proposes integrated or 'hybrid' exploratory qualitative and quantitative scenarios in its stead. Various methodological issues are explored towards formulation of a scenario development process. Integrated scenarios structure thinking on the future, bound uncertainty, document important assumptions, aid communication, widen perspectives, can explore new dynamics and permit exploration of 'softer' issues in development paths such as governance, social and cultural drivers. These can be crucial to outcomes but are not captured by quantitative approaches alone. An example of the technique employed to construct integrated scenarios for Ireland to 2020 is presented, which as a process is applicable with diverse quantitative techniques. The advancement of more broad holistic perspectives on development and processes of change is policy relevant in all states, for which purpose integrated scenarios are an ideal analysis and mainstreaming tool even on short time scales.

> Trying to predict the future is like trying to drive down a country road at night with no lights while looking out the back window.
>
> -Peter F. Drucker

1. Introduction

Energy and emissions analysis, the development of policy and the reporting of progress require insight into driving forces of change and potential future evolution. Energy and emissions are both dependent on, and influenced by, a wide development domain which is complex in evolution and uncertain in outcome. Conceptual, theoretical, methodological, empirical and praxis issues arise with all techniques proposing insight into the future. Because of the monopoly of short term point forecasts and projections in these tasks, issues of accuracy are of much concern. There is evidence of significant

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http://dx.doi.org/10.1016/j.futures.2013.11.002

problems with these approaches which nonetheless continue to dominate with inevitable consequences for policy. This paper has a methodological focus, discussing the use of point forecasting as a predictive tool for the short and medium term and innovates by proposing the hybrid exploratory scenario approach in its stead. It is original in discussing methodologies, techniques and processes relevant to the development of short term scenarios of energy and related emissions. As an example, the process used in generating scenarios for Ireland to 2020 is presented from O' Mahony et al. [1]. As per Varho and Tapio [2], most of the required tools and techniques are well documented but the combination is novel, particularly in the context of short term scenarios. In this paper Section 2 discusses forecast accuracy and Section 3 discusses methodological issues in developing short term energy and related emission scenarios. Section 4 reviews the technique used for development of short term hybrid exploratory scenarios for Ireland and evaluates outcomes. Section 5 offers concluding remarks on the issues arising and potential options to move forward methodologically.

2. Forecast accuracy and scenarios

The ex-post evaluation of energy or emissions forecast accuracy has not often been conducted. Linderoth [3] described large forecast errors in IEA member countries' arising not only from the discontinuities of the oil crises but also in more stable periods. Errors sometimes conceal the sum of considerable positive and negative forecast errors in the sectors, particularly with industry and transport. Linderoth noted that the underestimate of transport can have particular consequences for emissions reduction policy [3]. In looking at forecast error for the US, Winebrake and Sakva found a low mean percentage error for total energy consumption concealing an average 5.9% overestimate for the industry sector and 4.5% underestimate for the transport sector [4]. In general, errors occur not only in absolute totals and sectoral consumption, but in Gross Domestic Product (GDP) growth rates, energy intensity improvement and in fuel mix [5]. This reduces the potential accuracy of related forecasts of greenhouse gases[1] (GHG) including energy-related carbon emissions and as they are an input into policy processes this has further consequences downstream. Errors can occur even on short time-scales. Large errors can occur even when the forecast year is close to the review year [3].

At the United Nations Framework Convention on Climate Change (UNFCCC) Dublin workshop for Annex I parties on the preparation of the fourth national communications, it was suggested that in some cases Annex I nations need to produce additional scenarios [6]. Although the likely statistical dispersion of results is inevitably greater in the longer term, the statistical dispersion is potentially still large in the short term. Irreducible and omnipresent complexity and uncertainty corresponds with the difficulties in short term forecasting. This uncertainty is a challenge to probabilistic and predictive methodologies and suggests that scenarios have utility in bounding uncertainty.

While forecasts are useful in some contexts they can also give an illusion of certainty [7]. Allied to the issue of accuracy of forecasts are issues pertaining to the audience of energy and emissions forecasts. Those outside of the modelling process, including decision-makers, analysts and the public, may not be fully aware of the caveats attached, their significance, or how to incorporate the resultant uncertainty effectively into their frame of reference. A host of cognitive biases arise for forecast audiences such as overconfidence and confirmation bias [8]. Environmental and technical assessments altered actors' expectations, knowledge and behaviours [9]. Whereas scenarios can widen perspectives, the more limited view provided by forecasts is consequently subject to strategic risks and political and ethical concerns.

UNFCCC reporting guidelines describe three GHG projections required in national communications; "*With Measures*" (WM) of currently implemented and adopted policies and measures, "*With Additional Measures*" (WAM) of planned policies and measures and "*Without Measures*" (WOM)[2] excluding all policies and measures implemented, adopted or planned after the starting year referred to as the "baseline" or "reference" projection [10]. Parties are given the option of reporting sensitivity analysis, but are recommended to limit the number of scenarios. While this process may appear less cumbersome in analytical terms, projection exercises that rely on single point forecasts will inevitably be subject to greater uncertainty and difficulties with accuracy, as opposed to a range provided for by baseline scenarios. Strategic policy implications will arise where forecast inaccuracy increases. It could reasonably be assumed that given the importance of UNFCCC requirements in national energy and emissions policy that these rules encourage the continuation of point forecasts as the standard approach.

3. Scenario analysis

3.1. Background

Scenario analysis has a rich history in an increasing number of sectors and disciplines [11] as a tool to deal with uncertainty. An expanding array of business, community, policy and research contexts use scenarios with highly varied

[1] The six greenhouse gases covered by the Kyoto Protocol to the UNFCCC include (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), and two groups of gases, hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). CO_2or 'carbon emissions' are emitted during the combustion of fossil fuels. It is the most important greenhouse gas due to its net contribution to anthropogenic global warming.

[2] EU Decision 280/2004/EC requires the WM and WAM projections. While the baseline WOM projection is optional, reporting on sensitivity analysis of projections is required.