Energy Policy 52 (2013) 699–705

Contents lists available at SciVerse ScienceDirect

Energy Policy

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

Not locked-in? The overlooked impact of new gas-fired generation investment on long-term decarbonisation in the UK

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HIGHLIGHTS

▶ The potential conflict between new CCGT and decarbonisation targets is examined.
▶ A form of 'hysteretic lock-in' associated with CCGT investment is identified.
▶ Potential effects of 'lock-in' from new CCGT investment in the UK are highlighted.
▶ The paper argues for a clear long-term regulatory structure for new CCGT generation.

ARTICLE INFO

Article history:
Received 14 May 2012
Accepted 11 October 2012
Available online 3 November 2012

Keywords:
Lock-in
CCGT
Decarbonisation

ABSTRACT

This paper contrasts the potential increase in gas-fired power generation in the UK in the period to 2020 with the ambitious decarbonisation goals set forth for this sector. An increase in Combined Cycle Gas Turbine (CCGT) capacity, in particular, only represents a threat to long-term decarbonisation if some 'lock-in' exists. It is against this background, and in the interest of challenging the perception of no significant lock-in to gas-fired generation, that this paper identifies investment lock-in as phenomenon of relevance to policy-makers. The paper determines both direct and indirect ways in which investment in significant new CCGT capacity could negatively impact on the likelihood of meeting decarbonisation goals through 'locking-in' the existing technological system. It also identifies that the technical lifetime, and not just the capital repayment period, of CCGT assets is relevant in understanding the strength of the lock-in. Finally, a regulatory structure that aligns with the long-term targets in place is identified as providing a clear signal for investors and asset owners that may reduce the risk of 'investment lock-in'.

1. Introduction

Do investment decisions taken now impact on long-term policy goals? Gas-fired power generation is often seen as the 'medium-term' solution to power sector decarbonisation (Helm, 2011a) and natural gas has been described as a 'transition fuel' in the power sector (Hoggett et al., 2011). It is argued that gas-fired generation investment in the short-term is aligned to longer-term decarbonisation efforts (Poyry, 2010). For this to truly be the case, gas-fired generation investments need to be free of any inertia that would hinder power sector decarbonisation at a future point in time. Before embarking on such investments, it makes sense to consider how much inertia may be created by the construction of new gas-fired generation capacity and what this may imply for future decarbonisation trajectories.

The UK is an excellent place to study this topic. There is an expectation that natural gas generation will increase as a proportion of electricity produced in the coming years across the industrialised world. However, Britain is set to close a substantial (and unusually large) number of older coal and nuclear power stations in the coming decade, with gas expected to fill much of the 'gap' (Gross et al., 2008). Further, through enacting a series of carbon budgets the UK government appears to show ambition in decarbonisation beyond that of other large industrial economies. These budgets include the implication that the power sector needs to be largely decarbonised by 2030 (Committee on Climate Change, 2010). Taken in the context of legally-binding 2050 targets of an 80% reduction in greenhouse gas emissions on 1990 levels, decarbonisation can be seen as a primary long-term goal of policy-makers. This is the perspective taken in this paper.

Studying the UK power sector therefore represents an opportunity to understand if short term investment in gas-fired

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http://dx.doi.org/10.1016/j.enpol.2012.10.033

generation could endanger long-term decarbonisation objectives. While focused on the UK, the discussion presented in this paper is relevant for policy-makers in all countries with ambitions to reduce emissions whilst simultaneously investing in long-life carbon-emitting power assets.

1.1. CCGT and lock-in

Gas-fired Combined Cycle Gas Turbine (CCGT) capacity has been the 'default' generation technology choice for investors in the UK generation market since the early 1990s. Reasons include relatively low capital cost, operational flexibility, high efficiency and the expectation that gas and electricity prices are linked (gas is a 'price maker'), which creates an inherent gas price 'hedge' for CCGT operators (Gross et al., 2010).

This is likely to continue for the coming decade as a the need for capacity to ensure security of supply (DECC, 2011a) is coupled with lower expectations on gas prices (Committee on Climate Change, 2010). In particular, the mandatory closure of more-polluting coal and oil-fired plant under the EU Large Combustion Plant Directive in 2016 is expected to create a need for new capacity in the second half of this decade that gas-fired generation is likely to meet (Becker, 2010, Chignell, 2011).

Gas-fired CCGT capacity, where replacing older coal-fired plant in the UK, would reduce power system emissions intensity. However, the carbon emissions of gas CCGT capacity (350–400 g per kWh) can be contrasted with an indicative target of 50 g of CO_2 per kWh of electricity produced by 2030 (Committee on Climate Change, 2010). Investment in such capacity would have implications for long-term decarbonisation objectives if an inertia exists that makes it more difficult to stop generating from these assets once they are in place.

The prevalent opinion from a series of interviews conducted as part of a research project undertaken at Imperial College during 2011 was that no lock-in exists to CCGT generation once any capital commitment associated with the plant is paid off (Chignell, 2011). This paper posits the contrasting view that there is in fact additional inertia associated with investment and this inertia may hinder future attempts at decarbonisation of the power sector in the UK. This inertia is framed as 'investment lock-in' for the purposes of this paper. Use of the 'lock-in' term is an attempt to recognise this form of inertia within a holistic framework which captures the different sources of inertia in relation to technological change (see also Unruh, 2000; David, 1985; Foxon, 2002). This version of 'lock-in' is applied to gas-fired CCGT investment in the UK to assess whether such investment will make achievement of long-term decarbonisation more difficult and create additional issues for policy during the 2020s.

Section 2 discusses the orthodox view that capital repayment alone is relevant to the 'lock-in' associated with gas-fired generation investments. This draws upon existing literature and a series of semi-structured interviews conducted as part of the research that informs this paper.

Section 3 considers a definition of 'investment lock-in' unrelated to capital repayment, but instead associated with the sunkness of the invested assets.

Section 4 identifies the relevant investment lock-in effects that might be expected to emerge from significant investment in CCGT capacity and how this effect may interact with other lock-in effects.

Section 5 discusses the implications for UK energy policy of investment lock-in to CCGT in the context of the ongoing Electricity Market Reform (EMR) process. Section 6 concludes.

2. The 'orthodox' view of gas-fired generation investments

When questioned on the idea of an 'investment lock-in' in the context of CCGT investment, many of the experts consulted by the authors used the low capital intensity of such plant to argue that any investment lock-in to CCGT would not be significant (Chignell, 2011). As will be discussed in this section, this corollary of this argument would be that once capital costs are paid off there will be no significant lock-in to the CCGT plant.

One of the messages from the semi-structured interview process used to elicit views in the preceding research was that capital costs were the determining factor in deciding the level of lock-in. Many respondents argued that the characteristics of CCGT and the speed at which capital could be paid off would mean that the lock-in from investing in CCGT in the next decade would not be a significant barrier to 2030 decarbonisation goals in the UK. The argument runs broadly as follows:

Whilst representing a significant potential outlay, the capital costs of CCGT investment are lower than most other forms of generation both on an absolute basis and as a proportion of total levelised costs, as can be seen in Table 1 below.

In a project-financing model of generation investment – where capital financing obligations are tied to individual plant – financing obligations are paid off within a given period of time provided expected revenues are realised. These revenues are generally determined by market prices for output and plant load factor. Interview respondents indicated that this period of time could be expected to be between 10 and 20 years.

Firms investing in CCGT would expect, whilst capital is being repaid, that the plant would operate at a load factor appropriate to meet these repayments. Revenue needs to be maximised so capital charges can be serviced. Historically, for new CCGT this has also tended to mean maximised utilisation, or 'baseload' operation (Peña-Torres and Pearson, 2000). However, the argument is that after capital is repaid, the requirement from the plant to generate a certain level of revenue and therefore pursue a particular operational regime is greatly reduced. After the capital repayment period, it is argued, there is therefore little or no lock-in or inertia intrinsic to the investment that would affect a movement away from such generation, whether through closure, mothballing or operation at very low load factors (Chignell, 2011).

This model, where capital repayment matters to the 'lock-in', is a simplification that relies upon the idea of capital commitments being tied to the individual plant. This could be the case in a project financing structure or for a single merchant generator, where the project or firm would suffer losses and potentially bankruptcy should a particular CCGT investment not deliver the revenues anticipated due to changes in load factor and power prices. In the period to 2020 a significant portion of new investment in CCGT is expected to come from vertically integrated utilities (National Grid, 2011), and capital utilised in investment would not be tied to individual plants quite so directly. In this case the utility could maximise overall revenue and profitability by optimising the use of its *portfolio* of plants, not individual power stations. Nevertheless, over the life of a plant it is reasonable to expect operation to approximate to the

Table 1
Capital intensity of various power generation sources applicable in the UK.
Source: (Mott MacDonald, 2010); all figures produced using 7.5% discount rate at 2010 prices. *first-of-a-kind costs.

Generation source	Levelised capital costs (£/MWh)	Total levelised costs (£/MWh)	Levelised capital cost (percentage of total)
Gas CCGT	9.6	80.4	11.9
ASC coal	24.9	104.4	23.9
ASC coal CCS*	54.8	124.0	44.2
Onshore wind	63.2	77.8	81.2
Offshore wind*	100.1	136.8	73.2
Nuclear PWR*	54.5	76.1	71.6