Renewable and Sustainable Energy Reviews 58 (2016) 157–166

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Improving the economics of building energy code change: A review of the inputs and assumptions of economic models

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ARTICLE INFO

Article history:
Received 16 March 2015
Received in revised form
15 August 2015
Accepted 21 December 2015

Keywords:
Building energy policy
Zero energy home
Building regulation
Energy economics

ABSTRACT

Building energy code change in Australia, and many other developed nations, is subject to standardised economic tests, with a net present value calculation at the heart of the economic analysis. Although many nations have introduced minimum energy efficiency standards for residential and commercial buildings, increases in stringency have been hindered by limitations to the range of private and societal impacts typically incorporated in regulatory impact assessments. Given the policy move towards net zero energy homes, a more comprehensive set of inputs and robust assumptions are needed to support further regulatory change. Yet the literature provides substantial evidence of many private and societal costs and benefits not commonly incorporated into the economic assessments that underpin regulatory change. Drawing on a case study of Australian and UK residential regulatory change assessments, this paper highlights limitations to the range of inputs and assumptions currently incorporated within the economic arguments applied during residential energy code change processes, and presents a more comprehensive economic argument that could support further stringency improvements.

Contents

1. Introduction

On a global scale of human impacts, buildings are the largest users of energy [1], with residential building energy consumption a major contributor to global carbon emissions [2,3]. Residential

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http://dx.doi.org/10.1016/j.rser.2015.12.220
1364-0321/

energy efficiency and the domestic application of renewable energy sources are key policies being applied to address both economic and environmental issues [4–6], and often building energy regulation has been the policy instrument of choice for many nations to systematically reduce the economic and carbon emission impacts of energy use in homes [7–9].

Countries such as Germany have had a long history of building energy regulation starting with the first thermal insulation ordinance coming into effect in 1977 [10]. Similarly, the US Model Code for Energy Conservation was published in 1977 by the National Council of States on Building Codes and Standards in response to the first oil crisis [11], and New Zealand introduced mandatory insulation requirements in 1978 [12]. Australia followed this lead much later by introducing mandatory minimum energy efficiency standards into the Building Code of Australia as a measure explicitly to address domestic greenhouse gas emissions, setting the thermal efficiency performance level at 4 NatHERS[1] Stars in 2003, 5 Stars in 2006 and 6 Stars in 2010 [13]. The 2010 building energy code changes also included minimum performance requirements for water heating and fixed indoor lighting. Yet, while Australia's per capita emissions are amongst the highest in the world [14], its building energy standards are among the lowest in the developed world [15]. And although some policy discussions during 2010–2012 have referred to the potential for increased building energy code stringency [16,17], the policy debate has been retarded by questions about the effectiveness of previous building energy regulatory changes and concerns about the marginal economics of the 2010 reforms [18–20]. This paper argues that limitations to the range and applicability of various inputs and assumptions typically applied in the standard economic tests has become a major stumbling block to further building energy regulatory reform.

Recently, building energy policy in the UK, Europe, and other developed nations has begun moving towards regulatory levels approximating net zero energy or net zero carbon [21–25], although in the UK a change of national government and concerns about the predicted costs of higher standards has seen performance targets 'watered down' [26,27]. Still, the commitment to significant building energy reform, particularly in the UK and Europe, remains and is anchored by the practical experience of building near zero energy homes for more than a decade [28–30]. This regulatory change process has also been supported by an extensive research programme examining various technical and economic aspects of low energy/low carbon homes through government and industry funded organisations such as the Zero Carbon Hub and Buildings Performance Institute Europe [31–34]. This can be seen as a deliberate policy process to support regulatory change by building the evidence base and preparing industry. Yet little work has been undertaken to expand the range of inputs utilised within typical regulatory economic tests.

This paper reviews the economics of low energy and low carbon impact housing, and in particular, how the various inputs and assumptions have been applied in the economic tests typically used to assess building energy regulatory change. The paper points to a number of major weaknesses in the economic models previously applied during residential energy code change processes, and concludes by describing how a more comprehensive economic argument could support further stringency improvements. The knowledge developed in this paper will facilitate a more informed debate on the potential to transition toward near zero energy homes, and encourage the development of sophisticated and comprehensive economic models which might underpin future stringency change analysis.

[1] NatHERS thermal simulation ratings are based on annual sum of the heat energy required to be added or removed to maintain thermal comfort due to building design, orientation and construction material characteristics, the local climate and standardised user behaviour patterns. Further detail on NatHERS is available at www.nathers.gov.au.

2. Materials and method

The methodology employed in this paper is a critical examination of the literature: firstly, an examination of the economic approaches used in building energy regulatory change processes, particularly that used in Australia and the UK; and secondly, an exploration of the evidence that supports the monetisation of benefits and costs which can be utilised in building energy regulatory change economic analysis.

The first stage critiques and summarises the approach taken in Australia by analysing Regulation Impact Statement reports published for three building energy regulatory change processes, before comparing and contrasting the approach taken in the UK for similar regulatory changes. This stage also examines a range of government and consultancy material developed to support and guide the process of regulatory change.

The second stage analytically explores the international literature to examine the evidence for each of the key inputs suitable for incorporation into the net present value calculations used to test the economic viability of building energy regulatory change, and in particular a change towards a net zero energy standard [35,36]. As a case study, this second stage highlights the evidence supporting various inputs appropriate for residential building energy regulation in Australia, although the range of inputs and that evidence would be suitable for regulatory change in other jurisdictions.

3. The application of economics in building energy regulatory change

The economic costs and benefits associated with ultra-low energy and net zero energy homes has recently become the subject of much research [32,37–48]. Many of these studies consider the direct costs and benefits of low energy homes from the perspective of the household (private impacts), but this approach limits the range of inputs and factors that can be included in the economic equation as many of the cost and benefits may be realised by the greater community (social impacts) rather than the household. Typically, the economic analysis used for proposed building energy regulatory change incorporates a wider range of private and social impacts [49].

Proposed changes to the Building Code of Australia, and other similar building codes, are subject to a Regulation Impact Statement (RIS) and, in particular, a net present value (NPV) calculation of the economic costs and benefits of both private and social impacts. The RIS process is designed to assess the economic impact of a regulatory proposal and the primary alternative options which would achieve a similar outcome, with the objective of determining the option which delivers the greatest net benefits to society [49,50].

For more than a decade, building energy regulatory changes for Australian homes have been tested using the RIS process defined by the Office of Best Practice Regulation [50,51]. Separately, some State (regional) Governments have explored the economics of proposed building energy regulatory changes within their jurisdictions [52,53]. The economic tests used to examine the energy efficiency provisions proposed for the Building Code of Australia [54–56] have been limited by the available technical and economic evidence from energy efficient homes, and the quality of the building energy models in use at that time. The tests have