Journal of Cleaner Production xxx (2017) 1–11

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

Long-term targets for green building: Explorative Delphi backcasting study on wood-frame multi-story construction in Finland

Elias Hurmekoski [a, *], Jouni Pykäläinen [b], Lauri Hetemäki [a]

[a] European Forest Institute (EFI), Yliopistokatu 6, 80100, Joensuu, Finland
[b] University of Eastern Finland (UEF), School of Forest Sciences, Yliopistokatu 7, 80111, Joensuu, Finland

ARTICLE INFO

Article history:
Received 4 March 2016
Received in revised form
26 July 2017
Accepted 4 August 2017
Available online xxx

Keywords:
Backcasting
Bioeconomy
Consensus Delphi
Dissensus Delphi
Green building
Wood construction

ABSTRACT

Industries have set ambitious targets for 2030 related to green building: Tripling the market share of wood construction, doubling the value added of the woodworking industries and reducing the environmental impact of construction by 30%. The objective of the study is to identify measures for meeting these targets, taking the case of wood-frame multi-story construction in Finland. The study introduces a combination of consensus and dissensus based Delphi techniques within the framework of target-orientated backcasting. The results point to two alternative pathways: i) gradual increase of competition and the resulting increased credibility among the construction professionals, and ii) moving downstream in the construction value chain and introducing more direct policy support measures. The realization of the targets was considered more likely by following the latter pathway, yet it was considered unattractive by industry stakeholders. Thus, the industries need to either revisit their targets for 2030, or reconsider the strategies for pursuing them. Moreover, instead of traditional norms, the public sector may have to pursue novel measures for promoting business opportunities in green building. The combinatory approach allowed both exploring tensions among the experts' and stakeholders' opinions and critically evaluating the possibility of achieving the targets.

1. Introduction

In its definition of a bioeconomy, the European Commission stresses grand challenges, such as preventing the depletion of natural resources, reducing dependency on non-renewable resources, and mitigating climate change (EC, 2012a). The construction and building sector has significant potential for cost effectively reducing the environmental impact of the global economy (Ruuska and Häkkinen, 2014), with a possibility to influence 42% of final energy consumption, 35% of total GHG emissions, 50% of extracted materials and 30% of water consumption in some regions (EC, 2011). The accumulating environmental pressures faced by the construction sector have led to coining the concept of green building, which refers to construction methods that aim to address the environmental, economic and social dimensions of sustainability (Zuo and Zhao, 2014).

Many national policies promote bioeconomy and green building. Globally, 45 countries have a bioeconomy strategy (Bioökonomierat, 2015) and 22 out of EU27 countries have a national action plan for green public procurement relevant for buildings (Herczeg et al., 2014). Also the EU has promoted green building through a number of strategies (EC, 2012b), roadmaps (EC, 2010, 2011) and flagship initiatives (EC, 2014). However, at the EU-level there are binding targets only for energy efficiency and recycling (Energy Performance of Buildings Directive 2010/31/EU, Energy Efficiency Directive 2012/27/EU and Waste Framework Directive 2008/98/EC). Thus, currently in the EU there is no common framework for regulating the environmental performance of buildings in terms of the embodied carbon, water and non-renewable resources of construction products.

While the EU green building strategies avoid advocating any specific materials, many studies and national green building and bioeconomy strategies have emphasized the role of forest-based industries and wood construction (e.g., TEM, 2010; Växjö Municipal Council, 2013; Wang et al., 2014). Particularly in the Nordic countries, wood construction is emphasized as one of the most prominent means of pursuing a growing circular bioeconomy (Antikainen et al., 2017). The shown benefits of wood construction

* Corresponding author.
E-mail addresses: elias.hurmekoski@efi.int (E. Hurmekoski), jouni.pykalainen@uef.fi (J. Pykäläinen), lauri.hetemaki@efi.int (L. Hetemäki).

http://dx.doi.org/10.1016/j.jclepro.2017.08.031
0959-6526/

relate particularly to the CO_2 emission reduction potential by reducing and avoiding fossil-based fuel and material consumption (Sathre and O'Connor, 2010; Oliver et al., 2014). Wood-based industrial prefabrication has also potential for addressing, for example, the productivity, safety and convenience of construction (Esala et al., 2012).

Few of the previous market analyses on wood construction (e.g., Jonsson, 2009; Riala and Ilola, 2014) have systematically studied the possible ways of breaking the path dependencies of the construction sector (see Mahapatra and Gustavsson, 2008), nor the means of pursuing the industries' long-term targets for green building. Consequently, the purpose of the paper is to examine the future market potential of wood construction in the context of long-term targets set by industries and policy agendas. Specifically, the study aims to identify such private and public sector measures that appear viable and desirable for pursuing selected targets on green building.

The targets are adopted from the European Forest-based Sector Technology Platform (FTP, 2012a) and the European Construction Sector Technology Platform (ECTP, 2005). Disregarding the somewhat different emphases between the two organizations, the shared general goals include removing the barriers to innovation, improving the profitability and productivity, and reducing the environmental impact of manufacturing and construction. These goals bear resemblance also to the ambitions of bioeconomy strategies, such as the Finnish Bioeconomy Strategy aiming "*to generate new economic growth and new jobs from an increase in the bioeconomy business and from high added value products and services while securing the operating conditions for the nature's ecosystems*" (TEM, 2014). In this study, we focus on three interlinked targets towards 2030, the first two of which are adopted from FTP (2012a), and the third from ECTP (2005): Tripling the *market share* of wood construction; doubling the *value added* of the woodworking industries; and reducing the embodied *energy and carbon* of construction products by 30%. Despite the quantified targets, the paper takes a qualitative approach. This is partly due to the somewhat ambiguous reference levels for the targets that leave room for interpretation.

Due to the regional characteristics of construction and the regionally varying institutional conditions related to wood construction (Hurmekoski et al., 2015), the scope of the study is limited to a single area and market. The study takes the case of wood-frame multi-story construction (WMC) in Finland, defined as the construction of more than two stories tall buildings, whose load-bearing structural frame is made for the most part of wood-based products. A previous target for this market set by the Finnish Government (2011) aimed at increasing the market share from below 1%–10% by 2015. Despite almost continuous growth and active development work, the target proved to be too ambitious (see Fig. 1).

2. Methods and data

The empirical part of the study is based on backcasting, which is a normative scenario approach for studying preferable futures (Dreborg, 1996). Backcasting entails looking back from a preferred future typically set by stakeholders and identifying the steps that need to be taken to achieve it, or alternatively, determine actions to avoid an undesired future (Quist, 2007). Backcasting originated in the energy sector (Vergragt and Quist, 2011), but the focus of backcasting applications has shifted to cover broader sustainability and participation studies since the 1990s (Quist and Vergrat, 2006). Backcasting has been seen to be a relevant foresight approach particularly when the problem is caused by the existing structures, when the problem is complex with many interlinkages and trade-offs, and when the time scope is long enough to allow structural changes and deliberate choice on strategic emphases (Dreborg, 1996; Svenfelt et al., 2011).

Wangel (2011) identifies two alternative backcasting approaches: Result-orientated research approach and participation-orientated creative workshop technique. The result-orientated approaches can be further categorized into target-orientated, pathway-orientated and action-orientated backcasting approaches (Wangel, 2011). The approaches share a common feature of identifying the measures and agents for reaching normative goals, with varying weight on participation and the part of the results considered to be of most interest.

This study follows the target-orientated approach, which according to Wangel (2011) focuses on the question of what can change, and thus addresses, for example, organizational changes, policy changes or value changes. Wangel (2011) also notes that the approach challenges one to go beyond measures considered probable or even feasible. However, one could argue that focusing merely on extreme measures may have limited practical or academic interest, despite the general focus of backcasting on radical changes: The backcasting framework ought not to focus only on possibilities, but also provide an aspect of realism by identifying and evaluating the significance of the possible hindrances preventing certain measures to be taken, and specifically, the inertia created by the current institutional framework and market structures.

Höjer et al. (2011) summarize four stages in a typical backcasting process: (i) Definition of the targets, which ought not to be easy to reach, (ii) analysis of the feasibility of the targets, (iii) development of target-fulfilling images of the future, if the targets require deviating from the prevailing system structures, and (iv) analysis of the images of the future, in terms of desirability and feasibility. As further argued by Höjer et al. (2011), a target-orientated approach typically emphasizes the first and the third steps.

The backcasting approach does not prescribe the use of any specific method (Dreborg, 1996). While backcasting studies typically employ stakeholder workshops or focus group sessions (Zimmermann et al., 2012), this study applies a Delphi survey (Linstone and Turoff, 2002). The general aim of the Delphi technique is very similar to that of the more common techniques, i.e., to obtain the expertise, opinions and arguments of a specific group or groups (van de Linde and van der Duin, 2011). The distinction to a typical survey is that in a Delphi the survey participants are acknowledged experts of their respective fields and they typically remain anonymous in order to allow argumentation beyond the professional roles of the panelists (Linstone and Turoff, 2002). Also, a Delphi survey consists of a minimum of two rounds, in order to be able to iterate the survey towards the most relevant avenues (Linstone and Turoff, 2002). Thus, a summary of the results from the first round were made available for the panelists. By taking a survey-based approach, the study aims to remove the negative group effects associated with workshops (cf. Zimmermann et al., 2012). This leaves more room for the researchers to direct the survey and to assess the relative significance of the proposed measures, which is important for target-orientated backcasting.

Despite the highly complementary nature of Delphi and backcasting and the wide array of other novel applications of backcasting – ranging from econometrics (Robèrt, 2005) to Monte Carlo simulation (Mattila and Antikainen, 2011) – it seems that only few previous studies have combined Delphi and one of the several backcasting orientations. All of these studies appear to have been within the transport sector, notably in the context of transport telematics (Höjer, 1998), automated vehicle guidance (Marchau and Van der Hejden, 2003), electric mobility (Zimmermann et al., 2012) and transport climate policy (Tuominen et al., 2014).

Please cite this article in press as: Hurmekoski, E., et al., Long-term targets for green building: Explorative Delphi backcasting study on wood-frame multi-story construction in Finland, Journal of Cleaner Production (2017), http://dx.doi.org/10.1016/j.jclepro.2017.08.031