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The carbon footprint of Australia's construction sector

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Abstract

Australia accounts for just 0.33% of the world's population yet it is one of the highest emitters of greenhouse gas (GHG) emissions per capita in the world. The construction sector is a substantial area for mitigation efforts in Australia because of its economic importance and its involvement with indirect GHG emissions, i.e. those embodied in construction supply chains, including construction materials and electricity use. While the majority of policies and regulations focus on reducing direct emissions from buildings, more attention needs to be paid to the embodied emissions of the whole sector as these can take up anywhere between 10% and 97% of the whole life-cycle carbon emissions.

This study aims at unravelling the total carbon footprint of the construction sector in Australia from 2009 to 2013, identifying the key contributing supply chains, industries and products. An economy wide input-output (IO) analysis is performed using a collaborative, cloud-based data platform – the Industrial Ecology Virtual Laboratory (IELab). This allows for a detailed disaggregation of sectors and permits more refined analysis as well as benchmarking against other sectors in the economy.

Results for CO_2e emissions by final demand show the construction sector makes up 18.1% of Australia's carbon footprint, compared to only 1.9% of direct emissions in 2013. The largest contributors to these embodied emissions are electricity, water & waste and materials throughout the years. Results are also broken down by detailed construction activities in residential / non-residential, road & bridge, other heavy and civil engineering and construction services. Mitigation options for electricity supply and materials use in the Australian construction sector are suggested.

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Keywords: Construction sector; carbon footprint; embodied emissions; input output analysis; Australia

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1. Introduction

1.1. Greenhouse gas implications of the construction sector

The construction sector was directly and indirectly responsible for 18% of global greenhouse gas (GHG) emissions in 2010 [1], and it was the largest consumer of materials in 2005 with far-reaching implications on energy use and GHG emissions [2]. Among various major emitting industries, the construction sector offers large abatement opportunities for emission reduction in the short-term due to its economic importance and involvement with GHG emissions embodied in construction supply chains [3]. While the majority of policies and regulations focus on reducing direct emissions from buildings, more research over recent years has paid attention to the indirect or life-cycle GHG emissions of the whole sector [4]. A recent review of life-cycle energy in buildings found that embodied energy can take up anywhere between 5% and 100% of whole life-cycle energy consumption (equating to 10-97% of whole life-cycle carbon emissions) depending on building function, location, material use and assumptions about the service life and energy supply. This proportion tends to increase as buildings transition from conventional to passive, low energy and nearly zero energy buildings [5].

Acquaye and Duffy [6] found that 11.7% of Ireland's national emissions were from the construction sector in 2005, and 71% of these from indirect sources. Meanwhile, Norway reported its GHG emissions from construction as 4.2 Mt CO_2e in 2003 and 5.3 Mt CO_2e in 2007, of which embodied emissions constituted the majority of total emission [7]. Chang et al. [8] found that the energy use in the construction sector accounted for nearly 50% of China's total energy use in 2007 and that the largest contributors to embodied energy in construction were materials, heating, fuels and electricity supply. Chen et al. [9], furthermore, concluded later that the construction industry, accounting for 66.5 % of Chinese total carbon emissions, was the largest carbon emitter among all industries in China in 2009, of which 96.6% were indirect (embodied) carbon emissions with the largest contribution coming from the electricity, gas & water supply sector.

The studies of Ireland and Norway's construction industry emissions and others identified future areas for emission mitigation through measures such as increasing the share of renewable energy, enhancing the maintenance of machinery and equipment, optimizing operations, reducing the amount of carbon-intensive materials used, limiting the distance for materials transportation [6, 8].

1.2. Australia's construction sector

Australia accounted for just 0.33% of the world's population yet it was one of the highest emitting countries in the world in terms of per-capita emissions [10]. Since the Paris Climate Change Agreement confirmed the global transition to zero net emissions well before the end of the century, Australia, as a signatory to the Agreement, should be aiming to achieve the net zero goal by about 2050 in order to stay within the recommended carbon budget of 1% of global total, concluded by Australian Climate Change Authority [11]. The same report found that if Australia's built environment sector reaches zero carbon emissions for the operation of residential and commercial buildings by 2050, it could contribute 28% to the country's 2030 emissions reduction target and save up to AU$20 billion [11].

It is of great significance to track emissions where possible in construction sector because of its important economic position in Australia. According to the ABS Trend Chain Volume Measures for Value of Construction Work Done [12], the total construction work demonstrated an overall increasing trend from 2008 to 2014, and in the first quarter of 2016, the construction industry shared 7.64% of GDP, which made it the second highest industry behind mining [13]. Although the total value fell in recent years due to substantial reduction in heavy & civil engineering construction, the Australian Construction Industry Forum (ACIF) [14] estimated that construction will remain at this level for a few years because of the increasing residential building construction at the moment and predicted rise in non-residential building construction in the following years.

An early study conducted by the Australian Bureau of Statistics (ABS) [15] found that the construction sector within Australia had comparably small direct emissions from fuel combustion (4.6 Mt CO_2e in 1994/95) but significantly more embodied emissions from other sectors (21.4 Mt CO_2e in 1994/95). Taking embodied emissions into account reveals the impact of the construction as the fourth largest indirect emitting sector (excluding direct residential emissions) behind manufacturing (71 Mt CO_2e), electricity, gas, water & waste services (56.5 Mt CO_2e)