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Estimating the life cycle greenhouse gas emissions of Australian ambulance services

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Abstract

Emergency medical services, or 'ambulance services', are a vehicle-intense component of the health sector that could contribute to that sector's emissions reduction efforts. This analysis uses data from an inventory of ambulance service Scope 1 (arising from direct energy consumption) and Scope 2 (arising from purchased energy consumption) emissions, along with publicly available expenditure data and emissions multipliers derived from economy-wide input–output tables, to estimate the life cycle greenhouse gas emissions of Australian ambulance services. Total emissions are estimated at between 216,369 and 546,688 t CO_2e annually, and represent between 1.8% and 4.4% of total Australian health sector emissions. Approximately 20% of ambulance service emissions arise from direct consumption of vehicle fuels (diesel and petrol) and aircraft fuels, with 22% arising from electricity consumption, and 58% arising from Scope 3 (e.g., supply chain; waste disposal) processes. Incorporating alternative fuels and higher efficiency vehicles into Australian ambulance services' vehicle fleets could reduce their direct greenhouse emissions, but broader efforts targeting reduced electricity consumption, greener electricity generation, and environmentally friendly purchasing practices will be required to substantially reduce their total carbon footprint.

Highlights

▸ Ambulance services account for 1.8%–4.4% of Australian health sector emissions. ▸ Direct emissions responsible for 20% of ambulance service emissions. ▸ Electricity consumption responsible for 22% of ambulance service emissions. ▸ Upstream "Scope 3" processes responsible for 58% of ambulance service emissions.

Introduction

There is both scientific and political consensus that human activity, rising atmospheric carbon dioxide (CO_2) levels and increasing global surface temperatures are inter-related (Ramanathan and Xu, 2010; Solomon et al., 2007). While the 15th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) failed to achieve agreement on how best to mitigate climate change, all but five of the 193 participating nations supported the "Copenhagen Accord" and its opening paragraphs. They state, "We underline that climate change is one of the greatest challenges of our time…." and "We agree that deep cuts in global emissions are required…." (Ramanathan and Xu, 2010).

Much of the international emphasis on reducing greenhouse gas emissions has placed responsibility on national governments (Cushman and Jones, 2002; Macintosh, 2010). In reality, however, a country's total emissions are the sum of the emissions from many thousands of relatively low-emitting institutions, firms, and organisations, as well as thousands, millions or—in the case of India and China—billions of individuals. While national governments might be able to influence the behaviour of organisations, firms and individuals through policy efforts such as green energy initiatives or carbon taxes, reducing global greenhouse gas emissions will ultimately depend on the cumulative successes of multiple strategies implemented on international, national, local, institutional, organisational and individual scales (Cushman and Jones, 2002; Mulugetta et al., 2010; Pacala and Socolow, 2004; Reynolds, 2010).

Healthcare is one example of an economic sector with substantial total greenhouse gas emissions arising from the aggregation of many low-emitting activities. On a per-patient or per-procedure basis, healthcare related emissions are quite small: reflux control surgery emits about one ton of CO_2 equivalents (CO_2e) per patient (Gatenby, 2011); cataract surgery emits approximately 37 kg CO_2e per operation (Somner et al., 2009); 0.23 kg of CO_2 is directly emitted in the form of CO_2 gas used in each laparoscopic surgery (Gilliam et al., 2008). Even on a larger scale, a 5000 m^2 healthcare facility would emit only 500–900 tonnes (t) of CO_2e annually as a result of onsite fuel and electricity consumption, depending on its location, the services it houses, and its ventilation system (Lomas and Ji, 2009; Murray et al., 2008). Cumulative health sector emissions, on the other hand, are significant: they are estimated to represent 3% of total greenhouse gas emissions in England (Sustainable Development Commission-Stockholm Environment Institute, 2008), and 8% of greenhouse gas emissions in the United States (Chung and Meltzer, 2009), with more than half those emissions arising upstream in the supply chain. As with global emissions, for the health sector to substantially reduce its total greenhouse gas emissions will require the cumulative efforts of hundreds of component sub-sectors each reducing their emissions on what might appear to be relatively small scales.

Emergency medical services, or 'ambulance services', are a vehicle-intense subsector of healthcare that might be able to disproportionately contribute to the sector's emissions reduction efforts. In North America, each ground ambulance response is estimated to produce 36.6 kg (median) to 45.5 kg (mean) CO_2e of Scope 1 and Scope 2 emissions; that is, emissions arising from vehicle fuel (Scope 1) and electricity (Scope 2) energy consumption (Blanchard and Brown, 2011). In Australia, ground ambulance services emit approximately 22 kg CO_2e of Scope 1 and Scope 2 emissions per ambulance response (Brown et al., in press). To date, no attempt to characterise the Scope 3 (e.g., supply chain; waste disposal) and life cycle emissions of ambulance services has been reported.

This study attempts, for the first time, to estimate the life cycle greenhouse gas emissions associated with Australian ambulance services through a hybrid assessment incorporating both inventory-based and input–output (I–O) based emissions estimates. In addition to quantifying the contributions of Scope 1, Scope 2 and Scope 3 emissions in the 'carbon footprint' of Australian ambulance agencies, this study explores the leading structural paths that ambulance services might target in efforts to reduce their greenhouse gas emissions. Finally, this study exemplifies the difficulties associated with using aggregate

sectoral I–O based multipliers for estimating emissions from diverse sub-sectoral or cross-sectoral activities.

The remainder of this paper proceeds as follows: Section 2 describes the data sources used in this analysis; Section 3 describes the methods used to calculate the estimates of ambulance service emissions; Section 4 details the resulting estimations and identifies the most potentially relevant structural pathways; Section 5 discusses the practical utility of these findings for ambulance services and highlights the limitations of using the I–O based multipliers; Section 6 concludes the paper by summarising the main findings.

Section snippets

Inventory of Scope 1 and Scope 2 emissions

A recent study inventoried the Scope 1 and Scope 2 energy consumption and greenhouse gas emissions of Australian ambulance services (Brown et al., in press), duplicating a methodology previously used in a similar assessment of North American emergency medical services agencies (Blanchard and Brown, 2011). Briefly, Australian state- or territory-based ambulance systems serving 58% of the Australian population and performing 59% of all Australian ambulance responses reported their vehicle fuel,...

Estimations

The formulas for, and the sequences of, all of the calculations are shown in Table 2....

Results

Table 3 shows the results of all the emissions estimates. The estimates of annual life cycle greenhouse gas emissions from Australian ambulance services range from 216,369 t CO_2e (62 kg CO_2e/ambulance response) to 546,688 t CO_2e (156 kg CO_2e/ambulance response); the average of these estimates is 389,315 t CO_2e (111 kg CO_2e/ambulance response). In all of the estimates, the contribution of indirect emissions is substantial, ranging from 63% to 97% of total emissions. On average, indirect (Scope 2 ...

Discussion

In the 2009–2010 financial year, Australia's national expenditures on healthcare totalled $121.4 billion dollars (Australian Institute of Health and Welfare, 2011). Converting this sum to 1994–1995 dollars and applying the Hs TBL total emissions multiplier indicates Australian health services were responsible for approximately 12.3 million t of CO_2e emissions in the 2009–2010 financial year. Using the average estimate from this analysis suggests that ambulance services were responsible for 3.2% ...

Conclusion

This analysis used a recent inventory of Scope 1 and Scope 2 emissions from Australian ambulance services, along with publicly available expenditure data and I–O based TBL multipliers, to estimate the life cycle greenhouse emissions of Australian ambulance services. Life cycle greenhouse gas emissions are

estimated at between 62 and 156 kg CO_2e per ambulance response, or between 216,369 and 546,688 t CO_2e annually. Ambulance services are responsible for between 1.8% and 4.4% of total Australian ...

Disclosure statement

There was no external funding for this research. We know of no actual conflicts of interest with regards to this work, but one of the authors (JMC) has engaged in paid consultancy work for the organisation Healthcare Without Harm, which some might perceive as a potential conflict....

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> ...This highlights the sector's narrow conception of its own activities, how harms associated with health sector activities are accounted for, and implications for population health. Recent work has advanced the agenda of sustainability in health care (Connor and O'Donoghue 2012; McGain and Naylor, 2014), operationalizing resiliency in health care facilities (Bouley et al., 2017), and mainstreaming carbon management in health care systems (Pollard et al., 2013), and there are several life-cycle assessments of specific health sector activities (Brown et al., 2012; Grimmond and Reiner, 2012; McGain et al., 2012; Campion et al., 2015), but major progress in this area will require a broader scope and greater ambition for realizing sustainability imperatives in the health sector. Adaptation encompasses a broad range of pursuits, from passive shifts in response to changing weather conditions to intentional activities including conducting vulnerability and adaptation assessments and developing health adaptation plans to increase population resilience....

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2016, Journal of Cleaner Production

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...We summarize the list of studies that have started to estimate Scope 3 in specific industries. Estimating the carbon emissions of Australian ambulance services, Brown et al. (2012) use a combination of ambulance data and Environmental Input-output life-cycle assessment (EIOLCA) models, and find that Scope 3 accounts for 58% of total carbon emissions in that industry. Looking at the largest research institute in Mexico, Güereca et al. (2013) find that the fraction of Scope 3 is 53% of their total carbon emissions....

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