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Reducing Carbon Emissions from Transport: Multi-level Governance and the Problem of Monitoring

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ABSTRACT

Tackling climate change and reducing global greenhouse gas emission levels to meet the target ceiling of two degrees above pre-industrial average global temperatures will require multi-level governance. In this paper we examine the idea of multi-level governance and the role of the transport sector at city level in contributing to the global goal. We examine international examples and options for Australia. Although policy at city level is sometimes well developed, monitoring of the effect of policies is not yet carried out systematically, transparently and in such a way that would enable city governments to adjust their policies to maximise goal achievement. Without monitoring we cannot know whether policies are effective. We explore methods that have been proposed to monitor carbon emissions from urban transport and their potential application in Australia.

应对气候变化，减少温室气体排放，将全球平均气温控制在不高于前工业时 期平均气温2 度，这需要多层治理。本文论述多层治理的理念，以及城市交 通部门在达到这一全球目标过程中的角色。文章分析了国际案例，以及澳大 利亚的选择。尽管城市政策在某些地方非常完善，但对政策效应的监控常常 不够系统也不够透明，因此市政府无法调整其政策以最大限度地完成目标。 没有监控，我们就无从知晓政策的效果。本文探索了澳大利亚城市交通碳排 放检测方法及其未来应用。

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1. Introduction

The urban transportation sector is one which is both growing as a proportion of total carbon emissions, and also stubbornly resistant to playing a leading role in emission reduction. While the growing cities of Asia and Africa are, to varying degrees, following the developed world down the path of carbon-fuelled transport led by the private car, it is incumbent on developed world cities to demonstrate that low carbon urban mobility is not only possible but desirable (Corfee-Morlot *et al.* 2009).

In this article we discuss the evolving role of city government in the climate change debate, and suggest a framework suited to city governments for informing policy and monitoring progress toward urban transport emission reduction. A "city" government is to be understood as governing a bounded urban area as opposed to an area geographically defined by national or regional borders. But such a definition can cover a range of scales of governance. Administrative entities that call themselves "cities" can vary between small urban municipalities within much larger urban regions and metropolitan

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governments with jurisdiction over large parts of the urban region to which they belong. We discuss this issue with particular reference to the Australian context.

2. Multilevel Governance of Climate Change

Increasingly, cities are being viewed as a key part of the global response to climate change (World Bank 2010, UN-Habitat 2011). This is because GHG emissions occur in a particular place, and whilst regional and national governments can mandate and co-ordinate action, to change future emission pathways in the long term, action at the local level will also be required. Subnational or city-regional governments at metropolitan scale are mostly responsible for the management and delivery of transport networks. However, foregrounding the role of city governments in climate policy evokes the wider conceptual framework of multi-level governance, as evidenced, for example, in the OECD report *Cities, Climate Change and Multilevel Governance* (Corfee-Morlot *et al.* 2009).

The idea of multi-level governance has its origins in the forging of the European Union as a supra-national power (Marks 1993). The term was used to explain the complex intergovernmental networks which evolved as a result of European integration, leading up to and following the Maastricht Treaty (Treaty on European Union). The idea helped explain in simple terms the day to day reality of policy-making "were we to slice the EU down the middle to obtain a cross-section of governance activity" (Stephenson 2013, p. 818).

A very substantial literature developed around this European idea (e.g. Bache and Flinders 2004, Enderlein *et al.* 2010, Marsden and Rye 2010, Hull 2011, Bache *et al.* 2015). MLG is not only something that was observed, but is also now considered necessary for effective climate change policy. The main message of recent work is that setting targets at national level is not sufficient to avoid dangerous climate change (Bache *et al.* 2015, p. 848). Policy change must also occur at the "coal face" of service delivery, for our present concerns: transport infrastructure planning, building and maintenance, transport service planning and delivery, and the connected field of land use planning. Local and regional planning also requires a supportive framework at national level. What then is multi-level governance?

MLG as a concept has exploded out of its European integument for use in describing policy-making for global and regional issues that have an intergovernmental dimension. It should be noted here that "governance" is distinguished from "government" at least in part by recognition of the broader considerations of risk, regulation, markets, civil society and the role of non-government actors (Stephenson 2013, p. 819). There is a "vertical" dimension, between governments at different levels, and a "horizontal" dimension between governments at the same level, and including the community and private sectors. Accordingly, MLG includes non-government actors both in the commercial and community sectors working in partnerships for specific purposes with government. Arguably those who will be asked to change their behaviour in accordance with public policy or who are otherwise affected by policy, should be involved at an early stage of public policy development.

The MLG framework is not without its critics. Some analysts believe that the constitutional framework for MLG needs to be carefully rethought if democratic accountability and transparency are watered down by the inclusion of many non-government "stakeholders" (Olsson 2003, DeBardeleben and Hurrelmann 2007). Ultimately, elected governments are the only institutions that can be held accountable for partnerships with non-public agencies. Non-state actors such as transnational corporations holding significant economic power are not subject to electoral processes. Even large community sector non-government organisations are only accountable to their supporters, not to the wider public. Whilst the engagement of non-state actors in decision-making can add to the legitimacy and effectiveness of public policy-making, such actors are also able to influence governments in private to their own benefit instead of that of society. Horizontal governance can thus lead to the blurring of public and private boundaries, risking

opportunistic behaviour from the private side and weakening democratic control and accountability (Khan 2013).

As Meadowcroft (2007, pp. 196–197) warns, there are three kinds of potential deficits of democracy arising from MLG: when participation by stakeholders is conflated with participation by citizens, when power differentials are ignored, and when there are inadequate mechanisms to ensure accountability and transparency. Both Meadowcroft (ibid.) and Mol (2007), writing before the global financial crisis, remained optimistic that a kind of governance would develop which would allow the benefits of partnerships across institutional boundaries to occur without jeopardising democracy. Mol (2007, p. 232) writes: "Environmental partnerships, or partnerships for sustainability, are a manifestation of the world's search for new modes of governance following the new conditions of a globalized modernity". However, Meadowcroft (2007, p. 211) argues that representative democratic institutions "must assume a role of 'meta-governance' to ensure that different governance modes are operating in the public interest". For a variety of reasons, governments are sometimes tempted to engage secretively with the commercial engines of urban development.

In the above-mentioned OECD report cities were given centre stage within a framework of MLG of climate policy (Corfee-Morlot *et al.* 2009). The authors adopt a normative and up-beat assessment of the potential of MLG for effective climate governance in a way that allows public policy on climate change, responsive to international agreements, to reach vertically down to the levels at which the details of policy are worked out, and horizontally to the stakeholders and publics who will be affected and who may also have to change their behaviour. In contrast with analysis of climate change policy that takes an international regimes-based approach focused on international treaties, the authors argue that a MLG approach "can better characterise the relationships amongst different actors horizontally and vertically between different levels of government". They continue: "Cities and other local governments hold unique potential to work closely with local constituencies to develop visions of the future that match the needs of their constituents while also addressing climate change" (Corfee-Morlot *et al.* 2009, p. 26, citing Brunner 1996, Cash and Moser 2000).

It seems to us that while serious concerns about the horizontal dimension of MLG remain (particularly involving the corporate sector), the vertical dimension, the enhanced connectivity between levels of government, especially between national and city governments is becoming increasingly necessary for effective climate change governance.

3. The Role of Cities in Mitigating Carbon Emissions from Transport

City governments can connect both with their local communities (Walker 2011), and globally with each other through international networks. Despite their limited powers and resources, city governments' current and potential contribution to reducing GHG emissions is far from trivial or ineffective (McGuirk *et al.* 2015). City governments are well-positioned to create and implement climate policies that best suit specific climatic, geographic, economic and cultural conditions, enabling cities to function as seedbeds for innovation and experiment that have the potential to challenge dominant regional and national responses to climate change (Bulkeley and Betsill 2013, Bulkeley and Castán Broto 2013, Khan 2013).

Of course there are wider issues of climate governance of transport in a neo-liberal world in which the integrity of both governments and corporations is questionable, and regulation weak. They are beyond the scope of this paper to address. However, there are examples globally of city governments taking the initiative in transport policies for the mitigation of climate change (Crass 2008). For instance, in 2011 the City of Rotterdam launched its *Programme on Sustainability and Climate Change* (City of Rotterdam undated). The Progamme reports engagement in partnerships with Rotterdam "inhabitants", the port and large companies, shopkeepers, housing corporations, investors and developers, motorists and transport companies, educational establishments and city administrations. More specifically a partnership was formed entitled the *Rotterdam Climate Initiative* between the City government, the Port, the Rhine Mouth Environment Protection Agency and the Port Industries Association.

The Programme identifies ten "Tasks" to promote sustainability. Under "Task 4: Promote sustainable mobility and transport", the City has set targets to be reached by 2025 from a 2010 baseline:

- 40% increase in the use of public transport.
- 30% reduction in the number of people inconvenienced by noise.
- 30% increase in bicycle use (2008 baseline).
- Elimination of "cut-through" lorries in the city.
- 10% increase in the number of pedestrians at various locations.

These targets are to be achieved through "cleaner" transportation of both passengers and goods via investment in paths and parking places for bicycles, dynamic traffic management, more efficient logistics, encouragement of "more sustainable" inland and ocean shipping, cleaner and quieter vehicles, and cleaner fuels (City of Rotterdam undated, pp. 29–30). However traffic and mobility are increasing faster than carbon emissions will be saved. The City acknowledges that "the planned measures are not yet sufficient to compensate for the increase in CO_2 emissions caused by the growing mobility" (ibid, p. 30). As a longer term goal the report refers to a European Commission transport strategy to reduce CO_2 emissions by 2050 by 60%, eliminate fossil fuelled cars, transport 50% of middle distance passengers by rail or water instead of by road, and achieve a 40% reduction in shipping emissions (European Commission 2011).

In the same year that the Rotterdam Programme was launched (2011), the City published the first of what appeared to be a regular series of reports monitoring the Programme's progress (City of Rotterdam 2011). Actions taken under the ten sustainability tasks were reported. The second report in 2013 was a much thinner document which does not even mention the ten tasks set out in the Programme (City of Rotterdam 2013).

A related example of regional-municipal coordination is the "Stedenbaan" (city line) regional land use and transport plan developed through collaboration amongst the municipalities of The Hague, Delft, Rotterdam, Dordrecht, Leiden and Gouda as well as two regional authorities – Stadsregio Rotterdam and Stadsgewest Haagland, the Province of South Holland and two public transport service providers (Balz and Schrijnen 2009). The densely populated Randstad metropolitan region, together with the thick and seemingly complex network of governmental authorities within it, has made a culture of highly effective intergovernmental negotiation and collaboration imperative if the social, environmental and economic needs of the various communities within the region are to be met.

Stedenbaan is a plan, now being implemented, initially proposed by consultants (Atelier) reporting to the national government, to upgrade the regional road and public transport network so as to transform the south wing of the Randstad from a series of separate urban regions into a single cohesive metropolitan area: "an interconnected network city characterised by a growing exchange between its parts" (Balz and Schrijnen 2009, Fitzsimons 2014, p. 42). The plan was driven by the economic need to regenerate prosperity in a region which was suffering from the negative effects of the global economic crisis, but it also responds to the Netherlands' national environmental goals. It seeks to integrate the routes of new light rail lines and buses with major housing developments and the location of service and employment nodes. Its successful implementation depends upon the strength of partnerships amongst the various authorities at different levels and between public and private sectors. A small team based at the offices of the City of Rotterdam is tasked with promoting the plan and monitoring its performance. The team does this "through persuasive arguments based on extensive research and by monitoring and evaluating developments that are taking place in the South Wing" [of the Randstad] (Fitzsimons 2014, p. 42). Thus the collaborative project is an example of a networked polity: "a structure of governance in which both state and societal organizations are vertically and horizontally disaggregated but linked together by co-operative exchange" (Low 2005, p. 46).

As the above example shows, in the case of city governments that are not subject to strong control by an overarching metropolitan authority such as the Greater London Authority horizontal collaboration has to occur among governments on land use and transport planning (Schroeder and Bulkeley 2008,

Corfee-Morlot *et al.* 2009). Another example of such inter-municipal collaboration is that between San Francisco Bay Area's Metropolitan Transport Commission and Association of Bay Area Governments in the making of *Plan Bay Area* to reduce GHG emissions from transport (Metropolitan Transportation Commission and the Association of Bay Area Governments 2013). With the transportation sector accounting for around 40% of the Bay's GHG pollution, the plan calls for a reduction of GHG emissions from cars and light trucks through enacting infrastructural and technological changes to transportation modes. These include a "Regional Express Lane Network" which can be used by car-poolers and buses without charge and by solo drivers for a fee, and the "Regional Electric Vehicle Charger Network" which aims to increase electric vehicle usage through providing electric vehicle chargers in the Bay Area (ibid.). These initiatives require significant coordination between local and regional partners, planners, engineers, technical specialists and administrators at all levels of government.

Beyond metropolitan inter-governmental cooperation within nations, trans-national networks of municipal governments have generated an institutional foundation for the climate change mitigation effort at the city level (Aall *et al.* 2007). These networks have provided city governments with examples of best practice, access to funding, and recognition outside their formal structures (Bulkeley 2010). For instance, the success of the Velib rent-a-bicycle programme in Paris, and the spread of bus rapid transit systems from Curitiba to other Latin American cities (Bogota, Mexico), and further afield internationally (Delhi, Lahore, Dublin), has been facilitated through city governments connecting and sharing information. Some of these horizontal connections have been created through formalised networks such as the ICLEI Local Governments for Sustainability (ICLEI), C40 Cities Climate Leadership Group (C40), the World Mayors Council for Climate Change (UN-Habitat 2011). The potential benefit of these networks can be illustrated by the progress made by the City of Sao Paulo after joining the ICLEI's Cities for Climate Protection program in 2003. On completing an emissions inventory, the city discovered that land transportation accounted for 48.6% of its GHG emissions, which resulted in the introduction of hybrid buses in its municipal fleet, commencement of an automobile inspection program, and increased traffic restrictions during peak hour (Puppim de Oliveira 2009).

Whilst networks can provide city governments with necessary information to implement change, evidence suggests that the impact of these networks has been uneven, mainly benefiting well-off city governments and private stakeholders with existing technical and financial resources sufficient to implement change (UN-Habitat 2011, Khan 2013). Moreover, such networks' tendency to promote front-runner municipalities can focus public attention on active city governments, but distract attention from inactive municipalities and passive national policies (Aall *et al.* 2007). There is scope for some scepticism about the real role of networks in governance. Many city governments may be members of networks without actively engaging in them. It is impossible to obtain from network websites any detail about what their members are actually contributing in terms of policy-making and evaluation. Whitehead (2013) contends that, "Analyses of the Cities for Climate Protection Campaign have, for example, described the ways in which urban climate policies tend to be transformed into a 'neoliberal buffet of options' in and through which a metropolitan denizen's carbon conduct is regulated through a series of consumer-oriented discourses of cost savings and economic efficiencies" (citing, among others, Slocum 2004, p. 772).

We turn now to the role Australian governments could play in a MLG framework. By way of background, Australia is a federation with a Commonwealth (federal) government located in the capital, Canberra, and six States and two Territories each with democratically elected governments. Co-ordination between the Federal and State Governments takes place at meetings of the Council of Australian Governments (COAG) whose principal role is "to promote policy reforms that are of national significance or which require a coordinated response across all Australian governments" including funding and partnership agreements (COAG 2016, p. 2). Municipal government provides local services and some infrastructure under State supervision. It has no independent authority under the Commonwealth Constitution but is included in State Constitutions. There are currently 565 municipalities in Australia of which 129 are designated "cities". The Cities of Sydney (205,339 resident population in 2015) and Melbourne (135,000 resident population, 2015) are territorially small CBD municipalities. In the transport field the States and Territories plan and deliver infrastructure

and public transport services; that includes strategic metropolitan land use and transport planning responsibility for four of the five major cities (Perth, Adelaide, Melbourne and Sydney).[1] The federal level has an important role in funding infrastructure, traditionally arterial roads of national importance. The federal government also shapes policy on static energy with funding programmes and fiscal and regulatory initiatives such as emission caps, carbon taxes and trading schemes. Municipal government (including the Cities of Melbourne and Sydney) is currently left with aspirations and some powers over land use, local streets and bicycle paths.

Regional-municipal collaboration of the kind described above in Rotterdam provides a collaborative model which could be modified for the Australian context. Effective climate change policy in the transport sector requires a multilevel approach led by the federal government connecting the initiatives of State and local levels, and inclusive of the private and community sectors.

To put substantial meat on this skeletal proposition requires more space than is available in this article. Briefly, however, let us sketch a future scenario in which a Commonwealth (federal) Government has successfully introduced an emissions trading scheme, setting a cap – reducing over time – on emissions in the energy production sector. In order to achieve carbon emission reductions in the transport sector, the Government has further decided that a multi-level governance approach is required to transform Australia's urban transport systems towards low carbon emissions in a way that is both socially equitable and economically efficient. To this end the funding traditionally targeted to new road (and occasionally rail) infrastructure is now allocated to a new program: the *Sustainable Urban Transport and Development Program* (SUTDP). In accordance with the customary form of intervention at federal level, this is a program to provide funding. But funding is now for combined improvements to transport infrastructure and service together with planned urban development. There is a minor precedent for such a program in the *Building Better Cities* program of the Hawke Labor (Commonwealth) government, but the SUTDP is on a much larger scale and focused on carbon emissions reduction.

The need for the program has been explained to the public via a massive advertising blitz setting out the benefits of sustainable transport for health and safety, the reduction of congestion and improved mobility as well as the need to reduce carbon emissions under the Paris Agreement. This was considered necessary because of the very large change required in public perceptions of the nature of the climate change problem, the contribution of transportation and patterns of urban development to that problem, and the means necessary to address it. The program has been negotiated through COAG, and has achieved the support (if in some cases reluctant support) of all State and Territory governments. Under the COAG Agreement, bids for funding under the program are channelled exclusively via the State (and with some modifications Territory) governments. But projects bidding for funding would not be limited to those *initiated* at State level.

Under the program, there are two scales of project, a metropolitan regional scale and a local scale. The metropolitan-regional scale, initiated by the States, provides a plan for urban development and sustainable transport for the main metropolitan regions (Sydney, Melbourne etc.) including the public transport networks linking relatively nearby regional towns with the metropolitan centres of the State capitals (for instance linking Bendigo, Ballarat and the Latrobe Valley towns in Victoria with Metropolitan Melbourne). Local scale projects are typically initiated by subregional groups of local councils working together, and in collaboration with State transport and planning agencies to make improvements to local connectivity, for instance rationalising bus networks to provide direct feeder bus services between residential areas and employment/service centres, improving the design of modal interchange stations, and creating safe bicycle and pedestrian pathways connected to transport hubs and activity centres. At both scales projects include close collaboration between government and private sector transport agencies, developers and citizen groups. Critically important is the potential carbon impact of infrastructure improvements (whether road, fast rail or even improved bus routes) leading to longer distances travelled and therefore needing to be compensated by reductions in total carbon emissions of mobility (as noted by Metz 2008, p. 6).

Commonwealth seed funding is made available to State and local government (consortia) to prepare bids for substantive funding under the SUTDP. Final bids are evaluated by an independent statutory

Table 1. Total GHG emissions per PKT per mode.

Emissions (g CO2-e) per passenger kilometre travelled per mode				
Transport mode and fuel source of energy	BTRE	ACG	Kenworthy and Laube	AGO
Year	2005	1994–1995	1999	2004
Car (petrol)	181.16	248.47	212.74	210
Bus (diesel)	N/A	106.35	122.77	114
Train (electricity generated by brown coal)	116.95	184.53	N/A	162
Tram (electricity generated by brown coal)	116.95	288.63	37.11	178

Sources: (Bureau of Transport and Regional Economics [BTRE] 2005, Apelbaum Consulting Group [ACG] 2006, Kenworthy and Laube 1999, Australian Greenhouse Office [AGO] 2004).

authority reporting to Parliament. Independence of the authority is strictly necessary to protect the political tier from local pressures arising from projects, and to avoid the temptation of political intervention for the purpose of "pork barrelling" to win marginal seats.

Both to make effective bids for funding under a program such as SUTDP and to assess the carbon impact of such bids requires methods of measuring carbon emissions from different transport modes and fuels.

4. Measuring Carbon Emissions from Transport at City Level

As noted above, "city government" in Australia is divided between State and municipal governments, the former having responsibility for the metropolitan cities which are comprised of municipalities called "cities" which have limited powers. Even though Australian government agencies are no doubt tackling the problem of measurement of carbon emissions from transport, little is published that would enable useful comparison of their efforts. This is an important task for future academic research: to investigate, draw together and evaluate the experiences of governments in this field. The following discussion, however, must remain at a general level.

The monitoring of carbon emissions from transport is challenging because of the lack of clear-cut and reliable data, and the inherent complexities in the energy-transport-environment system, such as the range of vehicles and transport modes, the variety of objectives linked to transport choice, conflicting public policies and complex institutional and political frameworks (Bongardt *et al.* 2013).

This complexity was illustrated in a study commissioned by the City of Melbourne in 2006 (Legacy *et al.* 2007). An attempt was made to assess the carbon emissions from different transport modes for metropolitan Melbourne using existing data. Four data sets were reviewed – from the Apelbaum Consulting Group [ACG] (2006), the Australian Greenhouse Office [AGO] (2004), the Bureau of Transport and Regional Economics [BTRE] (2005), and Kenworthy and Laube (1999). While total emissions data per mode of transport for Australia's metropolitan cities could be established, it was much more difficult to find emissions *per person travelling*, by mode, which would be necessary to indicate the effect of mode shift, and thus be useful to shape policy. There was considerable variation in the findings from different data sets as Table 1 above illustrates. No doubt the differences in the figures reflect different assumptions about vehicle occupancy and the carbon intensity of fuel sources; but these assumptions cannot be accessed publicly.

Notwithstanding these difficulties, measuring and monitoring of carbon emissions from urban transport must somehow be done in order successfully to identify opportunities for climate mitigation initiatives, and to assess the progress and impact of change over time (Duduta and Bishins 2010).

For city governments, developing a transportation emissions inventory is an important first step. This involves a series of decisions concerning the following issues: the geographical area to be covered by emissions measurement, the methodology to be employed for such measurement, the kind and extent of data to be collected; and the timeframe in which the monitoring of emissions is to occur (Duduta and Bishins 2010). The decisions made will depend on the city's political and geographical

Table 2. Advantages and disadvantages of different monitoring methods for transport GHG.

Method of calculating GHG emissions from private road transport	Advantages	Disadvantages
Top-down: Fuel sales (Volume of fuel purchased within the administrative boundary)	• More consistent with national carbon emissions inventories • Enables measurement of all GHG emissions from conventional fuel by people and freight within a city boundary • Enables effective multi-city aggregation • Less costly and time consuming to gather data • Does not require a high level of technical capacity for data analysis	• Requires additional data on vehicle use: passenger vehicle occupancy or freight load per vehicle • Does not reveal reasons for, or distances of travel, or potential for mode shift • Does not comprehensively demonstrate mitigation potential • Does not allow for measurement of trans-boundary trips fuelled outside the city (administrative unit), or grid-supplied energy from electric vehicle use
Bottom-up: Resident activity survey (All travel activities of residents of the administrative unit)	• Produces detailed travel behaviour data useful for transport policy formation • Can be integrated well with existing city transportation models and land use planning processes • Can include data from electric charging stations within the city	• Expensive and time-consuming to gather data. (Using ASIF framework to establish emissions) • Difficult to ensure consistency amongst cities due to different survey methods • Overlooks the impact of non-resident traffic generated by longer distance commuters, tourists and logistics firms
Bottom-up: Induced activity (In-boundary trips and 50% of trans-boundary trips that originate or terminate within the city boundary)	• Quantifies emissions from trips *induced* by the city, including trips that begin, end, pass through or are fully contained within the city • Uses established travel behaviour modelling techniques (origin-destination of trips) • Yields VKT figure for each vehicle class • Can be modified for greater simplicity to exclude pass-through trips or allocate 50% of trans-boundary trip distances to the city emission load	• More expensive than fuel-sales method • Requires additional data on vehicle fuel intensity/efficiency for each vehicle class • Comparison amongst cities is possible only for those using the same travel behaviour data collection and modelling methods
Bottom-up: Geographic/territorial (All on-road transport occurring within the administrative boundary regardless of origin and destination)	• Quantifies emissions from all trips that occur within the city • Useful for local air pollution monitoring, but can be used to monitor GHG using the ASIF method	• More expensive than fuel-sales method • Requires additional data on vehicle fuel intensity/efficiency for each vehicle class • Quantifies emissions occurring solely within the city's boundaries, regardless of trip origin and destination • Difficult to ensure consistency amongst cities due to different survey methods

Source: (Fong *et al.* 2014, pp. 77–78).

context, as well as the data available. As different approaches can generate significantly different results for the same city, it is important that due consideration be given to the question of what might be the most suitable methodologies for municipal governments to adopt.

The methodologies for determining transport emissions can be broadly categorised as either top-down or bottom-up. Top-down methods use a consumption-based analysis of emissions, the calculations based on the total fuel sold multiplied by the GHG per unit emission levels for each fuel (Bongardt *et al.* 2013). But for effective policy formation, data on average vehicle occupancy is necessary: passengers per vehicle or tonnage of freight per vehicle. Bottom-up approaches, on the other hand, use detailed activity data based on vehicle kilometres travelled to determine total emissions

(Bongardt *et al.* 2013). Most cities commence by using top-down approaches and progress toward more comprehensive bottom-up methodologies that allow for more effective transportation emission mitigation assessments and planning (Fong *et al.* 2014, p. 74). It has been suggested that top-down methods based on fuel sales are not geographically precise enough for small scale city monitoring (Duduta and Bishins 2010). On that understanding, city governments should therefore use a bottom-up methodology to monitor progress, thereby permitting isolation of the impacts of particular policies (Schipper *et al.* 2009).

To "measure carbon" from transport emissions in a particular geographical area, Schipper and his colleagues recommend the ASIF framework, where emissions are a product of: total transport activity in passenger kilometres across all modes (A); the mode share (S); the mode fuel intensity in litres per passenger kilometre (I); and the carbon content of fuel in grams of carbon per litre of fuel consumed (F). This bottom-up method enables estimation of how each component of transport is changing, how those changes could be altered and the consequences of particular policies (Schipper *et al.* 2000), thus providing direct feedback to city governments on how to manage transport emissions and how specific investments in new technologies or transport systems are most likely to affect future emissions. The resulting information can then be used to inform policy directions and to obtain the necessary partnership and funding from other levels of government (Schipper *et al.* 2009). Duduta and Bishins (2010) also recommend that an inventory should include a measurement of emissions per capita to allow for control over changes in population and to compare the magnitude of emissions over time and between cities.

Although the ASIF framework is seen as best suited to enabling city governments to obtain an accurate and detailed account of emissions-causing behaviour, it has its drawbacks. Dependent on accurate and adequate data drawn from various components, it is information intensive and expensive to support and fund, requiring financial input from other levels of government or the private sector (Bongardt *et al.* 2013).

The *Global Protocol for Community Scale GHG Emission Inventories* devised by the World Resources Institute, C40 Cities and ICLEI published in 2014 (Fong *et al.* 2014), divides emissions in any one administrative geographical area into three "Scopes". In terms of transport emissions, Scope 1 refers to emissions produced within the geographic boundary. Scope 2 refers to grid supplied energy; Scope 3 to "out-of-boundary transport", that is movements with origins or destinations beyond the boundary, or passing through the geographic area (ibid, p. 32).

For metropolitan scale rail based public transport systems – heavy and light rail or trams – system wide measurement of carbon emissions can be relatively easily conducted based on the annual amount and type of fuel used by different components of the vehicle fleet, and vehicle occupancy data, to arrive at GHG emissions per passenger kilometre travelled (PKT). In the case of electric vehicles, carbon emissions per PKT will of course vary greatly with the fuel used to generate electricity. Data on carbon emissions from on-road public transport can also be gathered from transport operators in a similar way. But the private vehicle fleets pose a more difficult problem. The advantages and disadvantages of different methods of data collection were discussed by Fong *et al.* (2014, pp. 77–78) and are summarised in Table 2.

The primary aim for city governments ought to be to inform the development of carbon reduction initiatives in their own geographical area. The detail required for this could hardly be achieved using a simpler method based on fuel consumption. Therefore, at the city level, a detailed bottom-up approach such as the ASIF method would seem the most appropriate and effective tool for informing policy and monitoring progress towards the goal of urban transport emission reduction.

5. Discussion

What then should a city government do to plan, manage, operate and monitor transport systems for sustainable mobility that actively work to reduce carbon emissions? We have discussed above the

leadership role that a future Australian federal Government could take to initiate multilevel governance of transport. But what of State and municipal levels that encompass "city government"?

5.1. Multi-level Governance

There are many ways in which Australian State governments already engage in multi-level governance in the horizontal sense: from public-private partnerships on infrastructure projects to engagement with industry, trades unions and community groups. There is not space here to discuss or critique these approaches. But there are two models of horizontal MLG that deserve to be tried in Australia. The first is the European "Verkehrsverbund" (traffic community) approach to planning and managing public transport. The model can in fact involve both horizontal and vertical dimensions of MLG when national rail systems are included, as in Zürich. In this model the various public and private agencies supplying all forms of public transport in an urban region support and authorise a single planning and management agency (Pucher and Kurth 1996, pp. 135–139, 153; Stone 2011).

The second, applicable at municipal level, is the approach encompassing both transport and land use planning exemplified in the Stedenbaan project described above. Stedenbaan shows how a land use and transport plan can be developed for part of an urban region through a collaboration of public and private agencies. Such a collaboration could be initiated in part of an Australian metropolitan city by a consortium of local governments, by a State government or by a single municipality such as the City of Melbourne or City of Sydney, and involve private sector actors.

Importantly, though, what is most lacking is a federal initiative reaching down through regional and local levels to affect behavioural, planning and production outcomes. Bache *et al.* (2015, p. 848) found in recent UK climate policy, "a breakdown in carbon reduction policy at the point where policy objectives need to be translated into more specific measures on the ground". Australia still has a long way to go to catch up with UK climate policy settings, but in doing so that "breakdown" can and must be avoided.

5.2. Monitoring

All too often the "monitoring" or "evaluation" stage in the policy formation cycle is placed last in order of consideration in a report. We find, for instance in what is otherwise a very well developed report of the Rotterdam Programme, that the section on monitoring is brief and almost perfunctory, a mere six paragraphs in a 96 page report (City of Rotterdam undated, p. 78). Monitoring is of course something that happens in time *after* a policy has been in action for a period. But that temporal sequence – that policies must actioned *before* they are monitored – should not mean that planning for monitoring can be put off until the policy has been enacted. On the contrary the monitoring approach should be designed at an early stage in policy design.

A balance needs to be struck between the need for methodological consistency and the need for feasibility. It is true that the Global Protocol demands consistency both internally to cities over time and between different cities. "Emissions calculations shall be consistent in approach, boundary, and methodology. Using consistent methodologies for calculating GHG emissions enables meaningful documentation of emission changes over time, trend analysis, and comparisons between cities" (Fong *et al.* 2014, p. 25). But coordination of measurement methods across a spectrum of different city administrations is an expensive and time consuming activity yielding possibly indifferent results, or no results. It seems to us that there is an order of priority in monitoring. First, there should be consistency over time *within* an agency and its geographical boundaries so that the agency and the public it represents can know the results of its policy on the basis of transparent and consistent indicators. Second, where feasible, consistency *between* agencies and across geographical boundaries should be sought.

As a general rule, it seems reasonable that the agency responsible for making policy should also select the means of monitoring its results. Australia has a diverse mix of CBD, inner and middle urban, urban fringe and rural municipalities with widely varying policy contexts. With 565 local governments,

and 129 of them sufficiently "urban" to be designated "cities", the cost and administrative difficulty of co-ordinating monitoring at municipal level would be prohibitive. Moreover municipal control over transport policy is limited, as mentioned above. On the other hand the Australian State governments have responsibility for and broad powers over transport policy across large geographical regions, including for each metropolitan State capital. They have competent and well-resourced administrations capable of collecting and analysing data for urban and rural regions of each State. So, in Australia it should be the State and Territory governments that take primary responsibility for monitoring carbon emissions from transport.

However, the federal role will be extremely important both in persuading States to undertake monitoring, in assessing their experience and working towards a unified and consistent methodology. As Bache *et al.* (2015) point out, national governments need to engage with other government levels if the national "headline targets" are to have a real impact. Federal assistance and regulation may be required to ensure that State level monitoring occurs consistently.

Monitoring of carbon emissions from transport across Australia at sub-national level should start with the top-down method using total fuel sold. For this purpose conventional geographical subdivisions of the administrative territory can be used (including for example the metropolitan area and various rural regions). The method should also include the amount and source of energy used to power public transport services from the electricity grid.

An agreement amongst the States/Territories and the federal government on the details of a common method can be worked out as the experience of measurement and monitoring is reported and assessed. Each State/Territory should meanwhile separately develop its own bottom up method using the ASIF framework to provide detailed indicators of the carbon performance of its transport policies over time.

6. Conclusion

Climate change is often posited as offering a global challenge to be resolved through international negotiation and the application of national emission reduction targets. The persistent failures of international climate governance and national policy to put into effect the required action have resulted in a proliferation of locally scaled initiatives. This has put city governments at the centre of the climate change debate. Municipal governments have shown that they are willing to reduce carbon emissions from transport either by acting alone, or in horizontal cooperation with other municipalities at a metropolitan level, by connecting with trans-national networks of city governments, and through engaging in private-public partnerships. Yet, without vertical integration between all levels of government, municipalities will remain constrained by structural divisions of policy responsibility.

For city governments to be able to complete the large-scale infrastructure required to create truly sustainable urban transport systems they will need national support, and for national governments to be able to meet their international GHG emission reduction targets they will need local action. However, irrespective of which level of government is implementing climate action to reduce transport emissions, the potential benefit can only be realised and replicated if policies are monitored in a manner that is credible, transparent and meaningful. The consistency and transparency of implementing such a monitoring system could be increased by using the recently launched GPC. However, whilst the protocol might offer a globally accepted common standard, without at least an agreed method (nationally or internationally), its flexibility in use significantly limits the comparability of results between cities.

Note

1. Brisbane is the only major metropolis to have a local government covering a large part of the metropolitan area.

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