

Carbon mitigation actions by peri-urban and regional cities in Queensland

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Abstract: Reducing greenhouse gas emissions within cities is a key objective of Australia's national urban policy *Our Cities Our Future*. During 1997 to 2009, some 238 mainly city councils in ICLEI's Cities for Climate Protection program adopted carbon mitigation actions and strategies. Since 2010, the *State of Australian Cities* reports on key sustainability indicators, including energy, water and waste, for 18 major cities. Under the *Clean Energy Act 2011*, some 40 city councils including 10 Queensland cities are liable entities required to pay a carbon price as their emissions exceed 25,000tCO₂-e a year from a single facility (i.e. landfill). The carbon price of AUD\$23tCO₂-e from 1 July 2012 also impacts on cities through the increased cost of energy, water, fuel, transport and materials. City councils are thus adopting eco-efficiency measures in energy, water and waste management to reduce operating costs and carbon liability.

This paper reports on carbon mitigation actions by Queensland local councils, including four peri-urban cities (Ipswich, Logan, Moreton Bay, Redland), five major regional cities (Gold Coast, Sunshine Coast, Cairns, Townsville, Toowoomba), and two emerging regional cities (Mackay, Gladstone). Two regional cities considered renewable energy guidelines in planning decisions, while two cities purchased Green Power. Cost savings, environmental regulations, council climate strategies/resolutions and climate leadership were key drivers for Queensland city councils to reduce carbon emissions. Peri-urban cities were opportunistic in adopting carbon actions, while coastal regional cities proactively implemented carbon mitigation actions. The paper discusses barriers and opportunities for city councils in carbon mitigation.

Introduction

Climate change and carbon mitigation are key issues for city councils and local government (ACELG, 2011; Pillora, 2011; Storey et al., 2012; Storey & Eckstein, 2013; Svara et al., 2011). In this context, "Mitigation involves taking actions to reduce greenhouse gas emissions being emitted to minimise the impact from climate change" (LGAQ, 2009, p. 58). Urban and regional centres generate carbon emissions from energy, water, transport, buildings, land use, and waste. Hence, local government strategies and reports include advice and case studies on greenhouse gas mitigation actions for cities and local councils (LGAQ, 2009; Storey et al., 2012). Local government engagement in carbon management includes energy efficiency, renewable energy, waste management, green procurement, land use planning and development approvals. Carbon mitigation actions to reduce emissions are driven by national and international responses to global warming (Iraldo & Gasbarro, 2013).

Municipal actions in relation to sustainability have been driven by Local Agenda 21, since the 1992 Rio Earth Summit, and by global climate change negotiations and agreements such as the Kyoto Protocol to reduce greenhouse gas emissions. Local authorities are one of the nine major groups in Agenda 21, engaged in global climate meetings. The International Council for Local Environmental Initiatives (ICLEI) has addressed local climate change actions since the early 1990s (Zeppel, 2013a).

Australia is a signatory to the Kyoto Protocol, with a national target of 5% emissions reduction on 2000 levels by 2020. In 2009, some 184 local councils in the Cities for Climate Protection (CCP) program abated 0.7% of Australia's emissions (Australian Government & ICLEI, 2009; Hoff, 2010). Hence, a reduction of 'between 10% and 20%...could be contributed by Australian local government by 2020' (Storey et al., 2012, p. 11). Energy efficiency is a key focus of this abatement. The federal Low Carbon Communities program has co-funded energy efficiency upgrades of council facility and street lighting, and in community facilities (DCCEE, 2012a).

Reducing greenhouse gas emissions is also a key objective of Australia's national urban policy for cities, with indicators for energy and gas consumption, Green Star buildings and distributed energy generation (DIT, 2011, 2013). The Solar Cities Program funded solar and energy efficiency projects in Adelaide, Alice Springs, Blacktown (Sydney), Central Victoria (Ballarat, Bendigo), Moreland (Melbourne), Perth, and Townsville (DCCEE, 2012b). Only Randwick City Council (Sydney) operates a small scale urban wind turbine (Storey et al., 2012). States differ in wind farm policies and approvals (Hall et al., 2012).

Local government programs that focus on cities and councils reducing their carbon footprint include the ICLEI-Local Governments for Sustainability 'Cities for Climate Protection' (CCP) Program (Zeppel, 2013a). CCP carbon mitigation initiatives focus on energy and water efficiency, renewable energy, urban planning, building design, waste management and carbon offsetting (Newman, 2010;

Svara et al., 2011). During 1997 to 2009, some 238 Australian councils covering 84% of the population were members of the Cities for Climate Protection Program adopting energy, water and waste actions, and greenhouse gas reduction strategies with corporate and community abatement goals. This review found half of the CCP councils had completed milestone 5, 47% had a climate change action plan that set reduction targets for council's own emissions while half set targets for reducing community emissions, and 45% now included climate change in their council's organisational structure (Hoff, 2010). The CCP abatement strategy is to avoid and reduce emissions, switch energy sources, then sequester and offset residual emissions (FNQROC, 2011). Other climate change and carbon reduction programs have been implemented by the Australian Local Government Association (ALGA, 2011); Local Government Managers Australia (e.g. Climate Futures Program); capital cities (Kinesis, 2009); local government associations in New South Wales, Victoria and South Australia (Atkinson et al., 2007; LGASA, 2008; LGSA, 2010; MAV, 2013; Urbis, 2010); Regional Organisation of Councils (FNQROC, 2011); and ten Greenhouse Alliances of councils in Victoria (CVGA, 2013).

City councils are multi-million business operations with significant control over local environmental and social impacts, including carbon reduction strategies and activities. Research about carbon management by local government in Australia includes: climate change mitigation strategies of local councils in Queensland (Burton, 2007; Zeppel 2012a, 2013c); climate change law and liability (England, 2008); assessing local carbon emissions (Hamilton et al., 2008); carbon mitigation by councils in the Cities for Climate Protection program (Hoff, 2010); and carbon actions by Greater Adelaide councils (Zeppel, 2012a, 2013b). The report, *Local Action for a Low Carbon Future*, evaluated local government contributions to carbon abatement goals in Australia (Storey et al., 2012). Case studies of emissions reduction initiatives by regional and peri-urban cities included street lighting (NSW), Greenhouse Alliances (Vic), Newcastle City (NSW), Townsville Solar City (Qld), Living Smart (Moreton Bay and Sunshine Coast, Qld), energy management (Parkes and Cowra, NSW), solar councils (SA), smart grids (La Trobe, Vic), and Regenesys carbon forests (Blacktown & Liverpool, NSW) (Storey et al., 2012). Other large-scale solar power hubs are in Mildura (Vic) and Dubbo (NSW). Dubbo City Council in western NSW has leased land for a 2.5MW solar farm (Energy Matters, 2013). Regional and peri-urban cities are often leaders in these carbon mitigation projects.

In Australia, under the *Clean Energy Act 2011*, local governments are required to report and pay a carbon price for greenhouse gas emissions exceeding 25,000tCO₂-e a year from a single facility, mainly from landfill. In 2013, some 40 local councils, mainly regional cities, were listed by the Clean Energy Regulator as liable entities for the carbon tax (CER, 2013). In Queensland, ten cities are liable entities for the carbon tax from landfill emissions (i.e. Brisbane, Logan, Gold Coast, Townsville, Gladstone, Mackay, Moreton Bay, Rockhampton, Sunshine Coast, and Toowoomba). The implementation of a carbon price of \$23tCO₂-e from 1 July 2012 (\$24.15 from 1 July 2013) also impacts on city councils through the increased cost of energy, water, fuel, transport and materials (ALGA, 2011; IPART, 2011; LGAQ, 2012; MAV, 2012). A special levy on hydrofluorocarbon (HFC) refrigerants increased the retail price of HFC's by 300 to 500%. Australia must also reduce its consumption of HCFC22 in refrigeration and air conditioning systems by 90% by 2015, to be phased out by 2020 (Jensen, 2012). Local councils are thus adopting eco-efficiency measures in energy, water and waste management to reduce operating costs and address carbon liability. This paper evaluates carbon mitigation actions adopted by peri-urban and regional cities in Queensland.

Regional Cities

Australia's regional population growth is mainly occurring in regional cities, especially in Queensland. In June 2010, some 36% of Australia's population (8.03 million people) resided outside greater capital city areas. The population outside capital cities is also projected to grow by 26% during 2007-2026 (RUN, 2013). During 2005-10, population growth was highest in satellite cities (within 150 km of a capital) and coastal cities, then inland cities (Daley & Lancy, 2011). Some 6.3% of Australians live in 25 regional cities with a population from 30,000 to 100,000 residents. Queensland mid-size regional cities growing faster than the national average include Hervey Bay (3.9%), Gladstone (2.6%) and Mackay (2.6%) (DIT, 2013). Peri-urban areas with expanding populations on the outskirts of Brisbane include Ipswich, Logan City and Moreton Bay, all part of the National Growth Areas Alliance (NGAA). The 25 municipal members of this Alliance are fast growing peri-urban cities, housing 3.5 million people with population growth over the next 20 years at double the national rate (NGAA, 2013).

Based on the 2011 census, Australia now has 43 cities with a population greater than 30,000 people. Excluding the five largest capital cities, and Canberra, these larger cities are regional or peri-urban centres. Ten of these large regional cities are in Queensland (Table 1) (ABS, 2012a). The Gold Coast, Sunshine Coast, Townsville, Cairns and Toowoomba are included in the National Urban Policy and Liveable Cities Program which targets 18 major cities with a population of more than 100,000 residents. During 2001-11, the population of Queensland grew by 23% or 845,200 people. Regional population growth of 412,900 was greatest in coastal areas of the Gold Coast, Sunshine Coast, Wide

Bay, Cairns, Townsville, and Mackay (ABS, 2012b). Managing urban growth and carbon mitigation is a key challenge for these regional cities, and the peri-urban cities around Brisbane.

Table 1 Large Regional Cities in Queensland

| City | Population | Rank |
|------------------|------------|-----------|
| Gold Coast/Tweed | (576,747) | 6 |
| Sunshine Coast | (241,643) | 10 |
| Townsville | (167,636) | 13 |
| Cairns | (146,477) | 14 |
| Toowoomba | (125,265) | 16 |
| Mackay | (83,350) | 23 |
| Rockhampton | (75,648) | 25 |
| Bundaberg | (69,728) | 27 |
| Hervey Bay | (58,261) | 28 |
| Gladstone | (50,507) | 31 |

Source: ABS 2012a

Queensland Local Government

There are 73 local government areas (LGAs) in Queensland, including seven city councils, 30 regional councils, 24 shire councils, and 12 Aboriginal shire councils. These councils range in size from five of the 10 largest LGA in the urban growth region of South East Queensland (i.e. Brisbane, Gold Coast, Moreton Bay, Sunshine Coast, and Logan); mid-size regional cities (i.e. Cairns, Townsville, Mackay, Rockhampton, Gladstone, and Toowoomba); regions based on agriculture, mining or tourism; and small rural or Aboriginal shires. These LGAs operate under the *Queensland Local Government Act 2009*. Some 20 councils (and 8 former shires) were CCP members; most had actions plans to reduce greenhouse gas emissions (Zeppel, 2011). A *Climate Change Mitigation* guide (LGAQ, 2009), includes advice on carbon abatement and offsetting actions for councils to reduce emissions. A mitigation plan by five LGAs in Far North Queensland, including Cairns, has set a target of 50% reduction in carbon emissions on 2007/08 levels by 2020 from council operations (FNQROC, 2011). The climate change plans of four coastal cities have set a goal of being carbon neutral by 2020 in their operations, by energy efficiency measures and purchasing offsets (i.e. Brisbane (2026), Cairns, Gold Coast, and Sunshine Coast). There is no state-wide climate change strategy for Queensland LGAs and no renewable energy, Green Power or carbon mitigation targets have been set for local councils.

Regional cities in Queensland face the challenge of implementing policy, organisational and technical initiatives to mitigate their greenhouse gas emissions (LGAQ, 2009). It is mainly peri-urban and regional cities in the fast-growing coastal areas of Queensland that need to manage and report on their carbon emissions (Zeppel, 2012a, 2013b). Queensland councils are also heavily impacted by the climate change effects of drought, floods and cyclones on towns, roads, infrastructure, and services, and the need to reduce carbon emissions (Steffen et al., 2012). This paper reviews carbon mitigation actions adopted by peri-urban and regional cities in Queensland. It includes responses by:

- four peri-urban councils (146,000 to 390,000 residents) (Ipswich, Logan, Moreton Bay, and Redland)
- five major regional cities (160,000 to 530,000 residents) (Gold Coast, Sunshine Coast, Townsville, Cairns, and Toowoomba), and
- two medium regional cities (50,000 to 90,000 residents) (Gladstone, and Mackay).

The results are drawn from a 2012 survey of climate change mitigation actions adopted by 32 Queensland LGAs, with respondents including five cities, 18 regional and nine shire councils (Zeppel & James-Overheu, 2012). The city councils are Gold Coast, Ipswich, Logan, Redland and Townsville. These peri-urban and regional cities are all experiencing population growth and urban development. Some 15 councils were on the coast, while 17 were inland. By size, 15 surveyed councils had a population of over 30,000 residents, with 14 councils also in the Cities for Climate Protection program.

Carbon Mitigation Survey

The climate change mitigation survey for Queensland councils was based on carbon mitigation actions recommended in the Cities for Climate Protection (CCP) program, and a desktop review of climate change plans and carbon actions listed on Queensland council websites (Zeppel, 2011). The survey also adopted some questions from ICLEI's review of Australian councils in the CCP program (Hoff,

2010), and previous climate change surveys of New South Wales local councils (LGSA, 2010; Urbis 2010). Sustainability officers at two Queensland councils (1 peri-urban, 1 regional city) with climate change programs provided feedback on the draft survey. A pilot survey was also conducted of 14 Greater Adelaide Councils in 2011 to assess their carbon mitigation actions (Zeppel, 2012b, 2013b).

The Queensland council survey included 36 questions in five sections: A: Your Local Council; B: Climate Change; C: Climate Change Mitigation; D: Carbon Offsetting; and E: Preparing for the Carbon Price. The survey included climate change responses, a checklist of 64 carbon mitigation actions, ranking of council motives for carbon actions, and open-ended questions on reasons for climate change actions by councils. This paper reports on survey responses to section B and C on carbon mitigation actions by Queensland councils. The survey was mainly completed by council staff with roles related to environmental, sustainability, and climate change areas (78%). At smaller councils, the survey was completed by environmental health officers or the CEO; and by building or engineering staff. Comments by council respondents are included to highlight key issues in carbon management. The survey data covers carbon actions adopted by Queensland local councils, including 11 cities.

Carbon Management Assessment Matrix

This paper utilises a Carbon Management Assessment Matrix developed for LGAQ's *Mitigating Climate Change* guide (LGAQ, 2009), that assessed carbon mitigation actions across eight business areas (i.e. strategy, data, reporting, culture, operations, risk, assets, and results). The matrix identified five stages or steps in council responses to carbon management as latent, emerging, consolidating, mainstreaming, or leading practices (Table 2). The matrix thus evaluated the level of 'carbon-readiness' exhibited by local councils across a range of carbon and climate actions. It linked organisational learning ('culture') with strategic and operational responses to carbon management. This paper focuses on strategy and operations, in reviewing carbon actions adopted by Queensland councils. This matrix thus assesses corporate citizenship by councils in regard to emissions reduction. It provides a means to benchmark carbon actions and assess cities on carbon mitigation strategies.

Table 2 Carbon Management Assessment Matrix

| Business Area | Strategy | Operations |
|----------------------------------|--|---|
| Stage 1 Latent | No CM strategy | *No CM actions or planning implemented *No energy or GHG initiatives in place *Limited understanding of energy expenditure |
| Stage 2 Emerging | CM strategy acknowledged and committed to by Board/Senior management CM policy or position written Preliminary carbon targets set | *Need for initiatives identified *First implementation plan developed *First initiatives undertaken |
| Stage 3 Consolidating | Short term (< one year) CM strategy developed Implementation commenced Responsibility allocated Carbon targets reviewed and amended as required | *Energy and GHG management initiatives implemented *Preliminary actions result in emissions reduction *Energy spend reduced |
| Stage 4 Mainstreaming | Longer term (>two year) CM strategy development Strategic planning process includes CM and leads to business improvements | *Business energy efficiency in 'how we do business' *Continuous improvement is evident in measurable financial outcomes *Product responsibility procurement policy in place and implemented |
| Stage 5 Leading | CM is embedded in business planning | *Seeking out 'game changing' energy efficiency initiatives |

Notes: CM = carbon management, GHG = greenhouse gas, CC = climate change

Source: LGAQ, 2009 (Appendix B, p. 60)

Carbon mitigation actions by local government were also assessed against a 'philosophy of climate action' (Wood & McNamara, 2011) that categorised council responses as minimalistic, opportunistic, progressive or innovative. Reactionary responses were councils complying with statutory obligations on climate change (i.e. minimalistic) or implementing other additional climate change initiatives as resources allowed (i.e. opportunistic). Proactive responses were councils actively pursuing mitigation (and adaptation) actions addressing climate change (i.e. progressive) or integrating climate change thinking across all council operations (i.e. innovative) (Wood & McNamara, 2011). This climate action framework evaluated local government responses in regard to climate change and carbon mitigation.

Climate Change Responses by Queensland Councils

Two thirds of surveyed Queensland councils (20) considered that climate change was an important issue for local government. This included all five city councils, and three quarters of regional councils (13 of 18), but only two shire councils. Climate change was considered important because of the potential impacts on council infrastructure, service delivery, risk minimisation, community safety, biodiversity, and economic development. The main climate-related initiatives undertaken by half of the surveyed councils included participation in the Cities for Climate Protection (CCP) program (16) and the annual Earth Hour event (15). Other council measures included carbon foot printing (14), holding climate seminars (8), and environmental certification (e.g. ISO 14001) (8), followed by the ecoBiz program (7), Water Week (7), the Low Carbon Diet (6), sustainable street lighting (5), climate change workshops (5) and Climate Smart business (4). Overall, the average number of climate initiatives implemented per council was: City Councils (9.2), Regional Councils (3.5), and Shire Councils (1.3). For regional councils, there was a difference in the average (2.6) for nine inland councils, with 16 of 24 climate actions implemented by Toowoomba and Tablelands Regional Councils, versus 36 climate actions adopted by nine coastal councils (average = 4).

In terms of council response to climate change, around one-third are either complying with statutory obligations on climate change (13), or implementing other additional climate initiatives beyond legal requirements as resources allow (13). Nine of the regional councils (6 inland), and four shires (3 inland) are basically complying with their statutory obligations on climate change (i.e. minimalistic). Three cities, six regional councils and four shires engaged in climate change initiatives beyond statutory requirements as resources allowed (i.e. opportunistic). Just six Queensland councils, including five coastal councils with climate strategies (Cairns, Gold Coast, Sunshine Coast, Townsville, and one northern council), and one inland shire in the CCP program, were proactively pursuing climate change actions (i.e. progressive). Only Cairns Regional Council integrated climate change thinking and carbon actions into all areas of council operations (i.e. innovative or leading).

Households (15), community groups (12), schools/youth groups (12), and businesses (9) are the main groups that Queensland councils work with on climate change actions. There was only a minor focus by councils on advising developers and landholders of climate change actions (4 each). Townsville City implemented climate actions with conservation groups (*NGO's-Conservation Volunteers Australia, Reef Check*), while Sunshine Coast and Mackay utilised Advisory Panels or Committees. Mackay Council had sustainability champion awards for their staff (ecoMackay, 2013).

Climate Change Planning by Queensland Councils

In terms of strategic planning, carbon actions were included in waste, water, climate change, environment, and energy plans prepared by councils. The councils mainly integrated climate change actions into their waste (20) and water (16) management plans, due to increased state government charges for bulk waste services and a prior waste levy. Dedicated climate change plans (11), a climate change risk assessment (10), and climate change adaptation plans (8) had mainly been prepared by larger city and regional councils. Moreton Bay Council noted their *Community plan has targets on emissions reduction and (a) Sustainability Policy*, while Cairns Council had an overarching *Corporate Sustainability Policy*. Some eight councils had also prepared a greenhouse gas plan, while nine councils included climate change actions within an environmental policy, or healthy environment/environmental management plans.

Only a few larger councils have developed official policies on climate change (3), or renewable energy, carbon emissions, or sustainability (2 each). A few metropolitan councils have devised action plans for sustainable energy (4), energy transition (2), and peak oil (2). Logan City Council had a draft combined climate change strategy and peak oil plan. The climate change plans of three councils set a goal of being carbon neutral by 2020 (i.e. Cairns, Gold Coast, and Sunshine Coast). Climate change strategies were in preparation (2011/12) for Moreton Bay and Whitsunday Councils. South Burnett Regional Council was also developing a biodiversity and climate change strategy.

The climate change strategies prepared by Queensland councils covered key topics such as waste reduction (15), community education (15), and energy efficiency (14), water conservation (12), sustainable living (11) and sustainable transport (10) programs, followed by sustainable business (8), and renewable energy initiatives (5). Other areas covered in climate strategies by nine larger mainly coastal councils included climate change adaptation, risk assessment, energy transition, strategic/land use planning, infrastructure, and nature conservation. Just two coastal shire councils had climate change plans, covering energy, water and waste. Only a few larger coastal or urban councils incorporated clean energy business opportunities within their climate change plans (5). Most climate change plans regarded carbon mitigation as a cost for councils rather than an opportunity. An exception was the Sunshine Coast Council with its focus on promoting clean technology industries. Half of the surveyed councils (16), mainly larger regional (10) and city (4) councils, stated that climate change actions were incorporated into their corporate or strategic plans.

Only 13 larger councils (population over 30,000), including the 11 regional cities, had completed an assessment of carbon emissions from council operations, by council staff, or by a consultant. The emissions assessment was based on the National Greenhouse Accounts Factors or NGERs. One peri-urban council stated: *no reporting standard used, but beyond NGERs – rated every appliance and included building features*. Some 18 councils reported reduction of carbon emissions was either a low priority (including an inland regional city) or not a priority. However, reducing emissions was a medium to strong priority for most peri-urban and larger regional councils (>30,000 residents). Some 23 councils did not consider carbon mitigation guidelines for energy efficiency in planning decisions. Two larger city councils, Townsville and Sunshine Coast, referred to carbon mitigation guidelines in their planning decisions, such as the use of renewable energy, and energy efficiency for buildings.

Carbon Mitigation Actions by Queensland Councils

With carbon mitigation, 30 councils implemented a total of 433 carbon reduction actions, with the average number of carbon actions adopted per council at 14. The five city councils implemented 162 carbon actions (average = 32.4), the 18 regional councils employed 231 carbon actions (average = 12.8), while eight shire councils implemented 32 carbon actions (average = 4). The 15 largest councils, with over 30,000 residents, implemented 342 carbon actions (average = 22.8). The 17 smaller councils implemented 91 carbon actions (average = 5.35).

Overall, the main types of emissions reduction initiatives implemented by Queensland councils included: Energy efficiency actions (235), Water efficiency actions (75), Waste efficiency actions (57), and Behaviour Change actions (55). Less than 3% related to Carbon offsetting actions (11). Just three councils purchased Green Power from renewable energy (i.e. Tablelands, Townsville, and Redland-5%). In contrast, Brisbane City Council 'bought 100 per cent green power' to offset its vehicle fleet and public transport (Hepworth, 2012).

The top 20 carbon actions implemented by at least one quarter or more of surveyed Queensland councils related to energy efficiency initiatives in council buildings; waste reduction; water conservation and recycling; fuel efficient vehicles; and behaviour change action such as providing information on reducing emissions. The main energy reduction actions at council buildings and facilities were buying energy efficient appliances, installing energy saving lights and light sensors, energy efficient computers, roofing insulation, solar or heat pump hot water heaters, solar powered public lighting, variable speed pumps at water plants and public pools, and solar power. Other energy initiatives by Townsville City were a network demand management project with Ergon Energy and energy performance contracts for council buildings. The main water efficiency actions were installing water efficient technology, using recycled water, collecting rainwater, other water initiatives (i.e. leakage control), water purification, and stormwater harvesting. The main waste efficiency actions were recycling, waste reduction, composting organic waste, and other waste initiatives such as using recycled paper, gas flaring from landfills, and recycling bio-solids. The main behaviour change actions related to council information on reducing emissions, training staff, marketing carbon mitigation actions, setting emissions reduction targets, choosing suppliers reducing emissions, and providing community rebates for energy and water efficiency devices. Only Logan, Mackay, Toowoomba and Townsville Councils had implemented a green purchasing program, choosing suppliers taking actions to reduce carbon emissions.

The major reasons for councils to implement carbon reduction actions, by total responses, included: Cost Savings (24), Demonstrate Climate Leadership (15), Environmental Regulations (12), Council Climate Strategy (11), and Council Resolutions on Climate Change (9). By rank order of responses from one (highest) to five (lowest) the key reasons for councils to reduce emissions were: Cost Savings (1.8), Environmental Regulations (2.2), Council Climate Strategy (2.4), Council Resolutions on Climate Change (2.6), and to Demonstrate Climate Leadership (3).

Cost savings was the main reason to reduce emissions for the majority of surveyed Queensland councils of all types (88%). Complying with environmental regulations such as the *Queensland Government Waste Management Strategy*, meeting targets in a Council climate change plan, and demonstrating climate leadership were also important reasons to reduce emissions for one third to half of surveyed councils. Other minor reasons to reduce council carbon emissions included climate certification (e.g. CCP); business reporting; the Queensland renewable energy plan; to attract low-carbon industry investment; preparing for carbon legislation; prior Queensland government carbon targets; and differentiating the council as a 'climate friendly' region. Other reasons to reduce council emissions were: *SEQ Regional Plan requirements* (Logan); *prolonged drought throughout 90's and 00's* (Toowoomba); and *to reduce climate change impact risk* (Cairns).

The main barriers cited by council participants as impediments to adopting carbon reduction actions were: cost and lack of funding; reliance on the operating budget; lack of council policies; indifference to climate change by some councillors and managers; lack of staff to implement climate action; prioritisation; *risk aversion to new technologies*; and environmental regulations such as *restrictive DERM licence conditions on WWTPs* (waste water treatment plants), and *uncertain RECs*

(renewable energy certificate) *market over past 3 years*. A peri-urban council stated: *Not implementing actions which don't make business sense, or don't provide some other valuable benefit*. One peri-urban city council reported a barrier was *lack of funds for any mitigation even though demonstrated return is 3 to 5 years. Things are very tight*. Council waste practices that reduce emissions from landfill such as recycling, phytocapping, bio-covers, revegetation and organic waste diversion also did not earn carbon credits through the federal government's Carbon Farming Initiative. Hence there were a range of internal or external barriers to local councils adopting carbon actions.

The main opportunities identified by Queensland councils to reduce their carbon emissions were through managing methane from landfills, allied with waste management and recycling initiatives such as *improved organic matter management*. This was followed by planting trees on council land for carbon offsetting, and green building design for new council buildings, focusing on sustainability and energy efficiency. These included: *New build to green Star level, retrofits to NABERS level*, and a focus on *tropical design and energy efficiency*. Investment in renewable energy, mainly solar power, was also listed. Logan City Council highlighted a *Regional renewable energy station e.g. solar thermal*; (and) *working with State to generate commercial PV installation incentives*. Logan City has installed an ammonia-based electric chiller air conditioning system in its council building to eliminate HFCs (Jensen, 2012; Spolc, 2012). Other measures cited by councils included water/wastewater management such as *recent technologies that treat waste*; behaviour change programs such as staff training on carbon reduction, *ClimateSmart business clusters*; utilising sustainable technologies (i.e. lighting, cooling, IT); and integrated projects such as electricity demand management. Cairns Regional Council developed an intranet Energy and Emissions System database to track energy/fuel accounts and provide internal reports on carbon emissions down to facility/asset level.

Only six councils identified leasing council land for renewable energy projects. Other areas to reduce carbon emissions were through *continued retrofit of facilities* and *joint ventures with other businesses and local community*. Larger city and regional councils focused on opportunities to reduce emissions through significant investments in renewable energy, green building, and managing landfill.

Discussion

Newman (2010) reviewed seven types of infrastructure for resilient cities to reduce emissions. These included renewable energy (solar, wind, electric vehicles); carbon neutral (energy efficiency, renewable energy, offsetting); distributed (decentralised power/water systems, solar PV); biophilic (biofuels, greening, urban farming); eco-efficient (reduce waste and resource use, biogas); place-based (localism, urban planning, social needs); and sustainable transport (active/public transport). Peri urban and regional cities in Queensland are adopting carbon abatement actions for energy efficiency, renewable energy and eco-efficiency (waste, landfill) to reduce operating costs and carbon liability. Landfill gas power generation (Brisbane, Ipswich, Redland) (CEC, 2013) and methane flaring (Moreton Bay, Fraser Coast, Bundaberg, Gladstone) reduce emissions from waste (Faik, 2012). Gladstone's landfill gas capture is an approved CFI offset project (GRC, 2013), along with Willawong in Brisbane.

This study found significant variations among the main types of Queensland councils in terms of their climate change responses, emissions assessment and carbon mitigation actions (Zeppel, 2012b, 2013c). With regard to the average number of climate change and carbon actions, the highest is by city, then regional, and lastly shire councils. Climate change leadership is mainly evident among coastal councils and some larger inland councils (>30,000 resident population), that have adopted climate change plans and goals. Conversely, smaller shire and regional councils with a resident population under 30,000 were the least likely to assess emissions, have a climate plan, or implement carbon actions. Carbon mitigation actions by Queensland councils are more likely to occur where climate change policies and targets are included in a corporate plan or a climate change strategy. Overall, the carbon actions adopted by Queensland councils were similar to those of Greater Adelaide councils, except for minimal investment in Green Power, and limited use of reclaimed water (Zeppel, 2012a). Carbon actions focused on energy, water and waste efficiency and behaviour change actions.

This study found a positive correlation between institutional size and capacity, coastal location, and climate change strategies, for driving carbon mitigation. Mainly larger Queensland councils had already completed an assessment of carbon emissions, or planned to assess their emissions. However, reducing carbon emissions was also regarded as a low priority, due to the smaller size of many councils or being below the reporting threshold for landfill emissions. The carbon actions per capita of regional councils may still be locally significant and reduce costs. Overall, larger metropolitan and/or coastal councils are more 'carbon-ready' (i.e. consolidating or mainstreaming climate actions) than smaller inland rural councils (i.e. latent or emerging actions) (LGAQ, 2009). Based on their carbon management strategies and operations, peri-urban and regional cities are mainly implementing emissions reduction practices within the organisation. Regional cities embedding emissions reduction within their operations include Cairns, Mackay, Townsville, and the Sunshine Coast. In both Queensland and New South Wales, coastal and metropolitan councils with larger populations have

implemented more climate change actions than smaller inland councils (Urbis, 2010). City councils are more likely to have staff and resources dedicated to carbon mitigation actions.

In Australia's new carbon price regime, energy efficiency and cost savings will be key drivers for local government to reduce their emissions and carbon liability. Rate increases by local governments in 2012/13 budgets now include carbon price impacts from the higher cost of electricity and materials, through increased waste management and landfill charges, or new levies. Mayors also want municipal waste and council landfills to be exempt from the carbon tax. In mid-2012, the LNP Queensland State government ended the industry waste levy, reduced solar power feed-in tariffs, and scaled back state-funded sustainability or carbon programs, stating these were the 'responsibility of the Australian government.' Waste is also being moved from coastal cities to peri-urban or adjacent rural areas: waste from Cairns is trucked to landfill at Mareeba in the Tablelands, while Redland City waste is moved to landfill in the greater Brisbane area. In addition, some 8,660 tonnes of hazardous waste was transported in 2011/12 from New South Wales and other states with higher waste fees into South East Queensland landfills (Chamberlin, 2012; McKenny, 2013). The Queensland waste levy and The Waste Avoidance and Resource Efficiency Fund were cut in the 2012/13 Queensland state budget, along with the Local Government Sustainable Future Fund. In 2012, three Queensland councils were awarded federal government Community Energy Efficiency Program grants to upgrade their facility and street lighting and energy usage (i.e. Brisbane, Cairns, and Townsville). A Local Government Energy Efficiency Program allows all LGAs to apply for a one-off grant to install solar or heat pump hot water systems in community facilities (DCCEE, 2012a). However, \$98 million was cut from the Low Carbon Communities program in the federal budget for 2013-14 (Ecogeneration, 2013a). These policy aspects both hamper or enhance carbon mitigation action by city councils and local government.

All of these factors influence the capacity of councils to implement climate change responses, resulting in largely opportunistic approaches to carbon mitigation actions. However, city councils can still progress and support emissions reduction measures by establishing carbon and energy targets in their asset management, procurement, and tenders, or in planning and development regulations. Public transport, energy and water efficiency guidelines can be stipulated for new urban developments. Strategic partnerships with energy providers (e.g. electricity demand management, solar PV, performance contracts, bio-energy) could also help councils to reduce emissions (Steffen et al., 2012; Storey et al., 2012). One third of Mackay City's power now derives from a 38MW cogeneration plant producing bioenergy from bagasse or sugar cane fibre (Ecogeneration, 2013b). The Sunshine Coast Council (2013) is funding a utility scale solar farm at Coolumb to supply half its energy needs over the next 30 years and to reduce the council's electricity carbon footprint by 50%.

Impediments to carbon actions such as penalties for reduced energy use in bulk electricity contracts, higher fees to service energy efficient street lighting, and legal barriers to installing cogeneration or trigeneration systems need to be addressed for local councils. The drivers and barriers of carbon mitigation also need to be further investigated for peri-urban and regional cities. This includes the influence of Federal and State government policies, levies and funding programmes for energy, water and waste efficiency, land use, transport planning, urban development and renewal.

Local governments in Australia are still implementing carbon mitigation actions, irrespective of shifting climate change or energy policies (i.e. carbon price, solar tariffs) at State or Federal levels (Storey & Eckstein, 2013). This is driven by cost saving, community action, corporate responsibility and sustainability leadership. Urban, peri-urban and larger regional cities will continue to lead the municipal adoption of eco-efficiency initiatives in energy, water, waste management, and recycling.

Conclusions

This paper reviewed carbon mitigation actions by local councils in Queensland. The four peri-urban and seven regional cities had all assessed greenhouse gas emissions from council operations. Two coastal cities considered renewable energy guidelines in planning decisions (Sunshine Coast, Townsville), while three cities purchased Green Power. Cost savings, environmental regulations, council climate strategies, and demonstrating climate leadership were key drivers for Queensland councils to reduce carbon emissions. Carbon leadership was mainly evident among urban and regional councils (>30,000 resident population), that have adopted climate change strategies and goals and included carbon actions in a corporate plan. However, peri-urban cities were opportunistic in adopting carbon actions, engaging in climate change initiatives as resources allowed, while coastal regional cities proactively adopted carbon mitigation actions. One inland regional city was minimalistic in complying with statutory obligations. Managing urban development and economic growth often takes priority over carbon mitigation in regional cities and peri-urban areas. Both peri-urban and regional cities need to address barriers and opportunities for carbon management, including policy, funding, and project priorities. Some key areas include waste management and green procurement. Council planning and development approvals should also include energy efficiency and renewable energy criteria to reduce carbon emissions. Involving energy companies and communities in these carbon abatement actions will assist the sustainability and liveability of peri-urban and regional cities.

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