



Review of Carbon and Water Management Policies for the City of Newcastle, Australia

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1. Introduction

1.1. Purpose of Report

This report aims to evaluate sustainability solutions and to offer recommendations for the City of Newcastle's forthcoming Climate Action Plan. The report will refer to policies in the Newcastle 2020 Carbon and Water Management Action Plan, and include:

- A comparison of sustainability policies with other 'second cities',
- Evaluation of funding mechanisms for policies, where possible, and
- Suggestions for improvements or alternative policies.

In reviewing interventions and policies from other cities, we aim to review policy inputs that yield the best results based on outputs

and outcomes, e.g. electricity usage reduction and higher levels of community outreach. We will also attempt to uncover the possible factors that contribute to policy successes in other cities, where information is available. This includes a review of funding mechanisms, and the success and limitations of the policy.

Lastly, the report will provide a list of policy recommendations, which are ideally inexpensive and easy to implement in Newcastle while also providing the biggest impact on environmental sustainability. These recommendations aim to position Newcastle well to move beyond consider innovative solutions for increasing sustainability.

1.2. Methodology

In this report, we have divided the evaluation based on broad targets. Diverting from the 2020 Carbon and Water Management Action Plan, we will not be evaluating policies based on Council Operations, Residential Sector, Education Sector and Business Sector. Instead, we have divided the evaluation into broad goals, namely:

- Water Management,
- Waste Management,
- Carbon Emissions Reduction, and
- Community Involvement.

We also compare two types of cities: 'second cities', defined as those that are the second most important after capital cities, and a number of cities in Australia, due to the

similarity of background, geography and politics. The second cities considered in this report are as follows:

Second Cities

1. Dundee, Scotland
2. Cleveland, USA
3. Pittsburgh, USA
4. Richmond, USA
5. Bristol, England
6. Sheffield, England
7. Aarhus, Denmark
8. Geneva, Switzerland
9. Hamilton, New Zealand

For contextual purposes, and to truly assess the transferability of successful interventions; some Australian cities have been included for

comparison. This report also considers a range of population sizes, land types, climates and degrees of urbanisation, with a consideration of available data; therefore, the Australian cities considered are as follows:

Australian Cities

- 10. Hobart, Tasmania
- 11. Melbourne
- 12. Brisbane
- 13. Sydney

While not all of the second cities are explicitly referenced in our report, research has been conducted into all of them. The chosen cities

have been analysed based on their strengths in the related sustainability policy, and can be found in the table below. The strengths, weaknesses and relatability of their environmentally-directed interventions will be considered in section (3) where relevant. Basic demographic information of each city can be found in Table 1, in order to provide some context for the comparison study.

Lastly, we recommend that further research should be done in other cities listed where possible, even if the specific measures were not analysed in this report.

Table 1: Summary of cities covered in this report

City	Demographics	Sections
Newcastle, Australia	<ul style="list-style-type: none"> ● Population: 155,411 (2016) ● Area: 261.8 km² 	-
Aarhus, Denmark	<ul style="list-style-type: none"> ● Population: 273,077 (2018) ● Area: 91 km² 	3.1., 3.2.
Bristol, England	<ul style="list-style-type: none"> ● Population: 535,907 (2011) ● Area: 11 km² 	3.3.
Cleveland, OH, USA	<ul style="list-style-type: none"> ● Population: 385,525 (2017) ● Area: 213.6 km² 	3.1., 3.3., 3.4.
Geneva, Switzerland	<ul style="list-style-type: none"> ● Population: 200,548 (2017) ● Area: 45.86 km² 	3.4.
Liverpool, England	<ul style="list-style-type: none"> ● Population: 552,267 (2011) ● Area: 111.8 km² 	3.3.
Melbourne, Australia	<ul style="list-style-type: none"> ● Population: 4.443 million (2014) ● Area: 9,990 km² 	3.1.
Pittsburgh, PA, USA	<ul style="list-style-type: none"> ● Population: 302,407 (2017) ● Area: 151.1 km² 	3.3.

2. Overview of Newcastle's Progress

2.1. Newcastle: current progress

Newcastle has previously shown, and continues to show, vast improvements in their environmental action, reflected greatly by their sustainability policies. As a progressive city, Newcastle has made climate change action a priority. Having a well-educated public and a plethora of initiated interventions; the city has built a firm foundation. Existing intervention policies range from infrastructural improvements to targeting waste and recycling, from water and sanitation to transportation enhancements ⁽¹⁾. Yet, there remains much to be done.

Newcastle's smart city strategy is already award-winning, but further developments would allow more widespread uptake

throughout the city, with the ultimate aim of being environmental sustainability in the long run. The methods recommended in this report targets evidence-based improvements, drawing from both the successes and failures of cities around the world, those equally driven to protect their environment and its inhabitants.

Though there remains much to be refined, Newcastle's current efforts provide a stable platform to build upon. Having the mere communication between all three levels of government, the community and their skilled professionals will enable more multisectoral implementation of new interventions, and continuous execution of the current ones.

2.2. Newcastle: room for improvement

Like much of Australia, Newcastle unfortunately maintains a legacy dominated by the coal industry. Failure to pass legislation that would have reigned in Greenhouse Gases (GHG) emissions in August of 2018 implies the country's unlikelihood to meet the prescriptions of the Paris Climate Accord ⁽²⁾. As of 2009, Newcastle was "the world's biggest coal exporter" ⁽³⁾, and according to the Tyndall Center for Climate Change Research, while

Newcastle's carbon dioxide "emissions from the burning of fossil fuels remained largely stable over the study period 2005-2015, [the] trend reversed in 2014 since when emissions have increased" ⁽⁴⁾. Given Newcastle's historical contributions to GHG emissions in the form of coal and other fossil fuels, reduction of GHG emissions and shifting to renewable energy forms are two prevalent themes of our report.

3. Comparing Successes of Other Cities

3.1. Water Management

Overview

Water sustainability is becoming a more complex issue in developed cities. This can be attributed to the growing linkages between urbanisation, climate change and water management. In order to maintain water security, innovative methods must be used to protect Newcastle against shocks such as droughts and floods. In line with this, the United Nations Educational, Scientific and Cultural Organization (UNESCO) outlined targets to ensure water sustainability ⁽¹⁾.

While many of Newcastle's current solutions are targeted at reducing water demand, another method entails enhancing channels for water supplies. Some examples include wastewater treatment and methods of reuse of stormwater. This section will analyse two key issues of water management: water conservation and wastewater treatment.

Solutions

Water and Energy Conservation

The 2013 Sustainable Cleveland Municipal Action Plan ⁽²⁾ outlines the potential for water conservation savings through the installation of a building automation system (BAS). In 2013, the Cleveland City Council had seven of 175 buildings with BAS installed, with plans for further expansion.

Cleveland's BAS monitors and manages water use in order to identify leaks in buildings through a centralised computer-based system. Energy and water usage is tracked for appliances that provide heating, cooling, ventilation, motors, lighting, etc. Due to this smart technology, monitoring and troubleshooting tools can be accessed

remotely. Moreover, the BAS should include "robust trending capabilities" in order to log the system in order to establish baseline statistics on electricity and water demand, in order to make further improvements ⁽³⁾.

Cleveland estimates that the initial installation cost of BAS would be US\$0.75 to US\$1.00 per square foot, equivalent to 20 to 30% of annual utility costs. In the first four years, annual costs are estimated at US\$760,000, with yearly cost savings of around US\$160,000. In the longer term, net cost savings are expected to be around US\$430,000. Overall, combined water conservation, energy conservation and community education (Section 3.4.), would lead to 10 to 15 percent cost savings ⁽⁴⁾.

Wastewater Management

Sustainable Urban Drainage Systems (SUDS) are a main intervention to improve wastewater management. It has been implemented in many cities, including Dundee, Scotland ⁽⁵⁾; Aarhus, Denmark; and Melbourne, Australia. SUDS broadly refer to infrastructural improvements, such as the installation of ground-level filters to remove impurities from rainwater. In Melbourne, the 2017 Total Watermark: City As A Catchment programme aims to improve the city's drainage maintenance system to respond to at least 1 in 20 high rainfall events by 2030 ⁽⁶⁾. Additionally, the city plans to integrate water sensitive urban design (WSUD) by improving permeability of ground surfaces and doubling canopy cover by 2040. Benefits of WSUD includes flood mitigation, cooling of the city, and prevention of wastewater runoff.

In Risvangen, a neighbourhood in Aarhus, sewer pipes are separated for rainwater and wastewater ⁽⁷⁾. No rainwater pipes are dug down; instead, all rainwater is handled in the surface using SUDS infrastructure. The local water utility company handles installation of the system. Alternatively, local residents can manage rainwater on their own plots and can receive financial reimbursements for installation costs. While some residents were sceptical about the project, the city council involved citizens in the process through workshops, extensive FAQs, and even individual advisory sessions for owners of private plots ⁽⁸⁾.

Beyond infrastructural changes, Cleveland runs a Rain Barrel Program which aims to educate and empower residents, businesses and organisations to capture stormwater by providing free rain barrels. Stormwater refers to rain that runs off houses, footpaths, roads and carparks into gutters, ultimately flowing into the stormwater system. From 2008, the City of Cleveland has distributed at least 450 rain barrels to the public every summer and conducts 20 to 25 rain barrel workshops annually ⁽⁹⁾. The programme also relies heavily on youth engagement, and more than 4,000 barrels have been provided to residents through the Mayor's Summer Youth Employment Program since 2013. Rain barrels allow residents and businesses to divert water from downspouts into the barrel, and then use it for water gardens, lawns or washing cars. In the summer, when supply of water decreases and demand increases, 40% of water use goes to irrigation. The use of rain barrels helps to provide a sustainable and efficiency supply resource.

Lastly, the City of Cleveland also provides fee credits to incentivise owners to make improvements to their properties in order to reduce the amount of runoff from stormwater. Owners can get fee waiver by

disconnecting their downspouts, installing rain barrels or planting rain gardens in order to control stormwater runoff on their property. Likewise, the City Council of Richmond, Virginia, provides stormwater credits for residents and businesses which improve green practices and reduce stormwater runoff.

Evaluation

While Newcastle has made significant progress in improving resource efficiency via the installation of water- or energy-efficient appliances and rating systems ⁽¹⁰⁾, potential improvements can be made in resource management and monitoring. Smart systems promote greater cost savings in the long run, through monitoring and review of data and troubleshooting.

Moreover, Newcastle's last Stormwater Management Plan was in 2004 ⁽¹¹⁾. Few actionable plans have been made since to use stormwater and rainwater in a sustainable manner ⁽¹²⁾. However, Newcastle's 2017 Urban Water Cycle Policy aims to "[Work] towards valuing stormwater as a resource and not a nuisance that is drained to the nearest waterway." ⁽¹³⁾ The recommended policies should be taken into account to realise this aim.

Geographically, Newcastle's humid subtropical climate leads to heavy precipitation in late autumn and early winter. On average, there are 135.9 days of precipitation annually. While flooding is generally rare in Newcastle, the city predicts that it will continue to happen in the future. While Newcastle has not experienced the Probable Maximum Flood in the last 200 years, flood and stormwater management will continue to be a key concern moving forward. Hence, stormwater management is beneficial to Newcastle on many accounts

3.2. Waste Management

Figure 1: Categorisation of four types of waste



Municipal Solid Waste

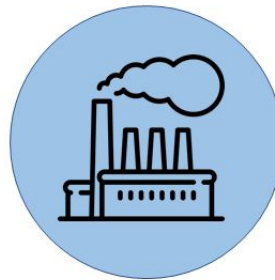
Waste collected by municipalities or other local authorities, e.g.:

- Food waste
- Garden or park waste
- Paper and cardboard, wood, textiles, disposable diapers, rubber and leather, plastics, metal, glass
- Other materials (e.g., ash, dirt, dust, soil, electronic waste)



Sludge

Usually refers to wastewater. Depending on the city, it can include industrial and domestic wastewater



Industrial Waste

Varies depending on the type of industry and processes or technologies used in the city.

The clearest example would be waste resulting from construction.



Other Waste

Clinical waste covers a range of materials, e.g.:

- Plastic syringes
- Animal tissue
- Bandages and cloths

Hazardous waste includes:

- Waste oil and solvents
- Ash, cinder
- Other flammable, explosive, caustic and toxic waste

Overview

Waste, in both its solid and liquid form, is a primary contributor to greenhouse gas (GHG) emissions. Under its 12th sustainable development goal, the United Nations emphasises the importance of reducing “waste generation through prevention, reduction, recycling and reuse” ⁽¹⁾. Which of these methods that should be used to manage waste most efficiently depends on the dominant type of waste; the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories recognizes four categories of waste, as illustrated in Figure 1 above ⁽²⁾:

In addition to categorize these types of waste, waste management policy must also consider

the mobility and transportation of waste. As illustrated in Figure 2 below, imported waste (waste that is brought into the city to be disposed) and exported waste (waste generated in the city but disposed elsewhere) both fall within a gray area regarding whether they should be counted amongst the city's emissions. In this report, we recommend including in the measurement of a city's waste-based GHG emissions strictly the waste that is treated within the city's boundaries.

Some of Newcastle's existing waste classification systems, especially regarding segregation of compostable forms of waste and food waste, are admirable, positioning the city well to capitalise on the incineration methods of waste management explicated

below. Newcastle possesses infrastructure for isolating garden waste and existing composting facilities for treating this “garden

waste”. It also is in the process of constructing “an organics processing facility [...] in the next three years” that will process food waste ⁽³⁾.

Figure 2: A city’s waste should be accounted as imported waste and waste generated and treated within the city (adapted from Fong et al, 2014)



With this existing infrastructure and the impending developments, Newcastle is poised to capitalise on the fact that organic matter, like food and garden waste, produces methane in its decomposition, which is a key generator of electricity.

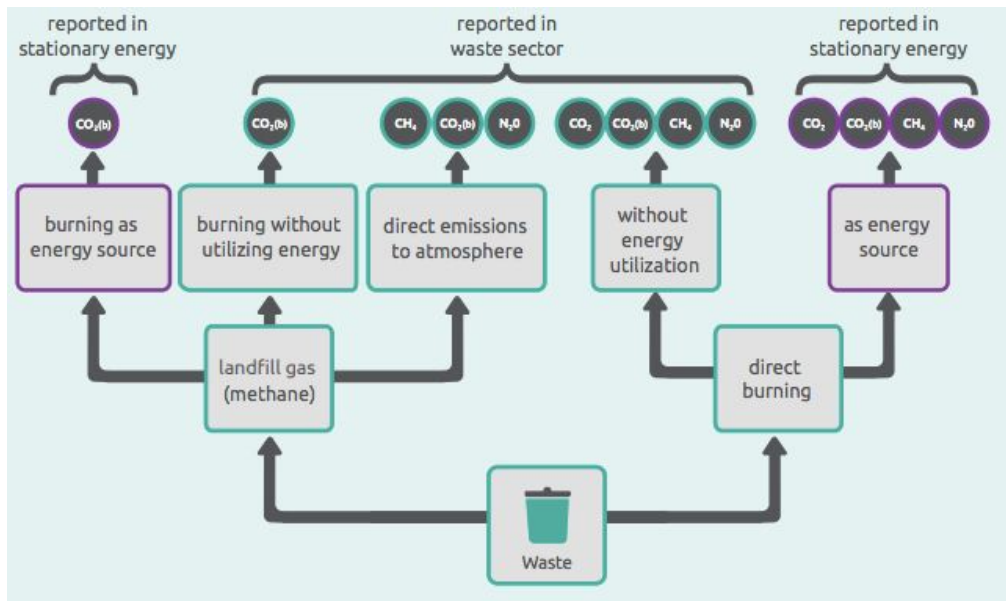
- waste disposal in landfills or dump sites,
- biological treatment of solid waste,
- incineration and open burning of waste, and
- wastewater treatment and discharge.

Solutions

Before launching into our analysis of Aarhus, Denmark’s innovative waste management strategies, we will introduce traditional waste treatment methods; the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories identifies four waste treatment strategies, as follows:

In this report, we will focus on the incineration of landfill gases, for, as shown in Figure 3, this method is one of the lowest contributors to GHG emissions and possesses the added benefit of providing an additional energy source.

Figure 3: Emissions by waste treatment practice (Fong et al, 2014)



Aarhus, Denmark

Aarhus “boasts a range of world leaders within the clean tech area” and has adopted especially innovative strategies for waste management ⁽⁴⁾. All of the country’s waste and heating systems are managed through one centralized, municipally-funded company: AffaldVarme Aarhus. In 2015 “AffaldVarme Aarhus collected 230,000 tonnes of waste in the municipality, mainly from households: 59% was sent to recycling, 39% was incinerated, 1% was deposited and 1% was sent to special treatment” ⁽⁵⁾. The energy generated from the waste treatment also provided 16% of district heating ⁽⁶⁾.

The combination of power and waste management systems is one of AffaldVarme’s hallmarks of success. AffaldVarme has begun to combine power and incineration plants to harness the energy gained from burning waste for heating and electrical purposes. In these “Incinerating Cogeneration plants...the fuel is waste” ⁽⁷⁾; a waste incinerator is located on the same site as a heating and power plant. While Newcastle already “captures this methane and uses it to generate electricity,” ⁽⁸⁾ we want to reiterate the efficacy of this

practice and propose Aarhus’ infrastructural design of the cogeneration plants as one to emulate.

Lastly, we will consider some of Aarhus’ small-scale, on-the-ground practices. According to Aarhus Municipality’s Waste Plan 2015-2018, one of its implementation goals was to provide more sorting close to citizens ⁽⁹⁾. AffaldVarme achieved this goal through the introduction of mobile sorting containers, containers stationed in the center of the city that automatically sort recyclables. This alleviates the burden of proper waste disposal from the people. This system is especially necessary because of Aarhus’ eight waste sorting categories: garden waste, construction waste, hazardous waste, residual waste, lightbulbs, batteries, paper and small cardboard, and glass, plastic and metal ⁽¹⁰⁾. The existence of such a complex and specific sorting system might not be viable for Newcastle to launch right into, but perhaps could be phased in gradually over time.

Evaluation

According to Newcastle’s Community Strategic Plan, the city’s goals for 2030 pertaining to

waste include diverting domestic waste from landfills, increasing recycling, and diverting green waste from landfills ⁽¹¹⁾. While these are admirable goals, the Community Strategic Plan provides few tangible tactics for achieving them. As suggested above, the most effective way to understand waste's environmental impact is through measuring GHG emissions.

We advise the city to consider adopting a GHG measurement system to better analyze its progress. Various practices are outlined in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. The widely used process entails identifying the mass of each type of waste and the emission factor correlated with that type of waste; these two quantities are then multiplied to

estimate the quantity of emission. Debate arises, however, about the accuracy of and best practice for determining the emission factor of each waste type, and regarding the process of distinguishing the types of waste amongst conglomerated and heterogenous waste. Quantification disputes aside, Newcastle should prioritize the use of Cogeneration Plants as a waste management strategy. Aarhus' small-scale practices, such as mobile sorting containers and extensive recycling categories, are less infrastructurally intensive and more immediately accessible strategies. Aarhus' revolutionary strategies, which positioned Aarhus amongst the global leaders in waste management, could greatly lower Newcastle's GHG emissions and contribute to its waste management goals.

3.3. Transport and Carbon Emissions

Overview

The targets to reduce CO₂ emissions of the cities that are comparable to Newcastle vary. Each city aims to reduce CO₂ emissions from the level of a self selected base year. However, each city has chosen different base years, making direct comparison between the targets challenging. The differences in targets also arise due to factors such as political will, council capacity, citizen engagement and education schemes and local and national priorities. The review of available data shows

that among the cities with the most ambitious targets globally are Copenhagen, which aims to be carbon neutral by 2025 and Stockholm and Pittsburgh, which aim to be carbon neutral by 2050. The cities analysed aim to reduce CO₂ emissions by 2035 by between 60 and 80 percent. More detailed information can be found in Table 2 which shows the relevant data.

Table 2: Targets to reduce CO₂ emissions of selected cities

City	Targets to reduce CO ₂ emissions
Newcastle, Australia	<p><u>City Council to reduce reduce emissions by 30% by 2020</u></p> <ul style="list-style-type: none"> • 30% reduction in council's electricity usage • 20% reduction in council's fossil-based liquid fuels usage • 80% reduction in council's operational waste going to landfill • 30% of council's electricity supplied from low carbon sources.
Pittsburgh, PA, USA	<p><u>Reduce CO₂ levels (below 2003 baseline)</u></p> <ul style="list-style-type: none"> • 50% by 2023 • 80% by 2030 <p><u>Pursue a future carbon neutral goal by 2050</u></p> <p><u>Improve internal city operations</u></p> <ul style="list-style-type: none"> • 100% renewable electricity use • 100% fossil fuel free fleet • Divestment from fossil fuels <p><u>Related Targets</u></p> <ul style="list-style-type: none"> • 50% energy use reduction • 50% water use reduction • 50% transportation emission reduction • Zero waste: 100% diversion from landfills
Liverpool, England	<p><u>Reduce CO₂ levels:</u></p> <ul style="list-style-type: none"> • 35% by 2024 <p><u>Make city adapted for future climate</u></p>
Bristol, England	<p><u>Council-wide reduction of energy consumption</u></p> <ul style="list-style-type: none"> • 40% by 2020 • 50% by 2025 • 60% by 2035

	<ul style="list-style-type: none"> • 80% by 2050 <u>City-wide reduction of energy consumption</u> <ul style="list-style-type: none"> • 30% by 2020 • 35% by 2025 • 45% by 2035 • 55% by 2050
Sydney, Australia	<u>Reduce CO₂ levels (below 2006 baseline):</u> <ul style="list-style-type: none"> • 44% by 2021 • 70% by 2030 <u>Improve renewable energy</u> <ul style="list-style-type: none"> • 50% electricity demand met by renewable sources by end June 2021
UK Core Cities*	<u>Reduce CO₂ levels (below a 2005 baseline) ⁽⁹⁾</u> <ul style="list-style-type: none"> • 33% by 2020 • 80% by 2050

*Note: UK Cities include Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield

Transport is a significant contributor of GHGs in urban areas, given that vehicles are largely powered by fossil fuels like gasoline, diesel and gas. Counterintuitively, the contributions from transport to the overall CO₂ emissions were similar in the cities reviewed despite significantly different population densities. Appendix B contains information available CO₂ emissions by sector in the cities analysed. However, it was not possible to make directly relevant comparisons given that the information is available for different years and measures different sources. Most importantly, some cities including Newcastle and Cleveland did not provide city-wide inventories but rather only the GHG generated by city council.

It is evident that in the cities where information was reviewed, transport contributes between 17% to 22% of CO₂ emissions. The review of the plans of Pittsburgh (2017), Liverpool (2009), Cleveland (2013), Bristol (2015) and Sydney (2017) shows was useful to identify the types of initiatives that each municipality is undergoing in the transport sector to positively contribute to

decreasing Greenhouse Gas Emissions and to reach the targets mentioned in Table 2.

Solutions

This section will outline the most relevant initiatives being implemented by comparable cities to Newcastle to address CO₂ emissions in the transport sector. The section contains two parts. The first part outlines city-wide initiatives, those that are led by the municipality but affect directly citizens of the city. The second section contains council-wide initiatives, those that are carried out by the council to lower their emission footprint.

City-wide initiatives

A number of cities have a Comprehensive Plan dedicated to improving the transport sector, namely Pittsburgh⁽¹⁾, Liverpool⁽⁴⁾, Bristol⁽⁹⁾ Cleveland⁽⁶⁾, and Sydney⁽¹²⁾. At the most basic level, cities like Pittsburgh have synchronised traffic signals to ensure smooth traffic movement, bus prioritisation, after-hours freight prioritisation, etc. Other measures include anti-idling enforcement,

which is carried out in Liverpool ⁽⁴⁾ and Cleveland⁽⁶⁾.

More ambitiously, Bristol aims to implement a Bus Rapid Transit system. The City will deliver the MetroBus network with a budget of £265 million, which includes the following infrastructural improvements:

- 6 km of new highways,
- 2.5 km of guided busways (two-way),
- 18 km of bus lanes and unguided bus alignments (one-way),
- 48 pairs of new or improved stops and interchanges,
- 50 new hybrid drive vehicles, and
- A reconfigured city centre interchange and public domain upgrade. ⁽⁹⁾

On top of improving public transportation systems, some cities aspire to increase the use of carbon-neutral commuting modes like walking and cycling. Pittsburgh aims to increase walking commute rates by 50% and increase bike use for 10% of trips. The latter would be done by implementing a citywide bike plan, improving bike infrastructure, and promoting and growing bike share programmes ⁽¹⁾. Bike infrastructure would also be integrated with public transit systems.

Bristol City Council (BCC) has a budget of £16 per person in Bristol City to implement a Cycle Strategy with 10 km of new cycling infrastructure. This includes the delivery of a cycle network, as well as urban planning policy that ensures new developments encourage walking, cycling, and good connection to public transport. BCC will work with partners to secure funding and deliver the Metro West scheme in 3 phases. Phase 1 (by May 2019) has a budget of £45-£55m (2019 prices), and Phase 2 has an estimated £43.1m (2021 prices)⁽⁷⁾.

Sydney has built 12.5 km of new traffic-separated cycle-ways to date. They offer training courses in safe and courteous cycling, and created public spaces and

pedestrianised area. The council advocates for improvements to public transport across the city as a more sustainable way to travel. Nonetheless, the city recognises how cars may still be a convenient mode of transport, and hence they facilitate car sharing schemes by providing dedicated on-street parking ⁽¹⁴⁾. This reduces the rate of car ownership, while still allowing commuters to drive when they need.

The promotion of multimodal trips can also reduce the carbon footprint of the transport sector. To drive big changes, some cities have expanded their central transit hubs. Bristol has developed a smart method for mobility management through information, behavioural change and 'soft measures'. These include Urban Traffic Control and management of the highway network, as well as conventional public transport improvements, as outlined above.⁽⁹⁾

Behavioural change is arguably the most difficult to enact. Hence, cities must incentivise commuters to choose public transport options. The Liverpool Plan will build on a plan for behaviour change and also will market "smarter choices" for commuting. Liverpool builds on the Personalised Journey planning work undertaken in Wavertree, where participants average a 10% modal shift to more sustainable choices.⁽⁴⁾

Council or Municipal initiatives

City-wide changes require ambitious targets and policies. Thus, many city councils also implement internal organisational changes. Firstly, council staff and employees should be engaged in sustainable commuting. For example, Liverpool builds on Travel Plans of the City Council Project via interest free loans and salary sacrifice scheme to promote more travel for council staff. They also encourage other partner organizations to develop a green transport plan. Cleveland uses a Green Employee Commuting scheme to reduce employee commuting VMT. This promotes an

increased use of tele-working and alternative transportation modes, such as the public transit system (RTA and downtown trolley system), carpooling (e.g., NOACA Ride Share Program), biking, and walking.⁽¹²⁾

City Councils also play a pivotal role in directing change of the municipality. Sydney reduced their fleet emissions by 26 per cent over four years and gained recognition as finalists in the National 2015 Banksia Awards' Mindful Movement category for our sustainable fleet management program.⁽¹²⁾ Councils should aim to develop local high profile initiatives, and can work with the private sector to do so. Liverpool, for example, provides an increased range of coverage for Whizzgo (private hourly car rental) and support for electric vehicles to be powered from renewable electricity sources.

This builds public awareness and behaviour change required for a low carbon transport city.

Some cities have initiatives to improve the existing municipal fleet. Liverpool promotes regular vehicle routes and uses the municipal fleet for occasional staff travel. Cleveland has a Vehicle Replacement and Repower scheme which seeks to establish policy ensuring that all new vehicle purchases and retrofits are more efficient. This applies to all types of vehicles: conventional, hybrid, electric or alternative fuel (such as compressed natural gas (CNG)). Technologies can be adopted, where the City's fleet includes hybrid and battery electric vehicles (BEVs) powered by renewable electricity. There is also as well as a bicycle fleet.

Case Study At a Glance: Achievements of Bristol

The following set of initiatives demonstrate the range of actions implemented by Bristol:

- Has a total of 62 hybrid vehicles, 15 CNG and 91 flex fuel vehicles in the fleet.
- Will install three electric vehicle charging stations.
- Passed an Anti-idling ordinance so no City vehicle or piece of equipment can be idled during non- emergency situations (2009).
- Passed a Complete and Green Streets ordinance requiring all construction and reconstruction in the right of way to incorporate best practices in complete streets and green infrastructure (2011); such practices include promoting alternative modes of transportation to accommodate pedestrians, cyclists, motorists and public transit.
- Passed a Bicycle transportation safety ordinance to protect cyclists on the road (2012).
- Built the Bike Rack, a downtown facility featuring 50 bicycle storage facilities, showers and related amenities for commuters (opened in 2011).
- Over 30 miles of bike trails currently in the City, with a goal of reaching 180 miles.
- The City participates in the Regional Transit Authority's (RTAs) Commuter Advantage Program. The City also participates in Bike to Work Day each year.

Given that transport contributes between 17% to 22% of CO2 emissions in the selected cities, it is important to take measures to use clean transport in order to achieve carbon neutrality. Additionally, the mental and physical health benefits from active and public transport contribute to the vibrancy of cities. Factors such as connectedness

contribute toward the efficiency of the local population and may also have positive effects on local economic development and skilled labour retention and attraction. Furthermore, investing in transportation is often well-received by urban dwellers and may generate better political goodwill than investment in other sectors.

3.4. Community Involvement

Overview

Individuals remain the cornerstone. Environmental sustainability cannot merely be achieved by policy, but must be done through social responsibility. Societies globally have always been of great influence on the milestones of nations, whether it be revolutions, civil disobediences, humanitarian aid or any impactful events of such magnitude; its value indispensable. If there are lessons to be learnt from history, a major one would be that collective understanding and efforts towards the same goal would always have a greater impact than an individual response.

Though in itself community engagement is a difficult indicator to measure, the ripple effect from its success seeps into more tangible measurements; from reduction in electricity in homes to use to reducing carbon footprint through transportation, from appropriate garbage disposal to the use of renewable energy sources; all of which are currently top priorities for Newcastle city council. Social inclusion in environmental action is not completely charted yet, there are interventions that have been implemented and reported, some that are in progress, and many that are yet to be. This report will focus on successful ones, their strategies and outcome.

Youth mobilisation

Having a similar population size, sustainability goal and 'developed country' stature as Newcastle, Cleveland in the United States of America (USA) is an impressive example of social involvement in environmental programs. Priding themselves on being "powered by citizens", Cleveland has managed to implement one of the most notable strategies in their country. This was done

through civilian inclusion in the creation of their Climate Action Plan (CAP)⁽¹⁾, empowering and encouraging their input in both its planning and, later, the achievement of its goals. They have also acknowledged parks, environmental safety and natural beauty as a means to achieve a better level population health. Additionally, they have implemented multiple social programs like the "Climate Action Funding Crowdfund Challenge"⁽²⁾ and the "Program of Cleveland neighbourhood"⁽³⁾. An approach of such mobilizes the most active population in their community; their youth. As a result of these state-funded events that their mayor has been announced as a 'green mayor'. The results were also apparent in their response to the country's withdrawal from the Paris Climate Change Agreement, where there was state-wide resistance that resulted in them following the agreement independent of the USA.

However, given the composition and structure of Cleveland's state-wide government, the scope of these programs may be somewhat different if it were to be implemented in Newcastle, as the city is focused more on state-level legislation and planning rather than that of a city level. This bottom-up approach has also yielded favourable results in multiple cities, including but not limited to Rio in Brazil and Hobart in Tasmania, Australia⁽⁴⁾⁽⁵⁾.

"The youth is the hope of our future". While Cleveland's method of inclusion of the younger generations was through social challenges, Hamilton in New Zealand approach was youth-encouragement through their schools. Several public schools have been declared "Enviroschools", meaning not only do they see environmental programs in action (through saving electricity in school

classrooms, minimising food waste and recycling), but they receive more extensive education on the matter through their strengthened environmental science programs ⁽⁶⁾. This would result in individual action change, both consciously and unconsciously, encouraging the continuation of these practices back in their homes and, later, in their lives after school; yielding long-term durable results. As Hamilton's main focus is on air quality, it's no surprise that this was a big part of their strategy; the behaviour change from this type of intervention encourages better means of transport (walking, cycling, or public transport), saving electricity and better individual waste management; all decreasing carbon footprint ⁽⁷⁾.

Enabling environmental action

Taking it a step further, Geneva in Switzerland, having an educated and involved

population, managed to lay out enabling factors to allow them to act on what they've been taught. Geneva aims to decrease their CO₂ emissions by 25%, with one of their biggest focuses the energy consumption of municipal real estate ⁽⁸⁾.

Encouraging individual action is not only the most practical but also the most cost-efficient way to achieve this goal. Providing them with an enabling infrastructure, transportation system and "Ecopoint" to sort out recyclable waste by themselves. The founding of organisations like the Geneva Environment Network have allowed for multiple social events and programs to be planned through a designated entity. Being famous for creating "Green economies, green trade and green jobs" the power and jurisdiction of this entity has been increasing dramatically since it was created, emphasizing their importance and roles in mobilising community action.

4. Recommendations

4.1 Overarching recommendations

Considering the environmentally-aware population of Newcastle, be it community or governance, the recommendations that will be put forth by this report are believed to be achievable in such a setting. First and foremost the Newcastle council is advised to maintain their current progress in environmental interventions, monitoring its effectiveness and sustainability continuously. Secondly, the interventions from the cities above should guide further advancement of the field and its consideration in others.

This report is intended to steer immediate attention towards the enhancement of the water, waste, transport and community engagement; with acknowledgement that other alternative methodologies remain. The sector-specific recommendations below, guided by the Sustainable Development Goal 13, promote capacity-building and policy changes to ultimately enable a healthy environment for the inhabitants of Newcastle.

4.2 Intervention-specific recommendations

From the above analyses of sustainability policy in other second cities, we have compiled the list of recommendations, categorised into public and private sector action. We recognise the importance of considering the local context of Newcastle when adapting these solutions.

It would require extensive public consultation and meaningful participation, such that civil society and the local community should be involved. Various models that have been effective are citizen-led project specific steering committees and youth councils among others. Lastly, we recommend that infrastructure projects be impactful to the complete range of people that will use the infrastructure that city council invests in.

Water Management

Newcastle's existing solutions have been highly effective in increasing water efficiency for households, organisations and the city council. However more can be done to implement technology-based, smart solutions for both the private and public sectors. The City should also look to increase community involvement to increase water sustainability.

Public sector

- Consider implementing pilot programmes for smart building automation systems (BAS) in municipal buildings, and consider extending the systems to corporate partners if proven to be effective in cost savings and reducing water waste.
- Further examine the feasibility of Sustainable Urban Drainage Systems in Newcastle, and consider retrofitting these systems for households and commercial buildings, where possible.
- Engage the local community in minimising stormwater and wastewater runoff, e.g. through providing rain barrels, fee waivers, etc.

Private sector

- Implement water sensitive urban design (WSUD) or Sustainable Urban Drainage Systems (SUDS) in new development projects.

Waste management

On the waste management front, we recommend that Newcastle consider adopting many of the successful strategies employed in Aarhus. Overall, investment in cogeneration plants should be prioritized over other methods of waste management such as landfills and biological treatment of waste, but given the high infrastructural demands of building new plants, smaller changes, such as more accessible recycling systems, may be more immediately pursuable.

Public sector

- Implement mobile sorting containers for recyclables
- Adopt a system to measure Greenhouse Gas Emissions
 - The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories explicates the emission factors associated with each type of waste and describes the chemical decomposition processes behind each of these emission factors.
- Reaffirm Newcastle's focus on using incineration and cogeneration plants as a primary method of waste disposal.
 - This method is especially viable considering Newcastle's existing practice of separating organic matter from non-organic -- organic matter produces high amounts of methane, which can be leveraged to produce electricity.

Transport

Regarding transport, the paramount importance of investing in effective public transport and in active modes of commuting such as biking or walking is now generally accepted world-wide. It is necessary to achieve densities within cities that make these modes of transport feasible. Additionally, this is a task that requires changing car-centric behaviours, which are entrenched among urban populations.

Public sector

- Synchronise traffic signals to ensure smooth traffic movement, as well as bus and pedestrian prioritization
- Increase the use of alternative commuting modes (biking, walking, public transit)
 - Implement a Bus Rapid Transit System
 - Expand transit hubs to promote multimodal trips
- Implementing a large scale behaviour-change programme across a metropolitan area building a case for smarter choices within Local Transport
- Anti-Idling enforcement

Council initiatives

- Facilitating council staff and employee sustainable commuting
- Developing high profile initiatives, such as support for electric vehicles to be powered from renewable electricity sources, to build the public awareness and behaviour change required for a low carbon transport city
- Reducing municipal fleet

Community Engagement

Through a more community driven scope, practices from other smart cities have proven to be useful though their usefulness should be contextualised to Newcastle, taking into consideration the nature of local communities, their interests and routines.

Public sector

- Public schools should further strengthen their environmental sciences programs as well as incorporate it into others like biology, physics and chemistry- mimicking 'Enviroschools' found in other countries. The cross-cutting nature of its importance increases the ease of its incorporation.
- Taxation is another platform to encourage individual-level changes through incentivising such actions.
 - This could be done through tax reduction for those who practice climate-friendly action, or by increasing the ease/ access through other governmentally- run programs. Through maximising the efficiency of those platforms, more community-based action would be encouraged.

Private sector

- Sustainable changes and programmes should be sought from corporations, through setting regulation standards that would be considered favourable. Some examples include:
 - Setting a minimum quota of involvement in environmental programs
 - A mandate number of climate experts per workers hired and rewarding good practice accordingly.
- Not only would these measures directly impact measurements like carbon emissions, it would also indirectly encourage the communities to participate through social pressures, and the further re-conceptualisation of environment-related experiences/skills as 'hireable' ones.

4.3 Monitoring and review

The council, considering the evidence from the cities above, should accordingly prioritise what they deem the most relevant to the city of Newcastle. It is advised that a monitoring and evaluation is put in place prior to its implementation; be in continuous or interval. This negates the short-termism of current action strategies, and considers the importance of proving effectiveness.

To Newcastle an evaluation system would guide the sustainability of the future programs, through; continuously assessing its cost-effectiveness, collect information about coverage and community acceptability, and guiding future interventions. It would also have a positive impact globally through providing information about said environmental interventions. In a relatively new field, with an extreme paucity of data, a monitoring system provides a global platform from which similar cities could in return learn from and later act accordingly. Climate change is a global issue and should therefore be targeted as one.

5. Bibliography

Title Image

1. Rad Season. *8 of the Best Bars in Newcastle Australia*. 2018
<https://dvmzqg36yy8ja.cloudfront.net/wp-content/uploads/2018/12/Best-bars-in-Newcastle-1.jpg>

Overview

1. City of Newcastle. *Local Environmental Plans (LEP)*. 2019. Available from:
<http://www.newcastle.nsw.gov.au/Development/Land-Use-Planning/Local-environmental-plans> [Accessed 30 April 2019]
2. Newspapers C. Issue 152 of Wyong Regional Chronicle [Internet]. Issuu. 2019. Available from:
<https://issuu.com/centralcoastnewspapers/docs/wrc152> [Accessed 30 April 2019].
3. The Economist. *Coals from Newcastle*. 2009. Available from:
<https://www.economist.com/asia/2009/06/04/coals-from-newcastle> [Accessed 30 April 2019].
4. Tyndall Centre for Climate Change Research. *Eighteen countries showing the way to carbon zero*. Available from: <https://tyndall.ac.uk/news/eighteen-countries-showing-way-carbon-zero> [Accessed 30 April 2019].

Water Management

1. Zandaryaa S. (ed.) *Water in the post-2015 development agenda and sustainable development goals: discussion paper*. UNESCO International Hydrological Programme. Report number: IHP/SDG-WATER/1/2014. [Online] Available from:
<https://unesdoc.unesco.org/ark:/48223/pf0000228120>
2. City of Cleveland. *Sustainable Cleveland Municipal Action Plan*. 2013. [Online]. Available from:
http://www.city.cleveland.oh.us/sites/default/files/forms_publications/SC-MAP_Final_10.1.13.pdf
3. City of Cleveland. *Sustainable Cleveland Municipal Action Plan*. 2013. [Online]. Available from:
http://www.city.cleveland.oh.us/sites/default/files/forms_publications/SC-MAP_Final_10.1.13.pdf
4. City of Cleveland. *Sustainable Cleveland Municipal Action Plan*. 2013. [Online]. Available from:
http://www.city.cleveland.oh.us/sites/default/files/forms_publications/SC-MAP_Final_10.1.13.pdf
5. Dundee City Council. *Whitfield Sustainable Urban Drainage Systems*. 2016. [Online]. Available from:
<https://www.dundee.gov.uk/sites/default/files/publications/SUDS%20Guidance%20Feb%202017%20optimised.pdf>
6. City of Melbourne. *Climate Change Adaptation Strategy Refresh*. 2017. [Online]. Available from:
<https://www.melbourne.vic.gov.au/sitecollectiondocuments/climate-change-adaptation-strategy-refresh-2017.pdf>
7. Hoffmann, B., Laustsen, A., Jensen, I. H., Jeppesen, J., Briggs, L., Bonnerup, A., ... Milert, T. *Sustainable Urban Drainage Systems: Using rainwater as a resource to create resilient and*

- liveable cities*. State of Green. 2015. [Online]. Available from:
http://orbit.dtu.dk/files/118747536/SUDS_White_paper.pdf
8. Hoffmann, B., Laustsen, A., Jensen, I. H., Jeppesen, J., Briggs, L., Bonnerup, A., ... Milert, T. *Sustainable Urban Drainage Systems: Using rainwater as a resource to create resilient and liveable cities*. State of Green. 2015. [Online]. Available from:
http://orbit.dtu.dk/files/118747536/SUDS_White_paper.pdf
 9. City of Cleveland. *Water and Green Space*. Available from:
<http://city.cleveland.oh.us/CityofCleveland/Home/Government/CityAgencies/OfficeOfSustainability/WaterQualityAndEfficiency> [Accessed 30 April 2019].
 10. The City of Newcastle. *Newcastle 2020 Carbon and Management Action Plan*. 2011. [Online]. Available from:
https://www.newcastle.nsw.gov.au/getmedia/b434c1a3-0034-4e46-a8f9-152b309dcaa3/FINAL_Carbon_Water_MAP_for_Web_secure.aspx
 11. The City of Newcastle. *Stormwater Management Plan*. 2004. [Online]. Available from:
https://www.newcastle.nsw.gov.au/getmedia/a80e8204-ffa5-4184-a64e-c98244223e67/stormwater_management_plan.aspx
 12. The City of Newcastle. *Newcastle Development Control Plan: 7.06 Stormwater*. 2012. [Online]. Available from:
<https://www.newcastle.nsw.gov.au/getmedia/24d7f2ef-f52c-49e5-9565-c3b5b1c815c0/7-06-Stormwater-amended-030417.aspx>
 13. The City of Newcastle. *Urban Water Cycle*. 2017. [Online]. Available from:
<https://www.newcastle.nsw.gov.au/getmedia/cf4f3f3f-287d-4c01-b59b-4f62b541acc2/Policy-Infrastructure-Urban-Water-Cycle-Policy-Adopted-28-March-2017.aspx>

Waste Management

1. UN Environment. *GOAL 13: Climate action*. [Online] Available from:
<https://www.unenvironment.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-13> [Accessed 30 April 2019].
2. World Resources Institute. *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories*. 2014. [ebook] World Resources Institute. Available from:
https://www.wri.org/sites/default/files/global_protocol_for_community_scale_greenhouse_gas_emissions_inventory_executive_summary.pdf [Accessed 30 April 2019].
3. City of Newcastle. *FoodWaste*. [online] Available from:
<http://www.newcastle.nsw.gov.au/Living/Waste-and-recycling/Food-Waste> [Accessed 30 April 2019].
4. VisitAarhus. *Energy, climate and environment*. [online] Available from:
<https://www.visitaarhus.com/In-int/central-jutland/nature/energy-climate-and-environment> [Accessed 30 Apr. 2019].
5. VisitAarhus. *Energy, climate and environment*. [online] Available from:
<https://www.visitaarhus.com/In-int/central-jutland/nature/energy-climate-and-environment> [Accessed 30 Apr. 2019].
6. VisitAarhus. *Energy, climate and environment*. [online] Available from:
<https://www.visitaarhus.com/In-int/central-jutland/nature/energy-climate-and-environment> [Accessed 30 Apr. 2019].
7. VisitAarhus. *Energy, climate and environment*. [online] Available from:
<https://www.visitaarhus.com/In-int/central-jutland/nature/energy-climate-and-environment> [Accessed 30 Apr. 2019].

8. City of Newcastle. (2019). *FoodWaste*. [online] Available from: <http://www.newcastle.nsw.gov.au/Living/Waste-and-recycling/Food-Waste> [Accessed 30 Apr. 2019].
9. Affaldvarme.aarhus.dk. *Affaldsplan 2015-2018*. [online] Available from: <https://affaldvarme.aarhus.dk/om-os/organisationen/tal-og-planer/affaldsplan-2015-2018/> [Accessed 30 Apr. 2019].
10. Affaldvarme.aarhus.dk. *Sortering derhjemme*. [online] Available from: <https://affaldvarme.aarhus.dk/affald-og-genbrug/sortering-derhjemme/> [Accessed 30 Apr. 2019].
11. Newcastle.nsw.gov.au. (2019). [online] Available at: <http://www.newcastle.nsw.gov.au/Newcastle/media/Documents/Strategies,%20Plans%20and%20Policies/Strategies/3119-CSP-Strategy-FINAL-WEB.pdf?fbclid=IwAR1s-Ja1dzpez8MBK3aROQD375Oq1BNeQj9nKjIw-5zwt4n-S66YX0F6ARk> [Accessed 30 Apr. 2019].

Transportation

1. City of Pittsburgh [Internet]. *Climate Action Plan Version 3.0* (Pg. 20) [Cited March 15 2019] Available from: http://apps.pittsburghpa.gov/redtail/images/606_PCAP_3_0_Draft-9-26-17.pdf
2. Pittsburgh Climate Action Plan 3.0 http://apps.pittsburghpa.gov/redtail/images/645_PCAP_3.0_Presentation.pdf
3. Merseytravel. *The third Local Transport Plan for Merseyside*. [Cited March 15 2019] Available from: [https://www.merseytravel.gov.uk/Site%20Documents/Full%20LTP3%20\(lo%20res\)%20-%20Regional](https://www.merseytravel.gov.uk/Site%20Documents/Full%20LTP3%20(lo%20res)%20-%20Regional)
4. Merseytravel. *A transport Plan for Growth Liverpool city region*. [Cited March 15 2019] Retrieved from: <https://www.merseytravel.gov.uk/about-us/local-transport-delivery/Documents/8375%20Plan%20for%20growth%20WEB%20FINAL.pdf>
5. Liverpool City. *Climate Impacts and Vulnerabilities Framework for Liverpool City*. June 2009 [Cited March 15 2019] Available from: <https://liverpool.gov.uk/media/9143/liverpool-climate-adaption-framework-report.pdf>
6. City of Cleveland. *Sustainable Cleveland Municipal Action Plan*. 2013 [Cited March 15 2019] Retrieved from: http://www.city.cleveland.oh.us/sites/default/files/forms_publications/SC-MAP_Final_10.1.13.pdf
7. Bath & Northeast Somerset Council. *West of England Joint Transport Study Transport Vision Summary Document*. 2016. [Cited March 15 2019] Available from: https://www.jointplanningwofe.org.uk/gf2.ti/-/757442/23234053.1/PDF/-/Joint_Transport_Study_Transport_Vision.pdf
8. Committee on Climate Change. *How local authorities can reduce emissions and manage climate risk*. 2012 [Cited March 15 2019] Available from: https://www.theccc.org.uk/archive/aws/Local%20Authorities/LA%20Report_summary.pdf
9. Minshull, A. Luke, A. Shiels, S, Phillips, J., Leach M. *Bristol City Council. Our Resilient Future. A Framework for Climate and Energy Security*. 2015. [Cited March 15 2019] Available from: <https://www.bristol.gov.uk/documents/20182/33423/Our+Resilient+Future+A+Framework+for+Climate+and+Energy+Security/2ee3fe3d-efa5-425a-b271-14dca33517e6>

10. The City of New Castle. Summary of proposed and ongoing measures Council is undertaking to measure and reduce greenhouse gas emissions and adapt to ongoing climate change. [Cited March 15 2019] Available from: https://www.newcastle.nsw.gov.au/getmedia/b434c1a3-0034-4e46-a8f9-152b309dcaa3/FINAL_Carbon_Water_MAP_for_Web_secure.aspx
11. City of Sydney. *Environmental Action 2016 - 2021 - Strategy and Action Plan - March 2017*. [Cited March 15 2019] Available from: https://www.cityofsydney.nsw.gov.au/_data/assets/pdf_file/0007/284749/Environmental-Action-strategy-and-action-plan.pdf
12. City of Sydney. *Connecting our city: 2012* [Cited March 15 2019] Available from: http://www.cityofsydney.nsw.gov.au/_data/assets/pdf_file/0006/124926/SummaryReport2012.pdf
13. City of Sydney. *Walking Strategy and Action Plan*. 2014 [Cited March 15 2019] Available from: <http://sydneyoursay.com.au/walking-strategy/documents/21576/download>
14. City of Sydney (2007) *Cycle Strategy and Action Plan: 2007-2017*. 2007. [Cited March 15 2019] Available from: <http://cdn.sydneycycleways.net/wp-content/uploads/2014/12/Cycle-Strategy-and-Action-Plan-2007-2017.pdf>

Community Engagement

1. Climate Action [Internet]. *Sustainable Cleveland*. 2019 [cited 30 April 2019]. Available from: https://www.sustainablecleveland.org/climate_action
2. Cleveland Climate Action Fund Crowdfunding Challenge | ioby [Internet]. Ioby.org. 2019 [cited 30 April 2019]. Available from: <https://www.ioby.org/campaign/cleveland-climate-action-fund-crowdfunding-challenge-0>
3. Neighborhood Transformation Initiative | City of Cleveland [Internet]. City.cleveland.oh.us. 2019 [cited 30 April 2019]. Available from: <http://www.city.cleveland.oh.us/nti>
4. Social Development [Internet]. Eprints.lse.ac.uk. 2019 [cited 30 April 2019]. Available from: <http://eprints.lse.ac.uk/62563/1/ToolkitSocialDevelopmentLSE2015.pdf>
5. Bottom-up driven community empowerment [Internet]. Eprints.utas.edu.au. 2019 [cited 30 April 2019]. Available from: <https://eprints.utas.edu.au/18659/2/Whole-hiruy-thesis-ex-pub-mat.pdf>
6. Enviroschools : Home [Internet]. Enviroschools.org.nz. 2019 [cited 30 April 2019]. Available from: <http://www.enviroschools.org.nz/>
7. Sustainability - Hamilton City Council [Internet]. Hamilton.govt.nz. 2019 [cited 30 April 2019]. Available from: <https://www.hamilton.govt.nz/our-services/environment-and-health/Pages/Sustainability.aspx>
8. Environment & sustainable development | Genève Internationale [Internet]. Geneve-int.ch. 2019 [cited 30 April 2019]. Available from: <http://www.geneve-int.ch/environment-sustainable-development>

Appendix

Table comparing sources of CO₂ emissions

City	Year	Percentage of CO ₂ emissions by source	Description	Population Density
Newcastle ⁽¹⁰⁾	Unknown	Transport: 20.2%, Natural Gas & LPG: 0,8% Water 1.2%, Office Paper: 0.2% Electricity 42.1%* *35.5%, excluding fugitive emissions from residential waste deposited at Summerhill Waste Management Centre	Council Scope 1, 2, & 3 *Emissions in 2008/2009 excluding Summerhill	1,233/km ²
Pittsburgh ⁽¹⁾⁽²⁾	2013	Transportation: 17% - 833,781 Residential: 51% - 193,128 Industrial: 6% - 265,684 Commercial: 51% - 2,447,908 Waste: 1% - 43,601	City-wide Green House Gas Inventory.	2,108/km ²
Liverpool ⁽⁵⁾	2006	Road Transport (mainly cars): 18%, Domestic (mainly heating and power): 37%, Industry/Commercial: 45%	City-wide CO2 emissions.	4,395/km ²
Cleveland ⁽⁶⁾	2010	Electricity CWD & Electricity Other: 84% Gasoline: 5% Diesel: 3% Natural Gas: 6% Steam: 1% Other: 0,7%	GHG inventory for City's municipal operations (not city wide).	1,971.8/km ²
Bristol ⁽⁹⁾	2013	Transport sector: 22% Domestic sector: 40% Commercial Other Fuels: 22% Non- domestic: 38%	CO2 Emissions based on data from DECC[2]	3,892/km ²