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Independent Review of the 2021 CDP submission based on SCATTER by Newcastle City Council

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Executive Summary

The path to Net-Zero is always a complex one. Newcastle City Council has long been a leader on green city and climate policy, recently has developed the Net Zero Newcastle: 2030 Action Plan and currently is a CDT tier-A city (based on its 2020 submission). In 2020 Newcastle City Council (NCC) made a Carbon Disclosure Project (CDP) submission for the first time. NCC deems this as a successful submission, which scored highly (A score) as a city. NCC therefore set the bar high and need to maintain that standard going forwards, especially with COP looming. To this end, one of the areas where NCC can improve its 2021 submission is to have an independent evaluation of our emissions inventory for the city, which by and large is based on national data which is extrapolated to local level and is largely based on the attached analysis through a tool called SCATTER which has been developed by Anthesis and made available to UK Local Authorities through a time-limited grant support from BEIS [central government]. This exercise was undertaken jointly by Northumbria and Newcastle universities, in a pro-bono activity in their guise as civic universities supporting the implementation of the UN's Sustainable Development Goals, including as members of the COP26 Universities Network[1] which both Northumbria and Newcastle University are part of. The independent evaluation took its cue from initial suggestions from NCC to verify – as far as possible within the time frame and the resources at hand - its 2021 SCATTER-based CDP submission (data, questionnaire, and local proxy data suggestions for the future) and to provide some general advice on how NCC (alongside its partners across the city and region) could potentially improve its disclosure and data strategy (including and especially with a more bottom-up one) in the future. A series of (online) meetings took place between NCC colleagues and the independent evaluations over June and July 2021, including an audit-style one where NCC colleagues demonstrated how they access and use the SCATTER tool, and obtain the data from there. Live questions were asked by the independent evaluators in the meeting, in addition to a list of questions that was shared with the NCC team only some hours before this audit-style meeting. NCC colleagues made a series of documents and data files available during the course of the exercise, including some reference examples after the audit-style meeting. The cross-universities independent evaluation team considers that Newcastle city Council is engaging well with the process and procedure of the SCATTER-based CDP disclosure activity, is committed to understand better inventory and

[1] https://www.gla.ac.uk/research/cop26/universities/

the data pre-populated by the Anthesis Group for its submission, is clearly on the way to consider potential improvements for the future which may also rest (partly) on a more bottom-up (locally generated and verified data). The evaluators have made some comments on the SCATTER tool and methodological approach in this report, and furthermore discuss in general terms some of the current limitations. The report also provides some general pointers as to how a more bottom-up data strategy could be built in the future for both CDP-compliant disclosure, but also to consider the links between data recording and interventions/policy impacts on the journey towards Net Zero (or carbon neutrality) via meeting the city's 2030 carbon emission reductions target.

1 Introduction and purpose of this review

This study was conducted jointly by Northumbria University and Newcastle University, after being approached by Newcastle City Council (NCC) to undertake this activity (pro-bono in their guise as 'civic universities' who both are committed to assist in the implementation of the UN's Sustainable Development Goals).

The aim of this report is twofold: Firstly, to review the 2021 Carbon Disclosure Project (CDP) submission by Newcastle City Council at the end of July 2021 (comparting this also to NCC's 2020 CDP submission) and secondly, to provide guidance for future submissions and work to underly those, including around data management and data sourcing (particularly for a more bottom-up data collection and reporting strategy that NCC may want to move towards to, in conjuncture with a (perhaps revised) SCATTER tool or possibly in the future with an alternative CDP-compliant route.

Newcastle City Council has developed strategies and action plans to deliver Net Zero targets by 2030 (20 years ahead of the current UK governmental target).

Newcastle City Council is, since 2020, using the SCATTER tool to provide a greenhouse gas emissions inventory following the Global Protocol for City-wide Greenhouse Gas (GPCGP) emissions.

Cities across Europe are aiming to meet the carbon emissions targets that are consistent with United Nations Paris Climate Agreement (Heidrich et al., 2016; Reckien et al., 2018; Salvia et al., 2021; Kotter et al., 2020; Kotter et al., 2020). In June 2019, the UK became the first G7 country to set the net-zero target by 2050, based on the UK's Committee on Climate Change recommendation[2]. Since then, over 200 UK local authorities have declared a climate emergency following the release of the IPCC 1.5 report, in which urgent climate action by 2030 is called. On the 3rd of April 2019, Newcastle City Council declared a Climate Emergency to make Newcastle carbon neutral by 2030. Separately, the North of Tyne Combined Authority (which includes the Newcastle City Council territory) also declared a Climate Emergency on the 7th of May 2019 with the same target date for carbon neutrality by 2030.

In line with – but in timeline significantly more ambitious than - the UK government's carbon emission target, Newcastle City Council (NCC) released the "Net Zero Newcastle: 2030

[2] https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

Action Plan"[3] to present a view on how the NCC can achieve the target of carbon neutral within the next decade. With the increased call for strong leadership in achieving net-zero target, NCC will need to focus their resources on the right actions / interventions and track their progress towards a low-carbon and then carbon-neutral city. This will need all stakeholders in Newcastle upon Tyne (and also in cooperation with regional partners), including citizens, local public and private businesses and local authorities to work together to help make this target a reality.

The city's climate change advisors, in their communication to Newcastle and Northumbria universities when commissioning this initial independent verification report, declared that Newcastle City Council (NCC) is keen to get an independent view on the gaps of NCC's approach / data utilised, and also to get a view of potential limits of the current SCATTER tool methodology so as that any feedback can be send to the Anthesis Group. If a new, more appropriate and more realistic, baseline emerges which is triggered by this or subsequent reviews which suggests that GHG emission of Newcastle-upon-Tyne are higher that what is suggested in NCC's current CDP submission (and therefore more decarbonatization efforts that are required to meet the 2030 / 2050 carbon emissions [reduction] targets), then this was declared as welcome by NCC. Methodologically, it can also be noted that the SCATTER tool utilises a mix of a top-down national data source approach as well as a bottom-up one (presently much more limited in the UK as currently implemented and operated at national and local level). This independent review will also suggest if there can be some tweaks to the former, and how the city could improve also on the latter over coming years.

It is hoped that this brief independent review exercise for NCC and the submission by NCC will help the city to understand and develop a credible decarbonisation pathway. The submission provides an opportunity to communicate and create a collaborative carbon reduction approach across the city.

2 The SCATTER tool and its latest changes

Launched in March 2018, SCATTER (Setting City Area Targets and Trajectories for Emissions Reduction) (Anthesis Group, 2021) is a tool developed in partnership between Anthesis Group (a research and business consultancy), the UK's governmental Department for Business, Energy and Industrial Strategy (BEIS) (who is funding the Anthesis group for it),

[3] https://www.newcastle.gov.uk/our-city/climate-change-newcastle/net-zero-newcastle-2030-action-plan

Nottingham City Council and the Tyndall Centre for Climate Research at the University of Manchester, with the purpose to provide a methodology for UK local authorities in order to capture and monitor carbon emission and to set carbon emissions targets that are consistent with United Nations' Paris Climate Agreement of 2015. The tool was originally piloted with the Greater Manchester Combined Authority. The Anthesis Group developed the SCATTER online tool and is still modifying it. The strategic partner for development of the Pathways functionality of SCATTER is Nottingham City Council.

The SCATTER tool is currently available free of charge (as central government through BEIS currently funds this directly to the Anthesis group) for UK local authority users (who access it by a single password for each UK local authority).

The SCATTER tool has been devised in order to help Local Authorities to report and manage their carbon emissions. It is a "city-focused emissions tool to measure carbon outputs, set reduction targets and implement a plan of action". It provides cities with the opportunity to standardise their greenhouse gas reporting and align it to international frameworks on GHG Reporting and the targets set by Paris Climate Agreement (UNFCCC, 2015). The SCATTER tool allows local authorities and city regions to gain insights on their carbon emission profile. It not only presents the trends and gaps of local authorities' carbon emission to acknowledge the seriousness of the challenges in achieving [Carbon] Net-Zero by 2050, but now also provides opportunities and pathway models for local authorities' policy development, resource management and investment. The SCATTER tool states that it "provides local authority and city regions with the opportunity to standardise their greenhouse gas reporting and align to international frameworks, including the setting of targets in line with the Paris Climate Agreement."

The aim for the UK (BEIS and across central government) was to find a supportive solution which aligns with the Global Disclosure Project (CDP), an international non-profit organisation headquartered in the United Kingdom but active for Europe, (North) America which helps companies and cities to disclose their carbon / environmental impact.

The SCATTER tool has two key functions, namely an inventory and pathways:

(1) Greenhouse Gas (GHG) inventories with carbon reporting compatible with global Carbon Disclosure Project (CDP).

(2) Carbon reduction pathways modelling of emissions reduction pathways to 2050, "based on the ambition of several emissions reduction measures that can be set by the (local authority) user."

The inventory function allows local authorities to gain a detailed understanding of their carbon emission profiles by inputting certain details into the tool. According to SCATTER, "creating a greenhouse gas inventory for a local authority allows an organisation to identify the sources of their emissions and where to focus action." The inventory provided by the SCATTER tool is compatible with the CDP (Carbon Disclosure Project), and local authorities may submit these emission profile figures generated by the SCATTER to CDP. The CDP project is a sustainability disclosure (reporting) system to support corporations, local authorities and cities disclose and manage their environmental impact. CDP states that it "works with over 550 cities and 100 states and regions, as well as over 6000 corporations to help them on effective carbon emissions reductions strategies". GHG emission inventories are developed by Parties to the [Climate Change] Convention [UNFCC], using scientific and methodological guidance from the Intergovernmental Panel on Climate Change (IPCC), such as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Revised Guidelines for National Greenhouse Gas Inventories (1996), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000), and the IPCC Good Practice Guidance on Land Use, Land-use Change and Forestry (2003).

The pathway function of SCATTER has been developed to help local authorities to obtain a predictive view of what their carbon emissions could look like up to 2050. The SCATTER tool now also offers the modelling of emissions reduction pathways to 2050, based on the ambition of several emissions reduction measures that can be set by the user, such as a local authority. For example, the SCATTER pathway model estimates what it would take for a local authority to achieve net zero under different levels of intervention, though in the view of the present authors the level of granularity and cause and effect attribution to measures/actions should be evaluated by each user to make an informed decision on how useful this function currently is. SCATTER states that this function should help local authorities to set targets and plan a strategy towards carbon neutralisation. For example, with the assistance of the pathway functions, local authorities are said to be able to explore different greenhouse gas reduction actions and create emission reduction scenarios, from which local authorities should be able

develop their climate action plans. The model of carbon reduction pathways can also be analysed against the 2015 Paris Agreement.

The SCATTER tool by the Anthesis group is not the only one around. For instance, it has been compared / contrasted by them[4] to Google's Environmental Insights Explorer (EIE) tool[5], and changes / upgrades have been made to the SCATTER tool over recent years. There is also the ClimateView tool[6], which Newcastle City Council is already using also[7].

There should be an intelligence loop between the monitoring and targets set, in the sense of motivating and understanding the (respective) contributions of interventions at the local level which can affect the meeting of the targets set.

According to NCC [e-mail communication on the 15th of July 2021 by the Climate Change Advisor team], "access the SCATTER Inventory is as simple as we 'register and access' the spreadsheet – individual Local Authority input is not required for the Emissions Inventory; Anthesis create all of this. The key point to consider is that BEIS have funded Anthesis to create this CDP compliant inventory, so as to avoid hundreds of UK local authorities replicating a complex data reporting process, largely using national datasets (and to support the number of LAs disclosing to CDP in the lead up to COP26). We have not had assurances that BEIS will continue to pay Anthesis to provide this service, and our focus is to unpack the inventory and see how our local actions can drive change, ideally impacting these metrics. The SCATTER 'product' also offers a Pathways calculator – which is more helpful in building consensus locally about which type of interventions (and the scale of task at the local level) to ensure a science-based reduction trajectory can be adopted; we have looked at this but are not using it with our CDP OR Net Zero Planning – it's [currently at least] too simplistic for our requirements." So, in simple terms, our CDP reporting process is to simply submit the Inventory (as downloaded) as part of the Cities Questionnaire. BUT that's not where the benefit lies – it's the process of familiarising ourselves with the content of the inventory and answering the wider questionnaire (within this context) to prioritize local actions."

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[4] https://www.anthesisgroup.com/scatter-carbon-footprint-tool/

[5] https://www.iclei.org/en/media/local-governments-benefit-from-googles-environmental-insights-explorer

[6] https://www.climateview.global/

[7] https://www.climateview.global/cities/newcastle-uk

2.1 The SCATTER inventory

According to the SCATTER tool website, methodologically the inventory is presented according to the Global Covenant of Mayors (GCoM)'s Common Reporting Framework (CRF). The key guidance used to calculate the emissions inventory is the GPC Protocol for Cities. The GPC report is based on the Accounting and Reporting Standard developed by the Greenhouse Gas Protocol, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. The Anthesis Group declares that "the SCATTER tool is based on the Global Covenant of Mayors' Common Reporting Framework (CRF)[8], a globally recognised GHG reporting standard for cities. SCATTER's summary categories map directly onto the GHG Protocol for Cities[9] categories. CDP[10] accepts this reporting framework as part of the submission to their annual [SCATTER] Cities Questionnaire."

2.1.1 Inventory Sectors

The emission inventory in the SCATTER is made up of 35 measures over six key sectors, which are compiled in line with the CRF of GCoM. The inventory sectors are:

(1) Stationary Energy (Domestic Buildings, Commerical Buildings and Industry)

Greenhouse gas emissions are generated in this sector through the combustion of fuel in buildings, manufacturing industries, construction processes and by power plants. This sector includes the following six sub-sectors: (a) *Residential buildings*, (b) *Commercial building and facilities*, (c) *Institutional buildings and facilities*, (d) *Industrial buildings and facilities*, (e) *Agriculture* and (f) *Fugitive emissions*. Fugitive emissions refers to emissions lost due to leakages that occur when extracting, processing and transporting fossil fuels.

(2) Transportation

Greenhouse gas emissions are generated in transportation sector through the combustion of fuel or the use of electricity during journeys travelled by road, rail, air

[8] https://www.globalcovenantofmayors.org/our-initiatives/data4cities/common-global-reporting-framework/

[9] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[10] https://www.cdp.net/en/guidance/guidance-for-cities

or water. The transportation sector includes the following five sub-sectors: (a) *On-road*, (b) *Rail*, (c) *Waterborne navigation*, (d) *Aviation* and (e) *Off-road*.

(3) Waste

Greenhouse gas emissions are generated in waste sector by disposal and treatment of solid waste and wastewater through incineration, aerobic and anaerobic decomposition. The waste sector includes the following four sub-sectors: (a) *Solid waste disposal*, (b) *Biological treatment*, (c) *Incineration and open burning* and (d) *Wastewater*.

(4) Industrial processes and product use (IPPU)

Greenhouse gas emissions are generated in IPPU sector in the process of physically or chemically transform materials. Also, industries use products that release greenhouse gas emissions throughout its use. The IPPU sector includes two sub-sectors: (a) *Industrial Process* and (b) *Product Use*.

(5) Agriculture, forestry and other land use (AFOLU)

Greenhouse gas emissions are generated in the AFOLU sector through methane created by livestock, nutrient management for agricultural purposes, and by land use change altering soil compositions. The AFLU sector includes three sub-sectors: (a) *Livestock*, (b) *Land use* and (c) *Other AFOLU*.

(6) Energy generation of grid-supplied energy

This sector is listed in the SCATTER inventory report (Anthesis Group, 2021), and the sector includes the following four sub-sectors: (a) *Electricity-only generation*, (b) *Combined Heat and Power (CHP) generation*, (c) *Heat/cold generation (NE)* and (d) *Local renewable generation*. National large-scale generation capacity is allocated to local authorities based in national datasets[11].

2.1.2 Inventory scopes

Activities taking place within a city can generate GHG emissions that occur inside the city boundary as well as outside the city boundary. To distinguish between them, emissions are commonly grouped into three categories based on where they occur:

(1) Scope 1 (Direct emissions):

GHG emissions from sources located within the city boundary

(2) Scope 2 (Indirect emissions):

GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary

(3) Scope 3:

All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

2.2 Latest changes to the SCATTER tool

The online SCATTER tool developed by the Anthesis Group developed is still being modified by them. Changes are made to improve the accuracy and completeness of the GHG emissions model, with corrections to errors and bugs, or when the data source or the emission factors are revised.

In the latest beta version of the SCATTER, the model is updated with some changes in emission factors and data inputted by the Anthesis Group. These changes are summarised as follows (Anthesis Group, 2021):

Livestock Emission Factors

The emissions factors used for livestock in the Pathways for CH4 and N2O have been amended in order to give the correct conversion to CO2e from their raw factors. Emissions factors affected are:

(1) Dairy Cattle;
(2) Deer;
(3) Goats;
(4) Horses;
(5) Non-dairy cattle;
(6) Poultry;
(7) Sheep;
(8) Swine.

IPPU Emission Factors

The emissions factors, impacting IPPU emissions, are corrected due to a mistake which was spotted in preparing the best tests for the SCATTER Pathways. The emissions factors affected are:

1. Industrial Processes_Chemicals;
2. Industrial Processes_Iron and steel;
3. Industrial Processes_Mineral products;
4. Industrial Processes_Non-ferrous metals;
5. Industrial Processes_Other industry.

These have been amended.

Tree-planting

The baseline data for tree-planting has been changed, giving a slightly different emissions profile. The data now comes from data from the National Forestry Inventory for trees outside woodland. This is an improvement on the previous more generic assumption for carbon sequestration by trees. For details of how data regarding non-lone trees have been modelled, see the SCATTER Pathways Methodology.

This replaces the data for N. LULUCF Net Emissions from BEIS, which was previously used to approximate CO2e uptake (sequestration) by trees.

Intervention trajectory amendments

(1) Revised baseline assumption are made for a number of interventions which had assumed a level-1 increase in installation of renewable generation capacity, updated now to assuming no changes. This applies to:

- Offshore wind;
- Onshore wind.

(2) The intervention for Livestock has been smoothed (it was previously modelled in five-year segments).

Methodology & annotation

Updates have been made to add more detail to the methodology, and to allow for interventions to follow the order of the SCATTER tool. This is in order to make the interventions trajectory view clearer.

3 Newcastle Emissions Profile

3.1 Current Submission (Reporting Year 2021, based on 2018 data)

The findings in this whole chapter are obtained from the SCATTER Inventory Summary, Methodology & Report Summary (Anthesis Group, 2021) and the SCATTER CDP Report Inventory 2021 Excel sheet (Anthesis Group, 2021) downloaded by Newcastle City Council from the SCATTER Anthesis Group website with the local authority, where the data is reported in year 2021 but is based on 2018. The explanation of the inventory sectors and subsectors mentioned in this chapter can be found in the composition in Section 2.1 of this report as per the SCATTER methodology.

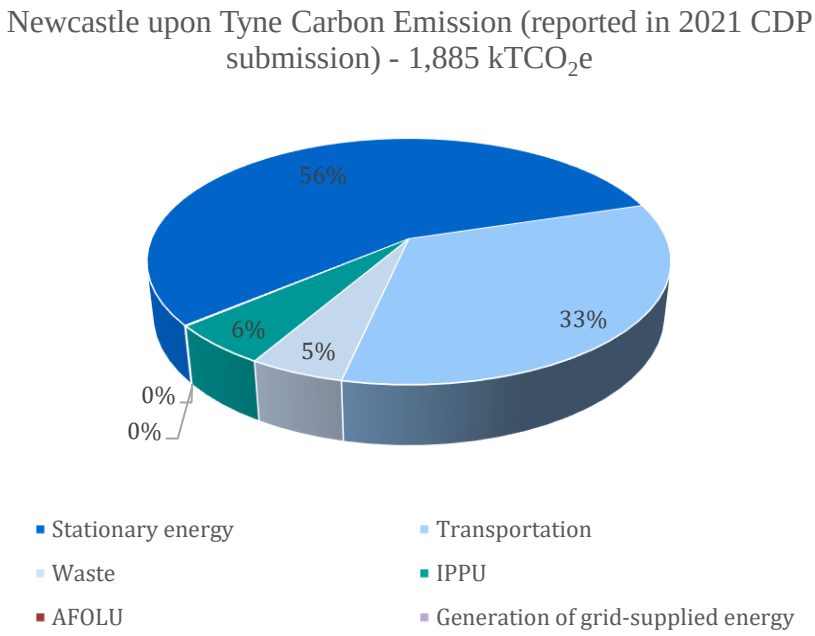

Figure 1 Newcastle upon Tyne sectoral share of carbon emissions overview, with the 2018 data that submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

According to the pie chart, stationary energy emits the most CO_2 when compared to the other sectors (56%). Transportation follows, accounting for one-third of all carbon emissions (33%). The carbon emissions of Industrial Processes and Product Use (IPPU) and Waste account for 6% and 5%, respectively. Agriculture, Forestry and Other Land Use (AFOLU) and Generation of grid-supplied energy represent a carbon emission share of 0.00061% and 0.00058%, where the numbers are so insignificant for Newcastle upon Tyne that they are shown as 0% on the pie graph. In 2018 (data reported in 2021), the total carbon emissions in Newcastle

upon Tyne are approximately 1,885kTCO_2e. Further observation on and discussion of different sub-sectors for each main sector will be made in following sections.

3.1.1 Stationary energy

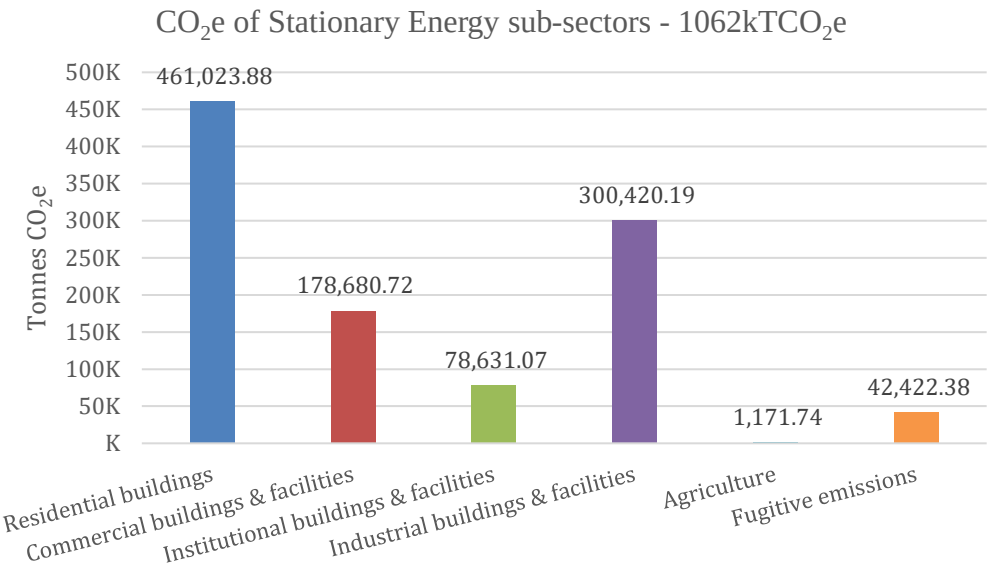

Figure 2 Newcastle upon Tyne carbon emission (Stationary energy), with the 2018 data that submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

Figure 2 depicts the CO_2e from stationary energy which is divided into 6 sub-sectors. The majority of carbon emissions are caused by residential buildings, which emit around 461kTCO_2e. Following that are Industrial (300kTCO_2e), Commercial (179kTCO_2e), and institutional (79kTCO_2e) buildings and facilities. The overall fuel consumption per Local Authority for the buildings and facilities are calculated from BEIS subnational energy consumption by Local Authority data source[11]. The Energy Consumption in the UK (ECUK) 2018 Data Tables[12] are then used to assign it for end use. Domestic energy consumption totals by fuel comes from ECUK Table 3.02: Domestic energy consumption by end use and fuel 1990 to 2017[13] while the Commercial, institutional & industrial energy consumption totals by fuel are from ECUK Table 4.04 Industrial final energy consumption by end use (different processes) [13] and Table 5.05a: Final energy consumption in the service sector, by sector and sub-sector, end use and energy source 2017[13]. These are calculated for the various end uses of "space

[11] https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

[12] https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

heating & hot water" and "lighting, appliances & cookery." Fugitive emissions totalled 42kTCO_2e, according to data from the UK Devolved Administration GHG Inventory 1990-2016: UK Informative Inventory Report (1990 to 2017)[13]. Agriculture produces the least carbon emissions in this sector, with only 1.2kTCO_2e, according to BEIS statistics(BEIS, 2016). The total tCO2e from stationary energy are 1062kTCO_2e.

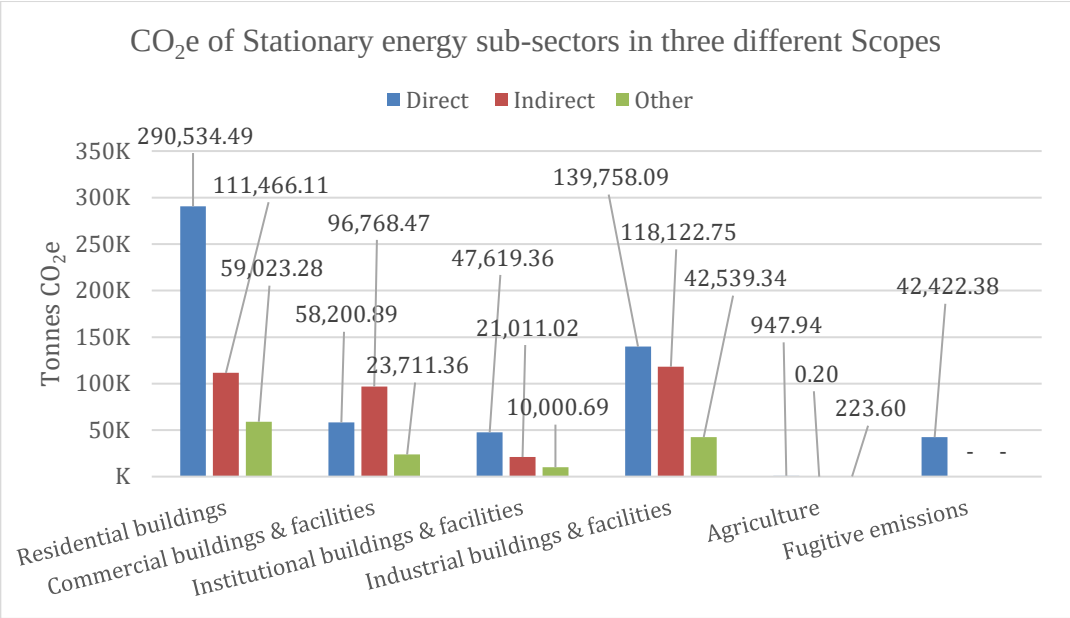

Figure 3 An overview of Newcastle upon Tyne's stationary energy sub-sectors' carbon emissions in three different Scopes [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

Table 1 The subsectors of stationary energy in Scope 1, 2, and 3, with calculated percentage of Scope 1 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

	Total	Direct (Scope 1)	Percentage of Scope 1	Indirect (Scope 2)	Other (Scope 3)
Residential buildings	461kT	291kT	63%	111kT	59kT
Commercial buildings & facilities	179kT	58kT	33%	97kT	24kT
Institutional buildings & facilities	79kT	48kT	61%	21kT	10kT
Industrial buildings & facilities	300kT	140kT	47%	118kT	43kT
Agriculture	1.2kT	0.9kT	81%	IE	0.2kT

[13] https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1904121008_GB_IIR_2019_v2.0.pdf

Fugitive emissions	42kT	42kT	100%	IE	IE

3.1.2 Transportation

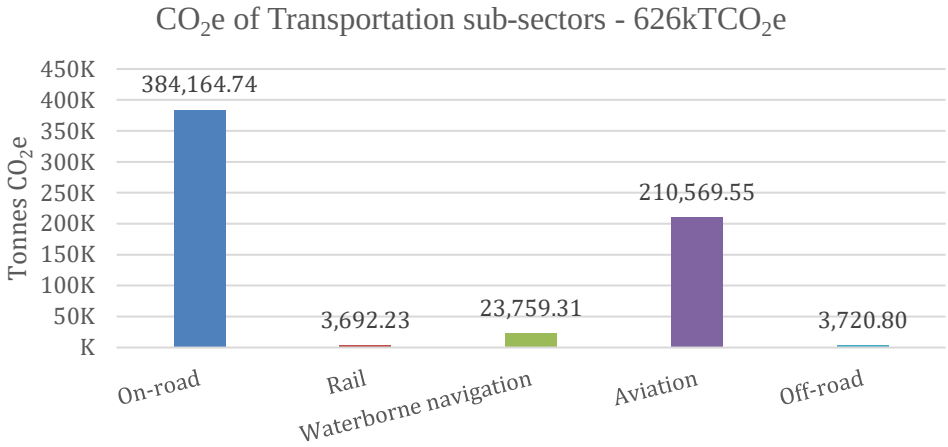

Figure 4 Newcastle upon Tyne's carbon emission (Transportation), with the 2018 data submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

The bar chart above (Figure 4) demonstrates the greenhouse gas emissions caused by the combustion of fuel or usage of electricity during intercity and international travel by road, rail, air, or water. According to BEIS statistics[12], on-road transportation produces the highest CO_2 (384kTCO_2e) in this sector. The fuel is assumed to be diesel, and a top-down technique was utilised by SCATTER to provide recommendations on the benefits and drawbacks of transportation methodologies, as described in Table 7.3 of the GPC procedure guidelines[14]. The same data source was used to calculate rail emission, representing only 3.7kTCO_2e. This is due to the impossibility of reporting all rail and road emissions as a separate sub-sector of the transportation sector. Instead, some rail sector consumption is included in the commercial and industrial sectors, and only diesel emissions are indicated in this sector. Aviation generates 211kTCO_2e, where the data was derived from the Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2017, Categories 1A3a and Aviation Bunkers for England, Wales, Scotland, and Northern Ireland[15] for Aviation Spirit and Aviation Turbine

[14] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[15] https://naei.beis.gov.uk/reports/reports?report_id=991

Fuel. Total fuel consumption from waterborne transportation was determined using the Digest of UK Energy Statistics: DUKES 1.1 Aggregate energy balance 2017 (2017)[16] and Domestic Waterborne Freight Statistics: Department for Transport Statistics Domestic Waterborne Freight Statistics table PORT0701[17]. With these data, the waterborne emission yields an overall value of 24kTCO_2e. Off-road transportation emits 3.7kTCO_2e based on the assumption of 1% of total on-road fuel usage from BEIS final energy consumption by Local Authority[12]. The total transportation emissions in 2018 (data reported in 2021) are 626kTCO_2e.

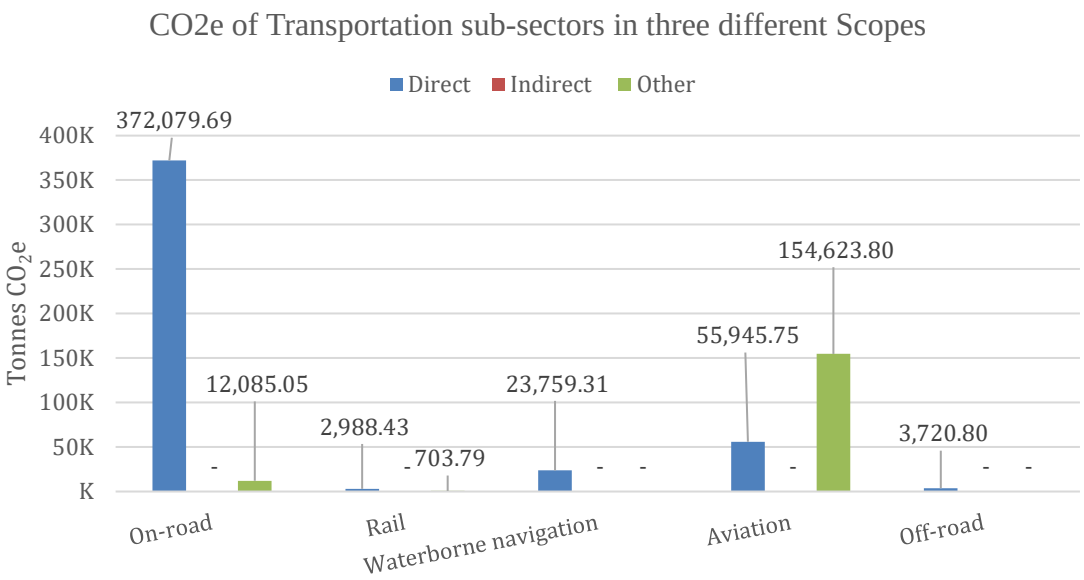

Figure 5 An overview of the transportation sub-sectors in three different Scopes for Newcastle upon Tyne's 2021 submission with data from 2018 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

Table 2 The subsectors of transportation in Scope 1, 2, and 3, with calculated percentage of Scope 1

	Total	Direct (Scope 1)	Percentage of Scope 1	Indirect (Scope 2)	Other (Scope 3)
On-Road	384kT	372kT	97%	IE	12kT
Rail	3.7kT	3kT	81%	IE	0.7kT
Waterborne	23.8kT	23.8kT	100%	IE	IE
Aviation	211kT	56kT	26.6%	IE	155kT
Off-road	3.7kT	3.7kT	100%	IE	IE

[16] https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes

[17] https://www.gov.uk/government/collections/maritime-and-shipping-statistics#published-in-2018

3.1.3 Waste

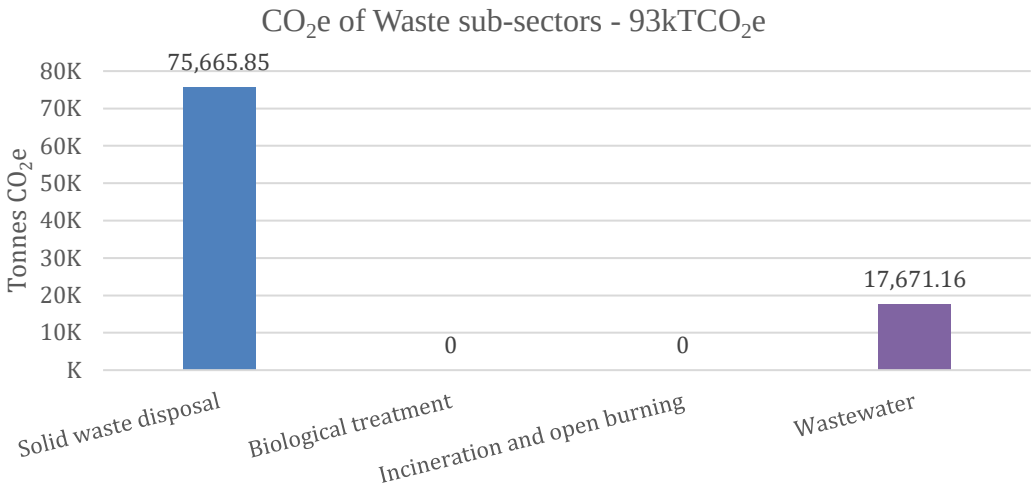

Figure 6 Newcastle upon Tyne's carbon emission (Waste), with the 2018 data submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

In this sector, eighty-one percent of the total carbon emissions comes from solid waste disposal (76kTCO_2e), whereas biological treatment and incineration and open burning are reported to have 0 emissions. Statistics on commercial & industrial, business, and municipal waste by local authority were compiled from UK country-specific sources and internet data portals, and where applicable, combined and/or waste authority averages were applied to individual local authorities. Sources of waste data are collected from four areas: England (EFRA, 2017), Northern Ireland (Department of Agriculture, Environment and Rural Affairs, 2018), Scotland (Scottish Environment Protection Agency, 2016; Scottish Environment Protection Agency, 2017; Scotland's Environment, 2017), and Wales (Welsh Government, 2017-2018). The total amount of wastewater (18kTCO_2e) treated has been estimated using emissions and emission factors from the UK Devolved Administration GHG Inventory 1990-2016[18]. The overall amount of carbon emissions comes from the waste are 93kTCO_2e.

[18] https://naei.beis.gov.uk/reports/reports?section_id=4

3.1.4 Industrial Processes and Product Use (IPPU)

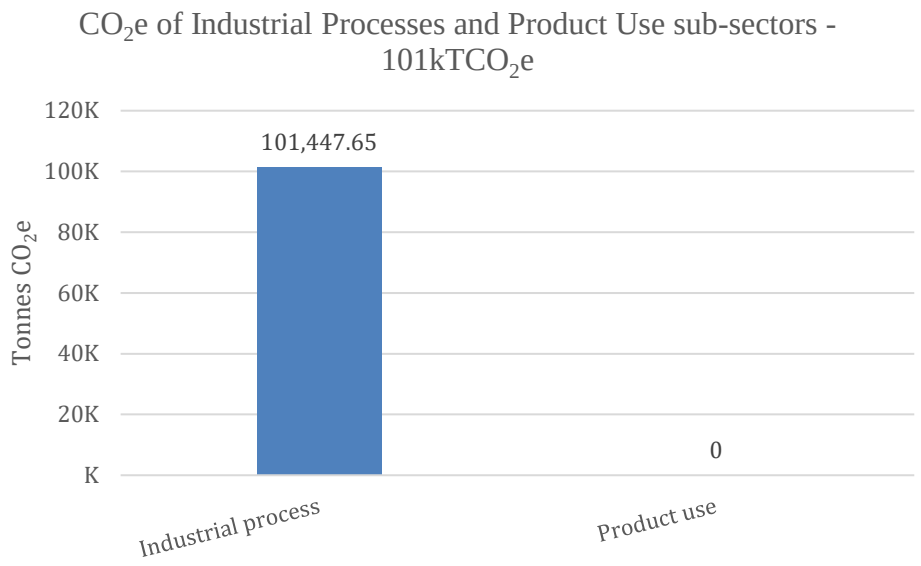

Figure 7 Newcastle upon Tyne's IPPU carbon emission, with the 2018 data submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

As shown by the graph (Figure 7), the emissions of Industrial Process are about 101kTCO_2e while the product use in industrial is 0. The fuel consumption share per LA was determined by dividing the industrial and commercial fuel consumption per fuel and per LA by the total fuel consumption from BEIS (Total final energy consumption at regional and local authority level; Department for Business, Energy & Industrial Strategy, Sub-national total final energy consumption data (2016))[12]. These results were then calculated per LA using the emissions factors obtained from the total UK GHG emissions[19]. An interesting fact spotted is that 100% of the emission of Industrial Process are within Scope 1 (Direct). Where the description of inventory scopes can also be found in the composition in Section 2.1 of this report as per the CDP SCATTER methodology. Overall, the IPPU sector was responsible for a total of 101kTCO_2e in 2018 (data reported in 2021).

3.1.5 Agriculture, Forestry and Other Land Use (AFOLU)

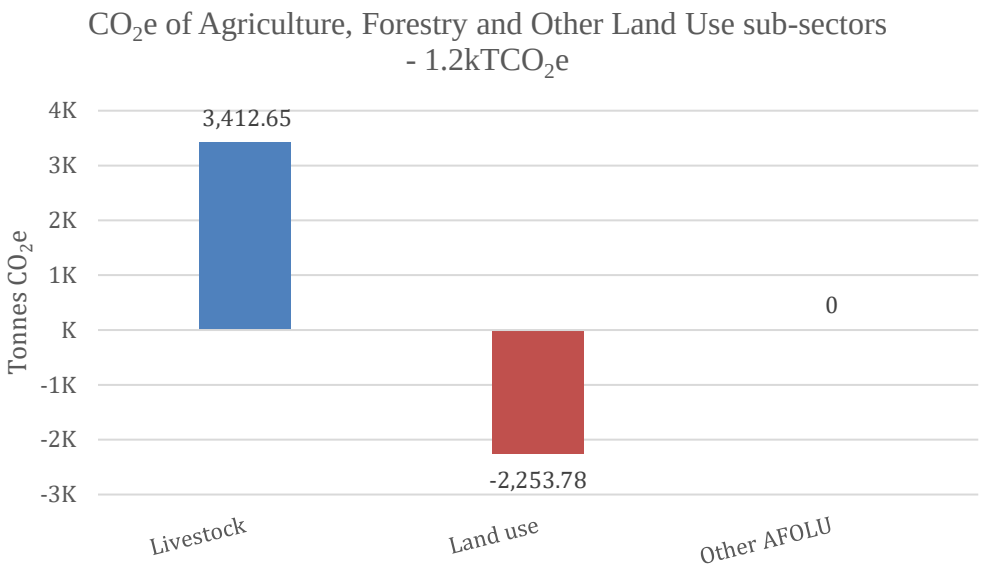

Figure 8 Newcastle upon Tyne AFOLU carbon emissions, with the 2018 data submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

Methane produced by livestock, fertiliser management for agricultural reasons, and land use change affecting soil compositions all contribute to greenhouse gas emissions in this sector. Agricultural data for livestock in England (Department for Environment, Food & Rural Affairs, 2016; Agriculture & Horticulture Development Board, 2016), Scotland (Scottish Agricultural Census, 2017), Wales (Welsh Government, 2017), and Northern Ireland (OpenData.NI Farm Census, 2016), including the total number of dairy cattle, non-dairy cattle, sheep, pigs, horses, and poultry by local authority, was merged, and where no individual local authority data was readily available, combined authority averages were used. The carbon emission of livestock is about 3.4kTCO_2e according to the given datasets from the four areas mentioned above. The emissions factors for livestock are based on UK averages from 1990 to 2017, as determined by the UK Greenhouse Gas Inventory[19]. However, the CO_2e from land use are -2.3kTCO_2e which comes directly from the UK LACO2 datasheet[20]. The total carbon emissions attributed to AFOLU are 1.2kTCO_2e.

[19] https://naei.beis.gov.uk/reports/reports?report_id=981

[20] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-2016

3.1.6 Generation of Grid-supplied Energy

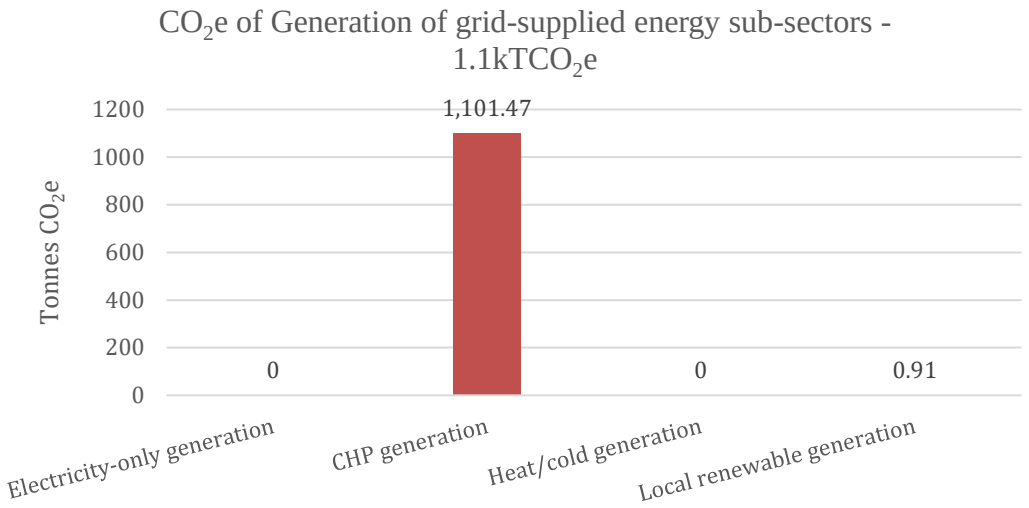

Figure 9 Newcastle upon Tyne Generation of Grid-supplied Energy carbon emissions, with the 2018 data submitted in 2021 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

To derive electricity-only generation, the plant installed capacity (MW) from DUKES 5.11[22] has been converted to kWh and multiplied by appropriate load factors for different fuel types taken from Table 6.5 in DUKES Chapter 6: renewable sources of energy[21] or DUKES 5.10[22]. A similar technique was used for large-scale local renewable energy, although load factors for various renewable technologies were calculated using DUKES 6.5[22][21]. Small-scale local renewable generation for instance: Solar PV, Onshore Wind, Hydro, Anaerobic Digestion, Offshore Wind, Wave/Tidal, Sewage Gas, Landfill Gas, Municipal Solid Waste, Animal Biomass, Plant Biomass, and Cofiring were obtained straight from the BEIS Renewable Electricity dataset (Department for Business. Energy & Industrial Strategy, 2017). Figure 9 shows that CHP generation emits a total of 1.1kTCO_2e (Department for Business, Energy & Industrial Strategy, 2018) when local renewable generation only produces 0.91CO_2e. There were 0 emissions reported for both electricity-only and heat/cold generation in accordance with

[21] https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

the Digest of UK Energy Statistics Chapter 5: statistics on electricity[22]. The total tCO_2e of the generation of grid-supplied energy is $1.1kTCO_2e$.

3.2 Comparison to the Last Submission (Reporting Year 2020, based on 2017 data)

The numbers presented below are obtained from the SCATTER CDP Report Inventory 2021 Excel sheet (Anthesis Group, 2021) and the SCATTER CDP Report Inventory 2020 Excel sheet (Anthesis Group, 2020) downloaded by Newcastle City Council from the SCATTER Anthesis Group website with the local authority user password, where the data is reported in year 2021 and 2020 but is based on 2018 and 2017, respectively. Comparisons of carbon emissions between the last submission (reporting year 2020, based on 2017 data) and the current submission (reporting year 2021, based on 2018 data) were made.

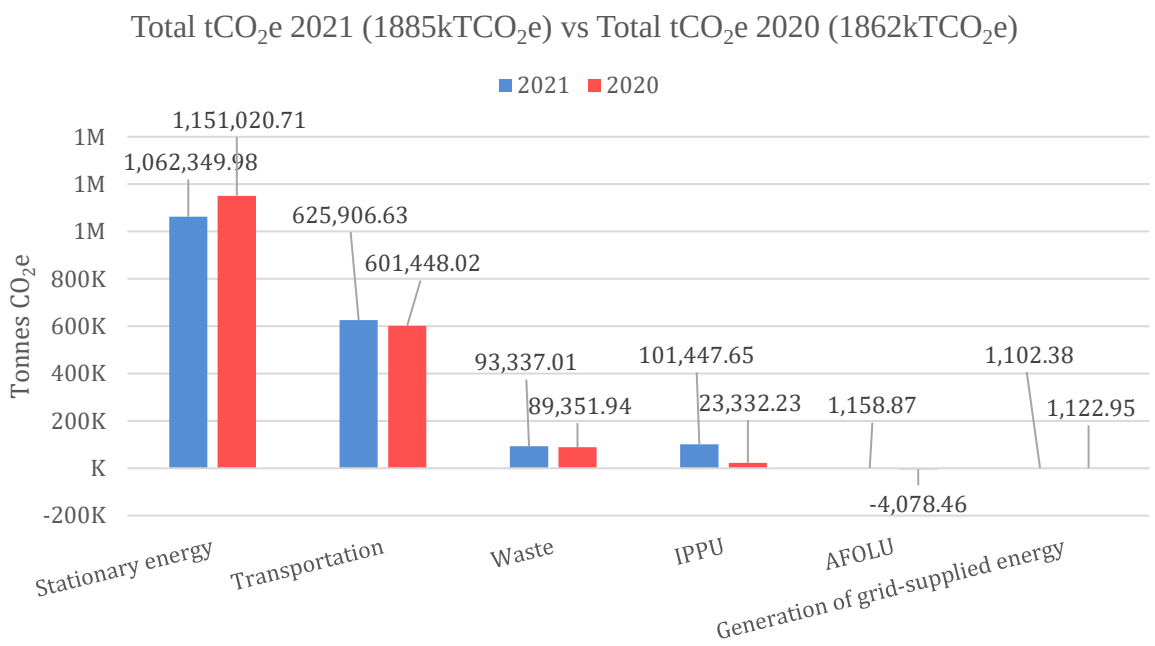

Figure 10 Comparison of emission profile in the main emissions sectors 2021 vs 2020 [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

Figure 10 shows the comparison of emission profiles between the main sectors in the 2021 (based on 2018 data) submission and the submission 2020 (based on 2017 data). The overall carbon emissions in the 2018 (data reported in 2021) have increased by 1.2% compared to the

[22] https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes.

previous year (2017, data reported in 2020). The transportation emissions in 2018 (data reported in 2021) increased by 4.07%, while waste emissions rose from 89kTCO_2e to 93kTCO_2e (↑4.46%). Moreover, the IPPU and AFOLU emission sectors saw very significant increases in 2018 (data reported in 2021), by 334.8% and 128.41% respectively. The explanation for this might be that the data collected in 2017 (data reported in 2021) for IPPU and AFOLU was not updated to the year 2017 but rather to the year 2016 (Department for Business, Energy & Industrial Strategy, 2016). The data collected in 2018 (data reported in 2021), on the other hand, demonstrates that it is up-to-date (Department for Business, 2018). Another noteworthy point is that the AFOLU emissions in 2017 are -4078.46kTCO_2e, with the negative numbers coming from forestland and grassland. According to the UK LACO2 datasheet[23], net emissions from Land Use, Land-Use Change, and Forestry (LULUCF) have been declining since 2005. This might be owing to an increase in the removal of greenhouse gases from the atmosphere (for example, by planting trees or managing forests), or to a reduction in emissions (for example, by reducing deforestation). The Stationary emission in 2018 (data reported in 2021) were decreased by 7.7%, while the Generation of grid-supplied energy sector also shows a drop of 1.83%.

According to the pie graphic in Section 3.1, the Stationary energy sector emits the highest CO_2e (1062kTCO_2e), followed by Transportation sector emissions (626kTCO_2e). As a result, a comparison of tCO_2e for each subsector between 2021 (based on 2018 data) and 2020 (based on 2017 data) is required to have a better picture of the 2017-18 trend.

[23] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-2016

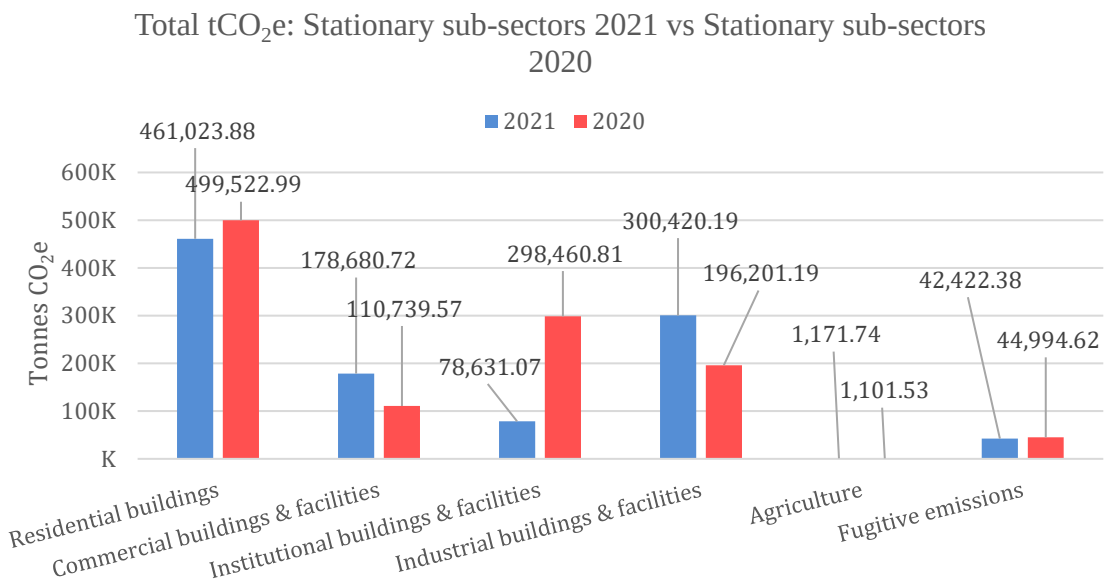

Figure 11 Comparison of emission profile in stationary sub-sectors for 2021 vs 2020 submission for Newcastle upon Tyne [generated by the authors based on SCATTER CDP Report Inventory 2021 Excel sheet]

As stated in the aforementioned data, Commercial and Industrial building and facility emissions have increased by 61.35% and 53.12%, respectively. While there was just a 6.37% rise in agricultural emissions However, Institutional buildings and facilities emissions decreased by 73.65%, followed by residential buildings and facilities emissions (↓7.71%) and in fugitive emissions (↓5.72%) This is why, as previously stated, overall carbon emissions in the Stationary energy sector fell over the previous year.

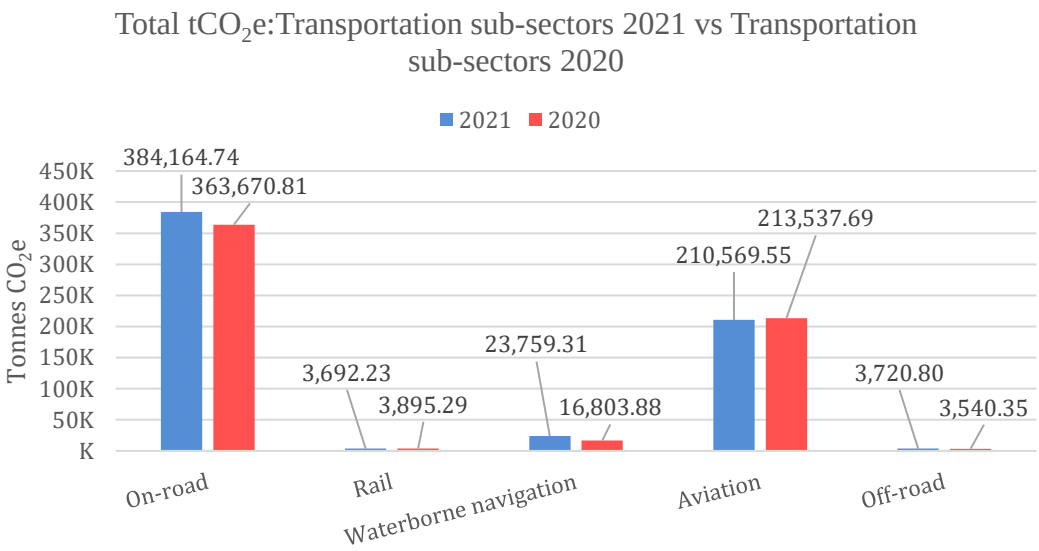

Figure 12 Comparison of Newcastle upon Tyne's emission profile in transportation sub-sectors 2021 vs 2020 [generated by the authors, based on SCATTER CDP Report Inventory 2021 Excel sheet]

As per Figure 12, On-road emissions in 2021 (based on 2018 data) climbed from 364kTCO_2e to 384kTCO_2e (↑5.64%), whereas Waterborne navigation emissions and Off-road emissions grew by 41.39% and 5.1%, correspondingly. Rail and Aviation emissions, on the other hand, were reduced by 5.21% and 1.39%, respectively. This might be due to the difficulties of reporting all rail and road emissions as distinct sub-sectors of the Transportation sector. Instead, certain Rail sector consumption is included in the Commercial and industrial sectors, and only diesel emissions are reported in the Transportation sector.

3.2.1 Overview of different Scopes

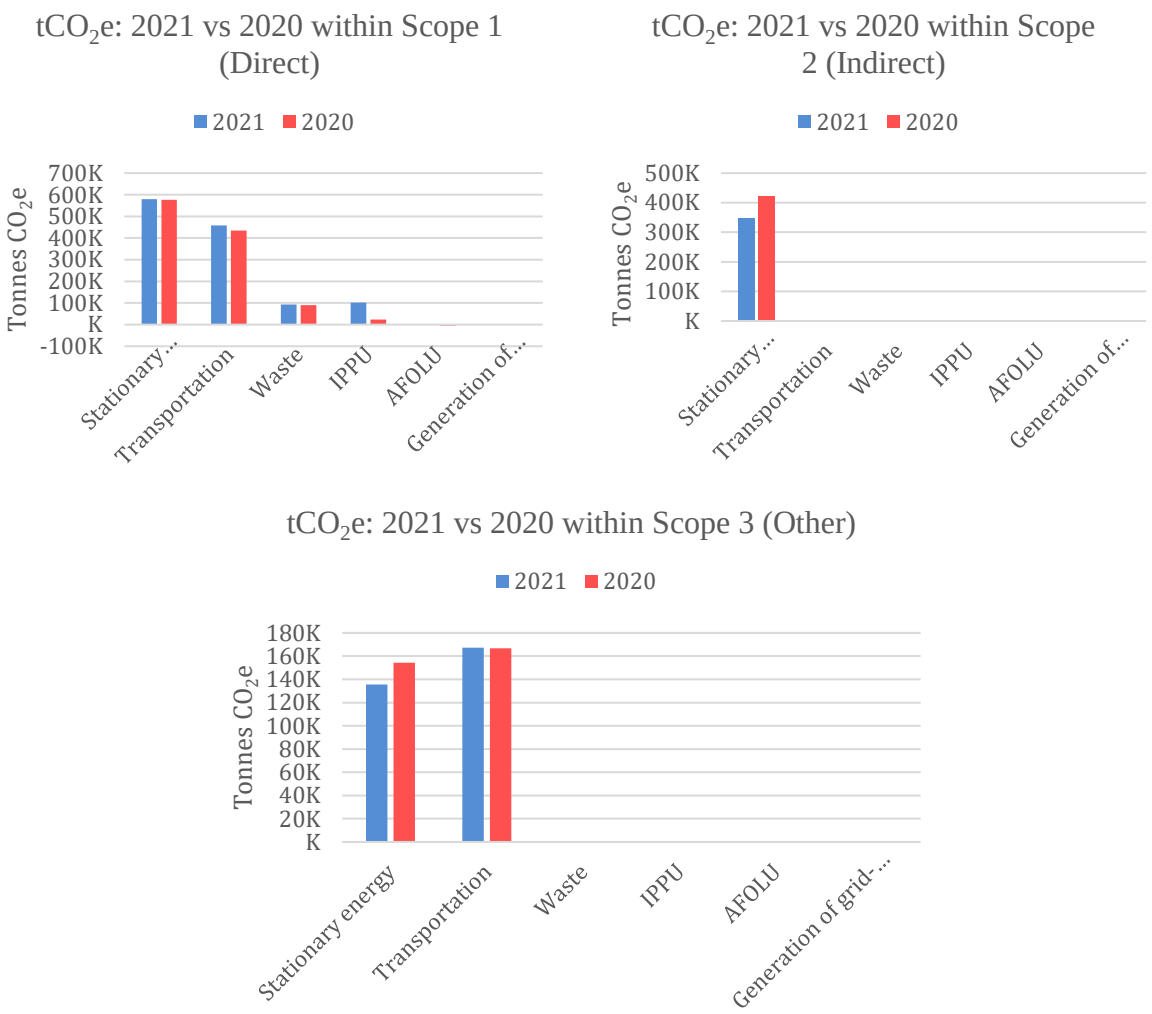

Figure 13 Comparison of emission profile in three different Scopes 2021 vs 2020 [generated by the author based on SCATTER CDP Report Inventory 2021 Excel sheet]

Table 3 Comparison of Newcastle upon Tyne's 2021 emission profile vs 2020 emission profile in Scope 1, 2, and 3, with the calculated percentage of Scope 1 [generated by the authors, based on SCATTER CDP Report Inventory 2021 Excel sheet]

	Direct (Scope 1)		Percentage of Scope 1		Indirect (Scope 2)		Other (Scope 3)	
	2021	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**
Stationary	580kT	576kT	55%	50%	347kT	421kT	135kT	154kT
Transportation	458kT	435kT	73%	72%	IE	IE	167kT	167kT
Waste	93kT	89kT	100%	100%	IE	IE	0	IE
IPPU	101kT	23kT	100%	100%	IE	IE	0	IE
AFOLU	1.2kT	-4kT	100%	100%	IE	IE	IE	IE
Generation of grid-supplied energy	0.9kT	0.9kT	85%	84%	IE	IE	0.2kT	0.2kT

3.2.2 Comparison with the National and Regional Trend

On the 24th of June 2021, the BEIS released the most recent estimates of end-user carbon dioxide (CO2) emissions for local authority areas in the UK. This research additionally covers data from 2005 to 2019, allowing it to evaluate the trend of local authority regions in the United Kingdom, including Northern Ireland and the North East of England (BEIS, 2021).

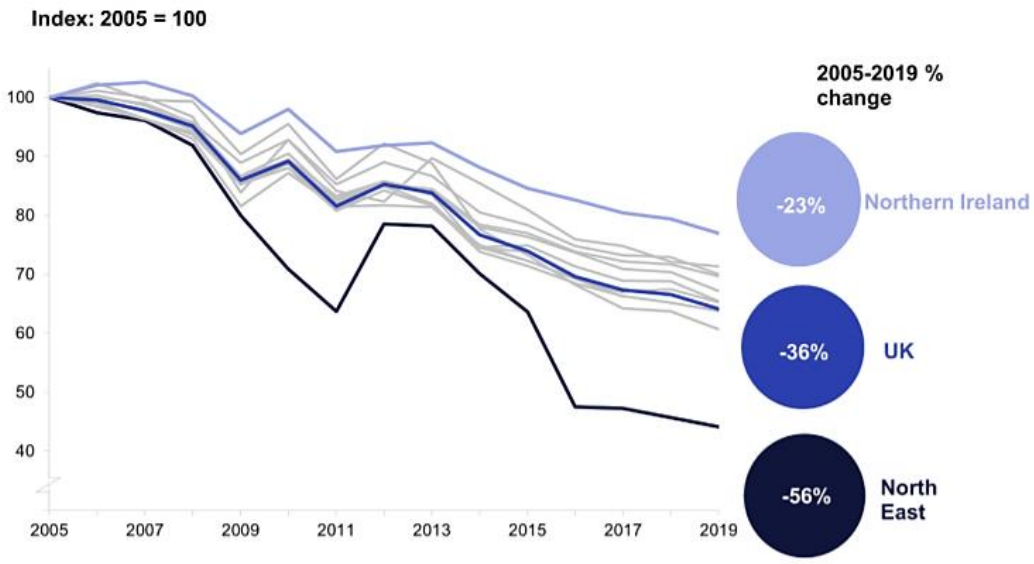

Figure 14 Carbon dioxide emissions from end-users by UK regions and countries [adapted from BEIS (2021)]

CO_2 emissions dropped in 360 of the UK's 379 local authorities between 2018 and 2019 (95%). This is consistent with the general drop in UK emissions from 2018 to 2019 (a 3.6% fall). The major driver of the drop in UK emissions in 2019 was a shift in the fuel mix for power generation, with less coal used and more renewables being used (BEIS, 2021). Figure 14 shows a 56% fall in carbon emissions in the North East of England between 2005 and 2019.

Nationally, transportation CO_2 emissions decreased by 1.8% in 2019 compared to 2018. Since 2018, about 83% (315 out of 379) of Local Authorities have reduced their transportation emissions, while 17% (64 out of 379) have increased their transportation emissions (BEIS, 2021). Overall national transportation emissions have dropped since 2005, despite an increase in both passenger cars and vehicle kilometres travelled. This is owing to reduced gasoline consumption by passenger cars outweighing an increase in diesel consumption, as well as increases in fuel efficiency of both gasoline and diesel vehicles. This is echoed in Local Authorities, where emissions have decreased in 92% (349 out of 379) of them since 2005 (BEIS, 2021).

However, statistics reviewed from the SCATTER CDP Report Inventory Excel sheet (2021 and 2020) for Newcastle upon Tyne indicated a 1.2% rise in overall carbon emissions between 2017 and 2018. In the transportation sector, there is also a 4.07% growth from 2017 to 2018. The reason behind this might be that the data released by BEIS was collected from all local authorities – with highlighting also certain regions – in the UK, but that the data reviewed from the SCATTER emission report for 2021 and 2020 was gathered by SCATTER nationally for

Newcastle upon Tyne in a somewhat different way, therefore resulting in this conflicting scenario.

Another comparison problem is that the BEIS data represents an estimate (only, so far) of carbon emissions for 2019, but the SCATTER's data supplied by SCATTER to the local authority when it is top-down data nationally pre-populated was only for the data years 2017 and 2018, thus no actual longer run comparison can be made data can be made between these differently reported data sources. The "UK local authority carbon dioxide emissions estimates 2019" report (BEIS, 2021) includes a range of maps showing 2019 carbon dioxide emissions per capita at Local Authority level. We have selected extracts from the maps in the 2021 BEIS report. it is noticed that annual emissions per capita vary noticeably between local authorities and (city) regions in the UK.

Figure 15 Net emissions of carbon dioxide per capita by Local Authority (tonnes CO2 per capita) in 2019 (BEIS, 2021: 24)

It can also be observed from Figure 15 above that Newcastle upon Tyne is doing reasonably well according to the BEIS 2019 data, though apparently not as well as South Tyneside or Northumberland in the Tyne and Wear region.

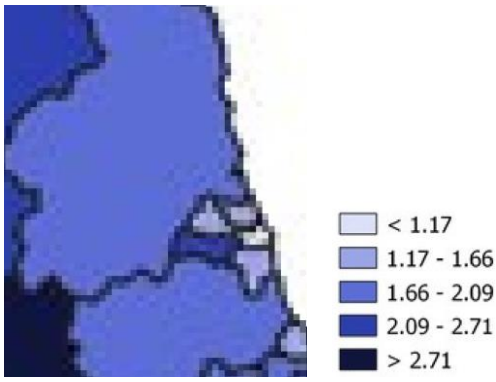

Figure 16 Transport CO2 emissions per capita by Local Authority (tonnes CO2 per capita) in 2019 (BEIS, 2021: 29)

For the transportation sector specifically, it can likewise be observed from Figure 16 above that Newcastle upon Tyne is doing reasonably well according to the BEIS 2019 data, though apparently not as well as South Tyneside in the Tyne and Wear region.

4 Verification check of NCC's CDP submission 2021

It is important to note (again) that the 2020 CDP year submission is based on 2017 data, pre-populated by SCATTER (i.e. the Anthesis Group). And that the 2021 CDP submission is based on 2018 data, pre-populated by SCATTER (i.e. the Anthesis Group). As also explained already in this report, at present (for the last two years), the Anthesis Group pre-selects and pre-populates the data categories and the actual data which is submitted by UK Local Authorities which is submitted by them as part of their SCATTER CDP submission.

4.1 General data management and managerial issues

As suggested by the figure below (Heidrich et al., 2013), with Corporate Social Responsibility reporting, for instance in the mining sector, in order to match the Global Reporting Initiative (GRI) or sector specific guidelines such as International Council on Mining and Minerals (ICMM), data can be narrowed down and channeled through various gates do ensure that the data is collected, verified and presented. The funnel will help (for instance) a company to determine the relevance of the data and the resources needed to obtain sound and verifiable data. The data are classified according to issues, such as for instance human rights, labour relations or carbon emissions. It is important to understand that although some headline indicators may *appear* straightforward, for example carbon emissions, substantial investigation may be required to produce realistic data.

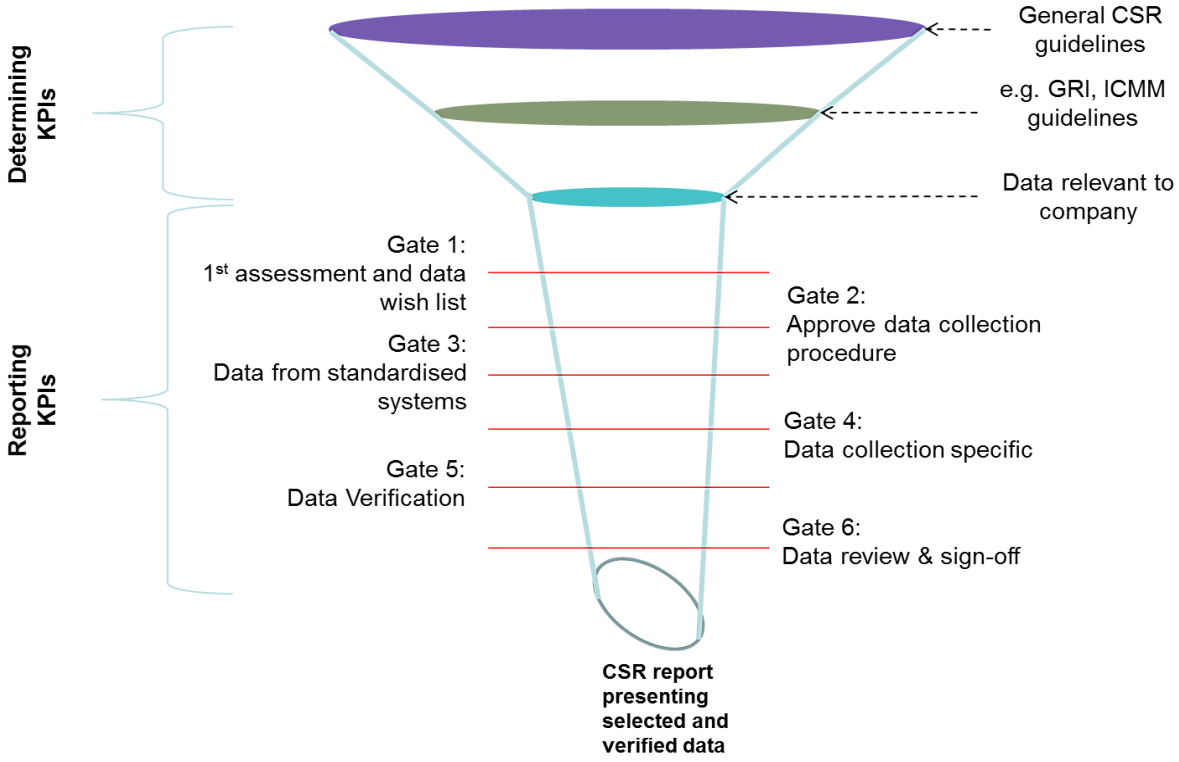

Figure 17 Decision funnel for preparation of a CSR report [Source: Heidrich et al. (2013: 22)]

Issues such as the selection and management of GHG data, procedures for collecting and processing GHG data, systems and processes to ensure accuracy of GHG data, managerial awareness, the availability of resources, clearly defined responsibilities, and internal review procedures within organisations, are all critical for a quality (assurance and verification) processes and procedures. Heidrich et al. (2013) illustrated this for the mining sector and its CSR reporting, as shown in the Figure 18 below.

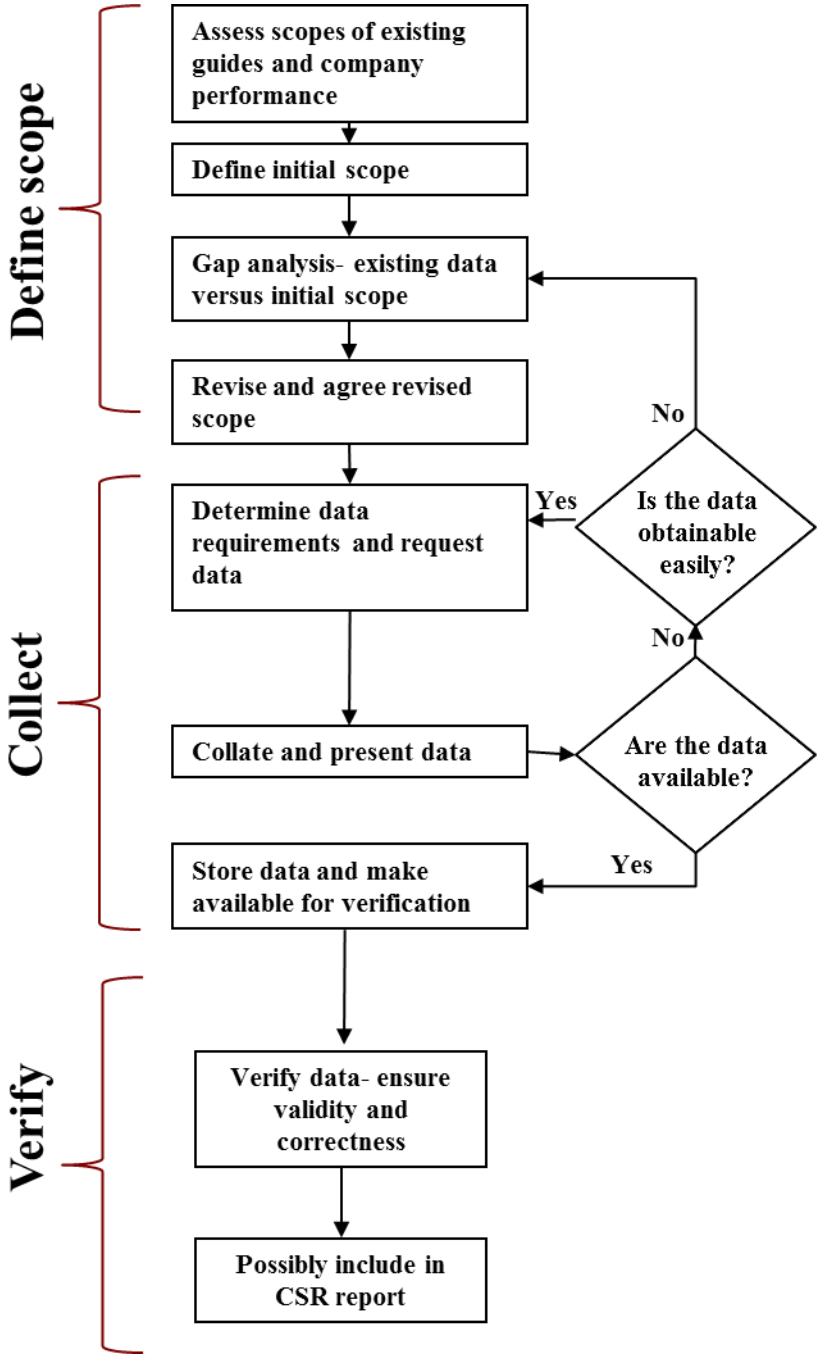

Figure 18 Data collection procedure for CSR reporting [Source: Heidrich et al. (2013: 21)]

The *ISO 9001 Auditing Practices Group's Guidance on: Identification of processes*[24] also makes some useful points for independent evaluators and auditors, which have tried to take on board here for the purposes of this independent verification and evaluation exercise.

[24] https://committee.iso.org/home/tc176/iso-9001-auditing-practices-group.html

"Distinguishing between the concepts of a process and an activity:

If an auditee cannot distinguish between the concepts of a process and an activity, the auditor can briefly explain the differences by using the guidance and definition as background information. The auditor must be able to adapt to the auditee's situation. It is the auditor's responsibility to understand the auditee's systems and approach.

During the audit, the auditor should determine whether there is a problem of difference of terminology only, or whether there is a lack of real implementation of the process approach by the auditee … The auditee has the right to use its own terminology, provided the requirements of the standard are met. The auditor should mentally develop a cross-reference list to ensure consistency and better understanding."

Since the SCATTER tool and methodology is currently pre-designed and pre-populated with data in the UK for Local Authorities, a major part of our job as independent evaluators (not having access to the tool ourselves), was to understand the process the NCC engages with it, and works in conjunction with pre-set structures, data, calculations and functions to develop their own insights and NCC's capabilities and Climate Change response process.

"A process has defined objective(s), input(s), output(s), activities, and resources:

If the auditee does not understand that a process must have defined (but not necessarily measurable) objective(s), input(s), output(s), activities, and resources, the auditor should try reformulating the questions to the auditee avoiding the use of QM [Quality Management] jargon, e.g. Can you explain to me your operations here? What are the basic jobs carried out in your department? What information do you need to start your work? Where does it come from? Who receives the result of your work? How do you know if you've done your job correctly? etc. This should help the auditor to establish whether the processes are already defined, have clear inputs, outputs, objectives and so on." We tried to adopt this approach in the online verification and audit meeting we had with Newcastle City Council on the 15th of July, including with framing and asking our questions live online in this manner.

"Processes should be analysed, monitored and/or measured, and improved:

If after applying the audit techniques outlined above, there is an absence of any records or other proof to demonstrate that the processes are analysed, and/or monitored, and/or measured, and/or improved, there would appear to be non-conformity with part of ISO 9001:2000 Clause 4.1." The SCATTER methodology is based on quantitative data which is analysed, albeit for

now pre-populated and pre-calculated and pre-analysed by the Anthesis Group. The SCATTER CDP Cities Questionnaire, however, also asks for qualitative data responses from Local Authorities, and the SCATTER CDP submission process also allows for LAs to present additional material to show their improvements in understanding and approach. This opportunity is taken by NCC, including by submitting the Local Proxy Data Excel sheet on possible bottom-up data sources for future CDP disclosure.

"Is the process approach as described in the 'Introduction' to ISO 9001:2000 a requirement of the standard? The description of the process approach in the 'Introduction' to ISO 9001:2000 is purely informative and does not introduce a set of additional requirements by itself. Clause 4.1 specifies the steps necessary to implement a process approach with regard to quality management system processes, the Note to clause 4.1 providing examples of processes needed for the quality management system. Audit methodologies must be oriented, accordingly, towards analyzing the processes of the organization." As independent reviewers, we have adopted this process-focussed approach, and have asked our questions and reviewed material given to us by NCC pro-actively and also in response to questions or queries by us accordingly.

4.2 Process of verification by Northumbria and Newcastle universities of NCC data management and CDP submission process

The first engagement from Newcastle City Council on the CDT submission was – initially to Newcastle and Northumbria universities on the 14th of May 2021.

On 19th of May, Oliver Heidrich and Xuewu Dai met the Newcastle City Council Climate Change Advisors, Tim Rippon and Adrian McLoughlin, for the first time online on this.

On the 2nd of June 2021, the request/briefing below was send to both universities – after an online meeting with Oliver Heidrich and Xuewu Dai earlier on that day:

[from Tim Rippon, NCC]:

"In terms of further information, please find attached:

1. A SCATTER inventory produced by Anthesis showing the latest emissions level, source data and assumptions that they've used in that analysis. This is the main element of our emissions inventory submission to CDP. There's also a Word document showing the SCATTER inventory summary, methodology and report.

2. A partially completed (draft) Local Metrics of Performance data directory which is an initial pass of potential local proxy datasets that could be used to enhance / replace elements of the SCATTER inventory to give more local input data and metrics to assess the effectiveness and speed of transition in the city to Net Zero.

As discussed in the call, one of the areas where we can improve in our submission this year is to have an independent evaluation of the SCATTER emissions inventory for the city, which by and large is based on national data. In terms of next steps, I'm keen that in advance of our submission at the end of July, we are able to include a short report (maybe somewhere between 2 and 5 sides of A4) detailing:

A. An independent review from Newcastle Uni and Northumbria Uni of the SCATTER inventory (and methodology) summarising your views on where the inventory is comprehensive, reliable and accurate, and areas where there are shortcomings in the data. This is essentially a verification exercise to check that the approach aligns to the GHG Protocol Guidance[25]. There are some broad verification criteria, summarised below, which I think would make a good structure for the report but open to your views:

- Inventory boundary is clearly and correctly defined;
- All required emission sources are included and notation keys have been used appropriately;
- Calculations are consistent with the requirements of the GPC;
- Data are time- and geographically-specific to the inventory boundary and technology-specific to the activity being measured;
- Data are sourced from reliable and robust sources and referenced appropriately;
- All assumptions are documented;
- General data management and managerial issues, such as selection and management of GHG data, procedures for collecting and processing GHG data, systems and processes to ensure accuracy of GHG data, managerial awareness, availability of resources, clearly defined responsibilities, and internal review procedures.

[25] https://ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf

B. Some initial consideration of where there is potential to integrate local metrics of performance / local proxy datasets into next year's inventory, and a very short summary of how NCC could [or – but this is to be written by them; intend] to do that over the course of the next 12 months.

[from Adrian McLoughlin, 08 June 2021]

"I've included a screenshot below to highlight some of the changes made within the data used by SCATTER, this suggests impacts beyond carbon factors. I have attached last years' inventory so you could compare – note the file names don't reflect the inventory year [they do now at our end, as Daniel has changed that]."

Xuewu Dai, with moderations made in meetings and discussions with Richard Kotter, produced a PPP for the 28th of June 2021 for another meeting with the Newcastle City Council team and Oliver Heidrich.

Oliver Heidrich from NCL produced and send a draft structure of the Independent Report by NCL and NU on the 23rd of June 2021.

This has since been changed by Xuewu Dai and Richard Kotter in online meeting between them and shared back to NCL and NCC.

For a number of reasons, and suggested and confirmed by Oliver Heidrich from NCL in e-mails and online meetings, Northumbria University is now leading on this report.

Then as a slightly enlarged group [Tim Rippon and Adrian McLoughlin, NCC; Oliver Heidrich, NCL; Xuewu Dai and Richard Kotter from NU] had an MS Teams call on the 28th of June 2021.

The next meeting of the same group as above was on the 7th of July 2021.

Oliver asked Tim Rippon of NCC that morning by e-mail: "maybe you have a newer version of your planned submission, which you could share with us prior to the meeting perhaps?

On the 9th of July 2021, Oliver Heidrich from NCL and Xuewu Dai and Richard Kotter from NU met and agreed the sample data row we would ask NCC about from the SCATTER CDP Excel sheet. Oliver Heidrich also suggested, and followed up on this, to contact a colleague at the Tyndall Climate Change Research Institute at the University of Manchester on their involvement with SCATTER, and also to see if they are aware of a UK verification exercise for a local authority in the UK. The colleague replied, and said they are performing

pro-bono a similar activity for Manchester City Council, but that to their knowledge there is no ready example or established way or format as to how to conduct this.

On the 9th of July 2021, Oliver Heidrich from NCL shared with Xuewu Dai and Richard Kotter a raft of documents that we could use as inspiration for the independent evaluation process for chapter 4.

On the 14th of July 2021 from Oliver from NCL:

"Dear Daniel and Richard, thank you very much for your work and preparation for this. … For now, please do proceed as you have outlined below, it does make sense. I guess key is to keep a record what they say and how they respond to the queries."

Xuewu Dai and Richard Kotter worked up the questions, sharing them with Oliver Heidrich for agreement, and then send them to NCC colleagues very early on the 15th of July 20201 for a meeting later on that day.

These questions were:

"Further to our meeting last week, Oliver, Richard and myself have had more discussions about the report. Six emission categories have been selected as examples to understand the data processing practice at Newcastle City Council. The 6 emission categories are (please also see the attached spread sheet "full table" with highlighted rows in yellow):

(1) Road Transport / Petroleum (row 93 in the pre-populated Excel sheet you downloaded from the Anthesis SCATTER website and shared with us)

(2) Road Transport / Electricity (row 94)

(3) Waterborne Transport / Internal water way (row 103)

(4) Aviation / in-boundary (row 108)

(5) Solid Waste Disposal / Open-loop (row 113)

(6) Small-Scale / Anaerobic Digestion (row 178).

We are grateful if you could give feedback/comments to the following questions below, which will help to us complete the data verification part of the independent review report you asked us to provide this July 2021.

1) What is Newcastle City Council's procedure for determining which data sources are selected for these inventory classes?

(2) Are there any NCC internal regulations or data processing protocols which are applied in the data source selection?

(3) How does the NCC update the data? What is the difference between 2017 and 2018 data?

(4) Do these selected data sources and connected calculation methodologies meet the SCATTER requirements? Was there a choice/range of options, and - if so - how did NCC make the choice and for which reasons?

(5) Do these selected data sources and their methodological treatment comply with the CDP requirements?

(6) Could Tim or Adrian explain the user interface of the SCATTER software tool and how this software is used? A user manual or something like that will be great.

On the 15th of July, for about 90 minutes, Xuewu Dai and Richard Kotter from NU and Oliver Heidrich from NCL met with Tim Rippon and Adrian McLoughlin from NCC online for a verification and audit meeting, based on the above questions and a live demonstration of their accessing and downloading the pre-populated SCATTER CDP material from Anthesis' SCATTER website with their local authority password, with further interactive questions asked by the independent evaluators.

From the 2nd of July 2021, Xuewu Dai and Richard Kotter were joined in their NU team by Stephanie Chu, an NU Opportunities [u/g student] Intern paid for centrally by Northumbria University to assist and gain experience. She signed a NU standard Non-Disclosure Agreement, which we communicated to NCC colleagues. All academic colleagues here are bound by their respective University's Ethics Codes and Procedures, as well as UK Data Protection Laws [in which all of them have had the requisite mandatory institutional training].

The NU team then produced the first draft of this report internally, sharing it with Oliver Heidrich internally, before making it available to NCC colleagues.

4.3 The Scopes of the Inventories

A range of activities that are taking place in a city will generate GHG emissions that either occur inside the city boundary or outside the city boundary. For the CDT submission by local

authorities, these need to be separated by the place of the origin and emissions are commonly grouped into three categories based on the source where they occur:

- Scope 1 (Direct emissions) GHG emissions from sources located within the city boundary,
- Scope 2 (Indirect emissions) GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary,
- Scope 3 All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

The CDP Cities Questionnaire which NCC completes as part of their submission includes the following for the verification process globally. The UK process is, as explained above, different as the Anthesis Group pre-populates the Inventory for UK Local Authorities, and the LAs simply download and submit them as part of their CDP disclosure.

4.4 Inventory boundary is clearly and correctly defined

For the UK, at present and also for last year's submission by NCC, this is pre-populated by the Anthesis Group. With the exception of some shortcomings and uncertainties discussed elsewhere in this report (chapters 3, 5 and 6), this is generally fit for purpose at present, and is also accepted by CDP as compliant.

4.5 All required emission sources are included, and notation keys have been used appropriately

Yes, this can be confirmed in general for the 2021 NCC CDP submission, and also for the 2020 submission. As NCC found, the labelling of the Excel sheet with the pre-populated data is not ideal, as it is not immediately clear for which year this is. NCC and also NU internally rectified this in their own data storage systems.

4.6 Calculations are consistent with the requirements of the GPC

This appears to be the case, though the time scale and resources of the independent verification exercise did not allow us to re-calculate the data used by the Anthesis Group, and to apply their calculation methods to the data they pre-selected for NCC and calculate for them. We note some limitations in chapters 3, 5 and 6 in this report.

4.7 Data are time- and geographically-specific to the inventory boundary and technology-specific to the activity being measured

This appears to be the case, though the time scale and resources of the independent verification exercise did not allow us to check all the data and data sources used by the Anthesis Group. We note some limitations in chapters 3, 5 and 6 in this report.

4.8 Data are sourced from reliable and robust sources, referenced appropriately

This appears to be the case, largely from national data sources, though the time scale and resources of the independent verification exercise did not allow us to check all the data and data sources used by the Anthesis Group to pre-populate the data parts of the submission by the Anthesis Group through the SCATTER tool. We note some limitations in chapters 3, 5 and 6 in this report. The NCC is also on its way to consider which Local Proxy Data could be used in the (near) future, as evidenced in the relevant Excel sheet they shared with the independent evaluators and which they will also submit as part of their 2021 CDP submission to show their engagement with the process and continuous improvement. We make some further comments and suggestions in chapters 5 and 6 in this report.

4.9 All assumptions are documented

These can be found in the publicly available parts of the SCATTER tool. These appear largely reasonable, and corrections and changes are made by the Anthesis group – as referred to in the report also in chapter 3.

5 Emission Modelling, Limitations and Suggestions

As detailed in the IPCC (2006c) 'Guidelines for National Greenhouse Gas Inventories', the basic concept of the emission model in most emission sectors such as buildings, transportation and heavy industry are the product of activity data A and an emission factor θ, as described by equation below:

$$GHG\ Emissions = \mathrm{A} \times \theta$$

The activity data A refers to the estimated quantitative amount of human activity resulting in GHG emissions taking place during a given period of time (e.g. energy consumed, volume of gas used, kilometers driven, tonnes of solid waste sent to landfill, etc.). In transport, sector, the widely used activity for the road transport sector is the total amount of fossil fuel consumed in road transport. And in the SCATTER model, fuel combustion is adopted as the transportation activities with city boundary. In the SCATTER emission report for year 2021 (Anthesis Group, 2021), the activity data for road transport are (1) Retail Market Monitoring Annual Transparency Report (for calendar year 2018)[26] released by Northern Ireland Utility Regulator; (2) Total final energy consumption at regional and local authority level from Sub-national total final energy consumption data[27] for calendar year 2018 released by the BEIS. This is a wide accepted practice in other countries, such as Canada (Khan and Awasthi, 2019).

The emission factor is a statistic measure of the average mass of GHG emissions relative to a unit of activity, measured in per units of activity. It relates the quantity of a pollutant released to the atmosphere with an associated activity, for example, kilograms of particulate emitted GHG per Mega Watt (MW) of energy consumed by fuel combustion.

The estimation of energy demand usually adopts the same methodological principle as shown in above equation, in which the same activity data is combined with energy intensity factor. Direct (Scope 1) and indirect energy (Scope 2) forms are estimated, respectively. Direct energy is measured as the consumption of fuel for energy purposes. Indirect energy includes

[26] https://www.uregni.gov.uk/sites/uregni/files/media-files/2018-08-31 Annual Transparency Report 2017 FINAL.pdf Note: This is labelled as 2018 data, but indeed is the report for 2017. The same report is referred in year 2020's SCATTER report but labelled as 2017.

[27] https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

steam, heat, electricity and cooling (SHEC), which are generated by third parties and purchased by the consumers for its own use.

5.1 Modelling of SCATTER

The publicly available technical details of the SCATTER modelling by the Anthesis Group are very limited and superficial. Since the SCATTER model accompanies with the GCoM's Common Reporting Framework (CRF), unless specified clearly, the following analysis of SCATTER modelling are mainly based on the GCoM's Common Reporting Framework (Global Covenant of Mayors (GCoM), 2019).

Table 4 Definitions for sub-sectors required under transportation sector [Source: Table 3 in (Global Covenant of Mayors (GCoM), 2019)]

Sub-sectors	Description
On-road	Emissions from energy use for on-road transportation of people or goods. Cities only need to report emissions from journeys occurring inside the city boundary. Cities **should** further categorise this sub-sector by municipal fleet, public transport, private and commercial transport, and **may** breakdown further by mode such as cars, taxis, buses, motorbikes, etc.
Rail	Emissions from energy used for rail transportation of people or goods, such as trams, urban railway subway systems, regional (inter-city) commuter rail transport, national and international rail system, etc. Cities only need to report emissions from journeys occurring inside the city boundary.
Waterborne navigation	Emissions from energy use for water transportation of people or goods, such as ferries, domestic inter-city vehicles, international water–borne vehicles, etc. Cities only need to consider emissions from journeys that are fully confined within the city boundary (i.e. both start and end inside the city, such as sightseeing cruises). Reporting of this sub-sector is only required if considered significant (see Box 1 for definition of insignificant emission sources).
Aviation	Emissions from energy use for air transportation of people or goods, including civil and military aviation. Cities only need to report emissions from journeys that are fully confined within the city boundary (i.e. both start and end inside the city, such as sightseeing or emergency helicopters and other local aviation). Reporting of this sub-sector is only required if considered significant.
Off-road	Emissions from energy use by off-road vehicles and mobile machinery within the city boundary. Reporting of this sub-sector is only required if considered significant.

The emission model $GHG\ Emissions = Activity\ Data \times Emission\ Factor$ used in the SCATTER tool covers emissions from fuel combustion and use of grid-supplied energy for all modes of transportation activities within city boundary. In SCATTER, emissions are calculated

by multiplying energy consumption (activity data) by the corresponding emission factors for each energy type, and by sub-sector. For the transportation sector, the subsectors defined by the GCoM and adopted by the SCATTER are list in the table above.

For the definition of subsectors under other sectors, please refer to Section 3.6 in (Global Covenant of Mayors (GCoM), 2019).

To calculate the emissions for each subsector, two modelling approaches, namely, Fuel sales approach (also known as top-down approach in GHGP (GHGP, 2014) and model-based approach (also known as bottom-up approach in GHGP (GHGP, 2014))), are available for LAs to choose. The GCoM allow local authorities may choose from the following two types of modelling approaches to calculate the energy consumption, then the emissions for transportation activities within the city boundary, depending on the LA's data and resource availability, However, at present, for LAs in UK, the top-down fuel sales approach has been pre-selected by the Anthesis Group if the LA use the SCATTER for their CDP submission. It is worth noting that the current version of SCATTER adopts the top-down (fuel sale) approach.

5.1.1 Fuel sale approach (top-down approach)

The top-down approaches usually use fuel consumption as a proxy for transportation activities. Then emissions are the result of total fuel sold multiplied by an energy factor, and by the GHG emission factor for each fuel.

$$GHG\ Emissions = Fuel\ sale\ data \times Energy\ factor\ \times Emission\ Factor$$

The activities in top-down approach are the energy consumption in Giga Watt Hour (GWh) due to fuel combustion for transportation activities within city boundary.

It is suggested by GCoM's "Explanatory Note accompanying the Global Covenant of Mayors Common Reporting Framework" section 3.6.2 (Global Covenant of Mayors (GCoM), 2019) that on-road and rail travel should additionally be disaggregated by municipal fleet, public transport, private and commercial transport. For waterborne and aviation, cities only need to report journeys fully confined within the city boundary.

According to the GCoM guidance (Global Covenant of Mayors (GCoM), 2019), LA may assume that all fuels sold within the boundary are used for journeys within the boundary. If it possible, LA may use surveys or other methods to determine the portion of fuels sold that are attributable to journeys within the boundary. Various data sources can be used to estimate the amount of fuel sold. Typical data sources in practice are fuel sale records of fuel distributors

and/or dispensing facilities, or fuel sales tax records. For waterborne and aviation, cities only need to report journeys fully confined within the city boundary.

The top-down model adopted by the SCATTER is consistent with national inventory practices and is suitable for cities that have limited resources, technical capacity or time. However, it does not capture all transportation activities within a city boundary (for example, vehicles may be fuelled outside the boundary but driven inside), nor does it disaggregate the reasons for travel emissions (such as origins, destinations, modes, vehicle types and efficiency). Therefore, it does not comprehensively demonstrate mitigation.

5.1.2 Model-based approach (bottom-up approach)

Another model for emission calculation is the bottom-up approach, which is based on the combining of physical activity indicators and their associated emission factors. Because such indicators relate directly to the emitting activity, the bottom-up approach is expected to be more accurate with a narrower margin of error than the top-down approach.

Since the SCATTER mainly use the top-down fuel sale approach, more discussion on the bottom-up model-based approach will be presented later in section 5.3 as the options and for methodology improvement.

5.2 Limitations of SCATTER Modelling

The SCATTER is designed to cover the calculation of emissions for all sectors and subsectors, in a methodology compatible with the GCoM Common Reporting Framework (CRF). In particular, it is to for all modes of transportation activities within city boundary. Although it is not yet used by all local authorities across the UK, SCATTER has been a popular tool for local authorities to report their emissions, analyse the impacts, set emission targets and make action needed, due to its free of use for the time being, simple and friendly user interface and compatibility to well-recognised emission standards and organisations, such as CDP and GHGP.

The SCATTER also has its limitations in modelling and emission calculation, mainly due to the constraints and granularity of selected data sources, the assumptions and simplification used for practical modelling and the selection of parameters. Some general limitations of SCATTER are: (1) The SCATTER is based on national scaled down data, rather than local authorities' regional data; (2) The SCATTER does not separate council's own emissions from

city-wide; (3) The SCATTER only provides sector-based energy use inventory not consumption; (3) The SCATTER does not model the costs / skills required.

There are also more limitations and methodological differences that should be considered when verifying and reviewing the SCATTER-based CDP submission.

5.2.1 Methodological difference in national and local inventory

Different methodological approaches are used in deriving the UK national/regional and individual local authorities' local inventory. For example, in the SCATTER's Newcastle upon Tyne emission report (full table) for year 2021 (Anthesis Group, 2021), the description of method used for 'on-road' emission (scope 1) is "Mapped against full Local Authority list to apply final LA code; combined areas (e.g. England, Outer London) removed from dataset." [28]. The many methodological differences in national and local inventory may be one of the reasons why the emissions trends in Newcastle upon Tyne are different from the national and regional trend. For more details about the difference of emission trends in Newcastle upon Tyne compared with national and regional trends, please see section 3.2 in this report.

5.2.2 Coarse granularity by using the national scaled down data

The SCATTER emissions inventory is by and large based on national data. SCATTER does not separate council's own emissions from city-wide. For example, in order to calculate the direct emission (Scope 1) for on-road subsector, the SCATTER uses the "Total final energy consumption at regional and local authority level published by BEIS is combined with Northern Ireland gas and electricity consumption data from the Northern Ireland Utility Regulator" [29].

During the scaled-down mapping, several simplifying assumptions are needed to maximise the practicality, which may not only lead to course granularity, but also introduces statistical bias. Statistical bias occurs when the selected data is not representative of the situation of local authorities. In the SCATTER tool, presently for the UK the data is the predominantly national

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[28] In the references sheet of the Excel file for the submission report year 2021, the "Method" field (column H) for the data "DATA_Fuel" (row 24).

[29] In the full table sheet of the Excel file for the submission report year 2021, the "Method" field (column AF) for the "on-road (direct, scope 1)" subsector (row 93).

data, not the data collected directly in the local authorities. The real situation in local authorities may differ from the national data on local authorities.

5.2.3 Temporal difference in year of submission and year of data sources

As seen in the SCATTER's full excel data file, the SCATTER's emission report for year 2020 is based on the data collected in 2017 (some may be earlier). Similarly, the emission report for year 2021 is mainly based on the data in 2018. There is an about 3-year lag between the report submission and the data collection. For example, in the SCATTER's Newcastle upon Tyne emission report (full table) for year 2021 (Anthesis Group, 2021), the on-road subsector in transport is based on the "sub-national total final energy consumption data" (termed as "DATA_Fuel", "Petroleum products, Road transport") [30], which was the data for year 2018. According to the link provided in the excel table, this data was released in the "Sub-national total final energy consumption data" by the BEIS in 2020.[31]

5.2.4 Selection of emission factor and assumption of activities

The choice of emission factor may not reflect the actual type of fuel consumed, which may lead to a biased estimation of GHG emission. For example, in the on-road subsector under transport, the emission factor is based on diesel fuel, which implies that diesel fuel is assumed for all on-road activities. As shown in the SCATTER's emission report for Newcastle upon Tyne (submission year 2021), the "emission factor reference" for on-road (direct) activities is "Diesel (average biofuel blend)" 32 and the source is "tab Fuels" in "BEIS, 2019. Greenhouse gas reporting: conversion factors 2018. Conversion factors 2018 - Full set (for advanced users)". However, it is obvious that, in the actual on-road activities in the Newcastle upon Tyne

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[30] In the full table sheet of the Excel file for the submission report year 2021, the "SCATTER data reference" field and the "Description of emission source" field for the "on-road" subsector are "*DATA_Fuel*" and "*Petroleum products (2)Road transport*", respectively.

[31] URL: https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

[32] In the full table of the Excel sheet for the submission report year 2021, the "data source" filed for the emission factor of "on-road (direct)"is stated as "*BEIS, 2019. Greenhouse gas reporting: conversion factors 2018. Conversion factors 2018 - Full set (for advanced users)"*

are not all by diesel. Indeed, it is a combination of petrol, diesel, biofuel, and electricity, etc. Since the simple assumption of all on-road activities are of diesel does not fully represent the actual activities. the emissions amount contains some approximation errors. Nowadays, less diesel vehicles are sold and there are more shares of EV in the car market, it is expected that the approximation errors will increase.

5.2.5 Unclear methodologies of projecting emission in future from history data

There is a lack of detailed technical document about the data processing and the projection of emissions, the methodologies adopted by the SCATTER is not clear. Considering the fact that the Anthesis Group collaborated with the Tyndall Centre[33] to develop the SCATTER model, and the "Carbon Budget Report" by the Tyndall Centre is produced as part of the SCATTER project[34], it is possible to have a brief insight of SCATTER's projection methodologies through the Tyndall Carbon Budget Report project.

In the "Setting Climate Commitments for Newcastle upon Tyne" report[35] retrieved from the online tool of "Tyndall Carbon Budget Report", a figure of pathway projections for Newcastle upon Tyne is presented (see the figure below). It is stated that "To align the 2020 to 2100 carbon budget with the budget periods in the Climate Change Act, we have included estimated CO_2 emissions for Newcastle upon Tyne for 2018 and 2019, based on BEIS provisional national emissions data for 2018 and assuming the same year on year reduction rate applied to 2019." This implies the SCATTER may also make the same assumption in the projection, if no further interventions are made. However, it can be seen in the figure below that the actual yearly reduction rate in 2010 to 2019 is not constant. Assuming a fixed reduction rate for the upcoming year and only use the last year's reduction rate may not fit the long-term history data. As a result, this may lead to a biased projection.

[33] https://www.tyndall.ac.uk/

[34] https://carbonbudget.manchester.ac.uk/about/

[35] https://carbonbudget.manchester.ac.uk/reports/E08000021/

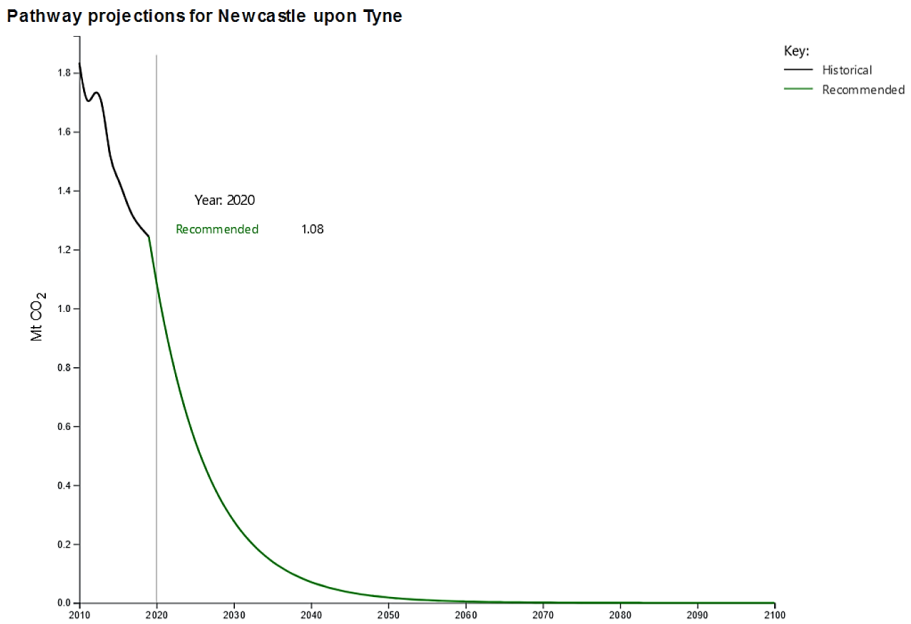

Figure 19 Energy related CO2 only emissions pathways (2010-2100) for Newcastle upon Tyne premised on the recommended carbon budget [Source: Figure 1 in the Tyndall carbon budget report for Newcastle upon Tyne, https://carbonbudget.manchester.ac.uk/reports/E08000021/]

Furthermore, although the SCATTER's pathway function is able to simulate some scenarios of carbon reduction action to estimation its impacts on the emission inventory, it cannot tell local authorities how much it would cost to implement any of the carbon-saving interventions, as the SCATTER does not model the costs / skills required.

5.2.6 Limitations in the Transport sector inventory

More specially, in SCATTER's modelling of emission inventory in transport sector, the are some additional limitations, mainly due to the lack of accurate local data sources.

(a) EV and indirect emission in road transport: Analysis using vehicle miles[36] , as currently used by BEIS, does not differentiate between vehicle types and fuel usage, therefore electric vehicles are not considered and electricity consumerist by EVs is not included in the BEIS data set. As a result, the scope 2 of indirect on-road transportation is zero. The GB The percentage of ULEV registered vehicles in GB now is about 0.5%, a little lower but broadly in line with the national average uptake of EVs. However, in the

[36] DfT Dataset VEH 0132 ULEV's by local authority area

future, more EVs will be in the road vehicles. This will be a main part of emission reduction in road transportation and should not be treated as zero.

(b) Consumption of biofuels in road transport: Similar to the EV and electricity consumption in road transport, the SCATTER only takes account of emissions arising from fossil fuels, making it difficult to know where exactly biofuels are being consumed. This is because the BEIS data only covers road transport consumption of petrol and diesel.

(c) Registration of road vehicles. The BEIS data and, therefore, the SCATTER model use vehicles registration data to determine where the vehicle travelling occurs. This does not account for the fact they will be used elsewhere, and non-Newcastle upon Tyne registered vehicles commute into the city. Some fleet vehicles used locally in Newcastle upon Tyne may be registered at head office locations outside Newcastle upon Tyne.

(d) Lower milage in a city: In a city, it is likely that although there are a high number of vehicles, they will tend to have lower annual mileage. Therefore, using the averaged statistical vehicle miles may not represent the actual milage in Newcastle city council.

(e) Through traffic: The estimates are made on the distribution of traffic, therefore some of the emissions within an **authority** represent through traffic, or part of trips into or out of the area, whether by residents or non-residents. this should be considered when looking at either totals or per capita estimates. Motor way has more through traffic.

(f) Breakdown between major and minor roads: How the road traffic estimates break down between major and minor roads should be considered.

5.2.7 Limitations in the Stationary energy sector inventory

One main limitation in stationary energy inventory is the differentiation of domestic and non-domestic consumption of electricity & gas. It is difficult to identify the energy consumption for domestic and small business: A small proportion of the gas and electricity consumption allocated to the domestic sector in these estimates is attributed to business in the UK inventory. This is because it is not possible to distinguish between domestic customers and smaller businesses in the meter point consumption data used in these local estimates

5.3 Options and challenges for methodology improvement

As discussed in Section 4, the data management and processing have significant impacts on the quality of the emission report. The CDP and GCoM propose several options from data selection to modelling, and they allow local authorities to determine which data and model to be used, given the process of data selection and modelling follow the required procedure and standards. In order to improve the emission inventory, the following options related to Newcastle upon Tyne's NetZero action plan is discussed. However, taking these options may also raise challenges to local authorities, and careful consideration and plan are needed to address these challenges.

5.3.1 Robust data management and processing

Accurate and reliable emission inventory requires robust data management and processing. In particular, if a bottom-up approach is selected by the local authorities, a robust data management and processing is the first priority, as the local authority has more freedom, in turn, more responsible for the data processing.

To take a bottom-up model-based approach, a robust data management and processing framework is needed. As shown in the figure below, such a framework consists of a series of sequential steps in processing and integrating both activity data and energy coefficient data.

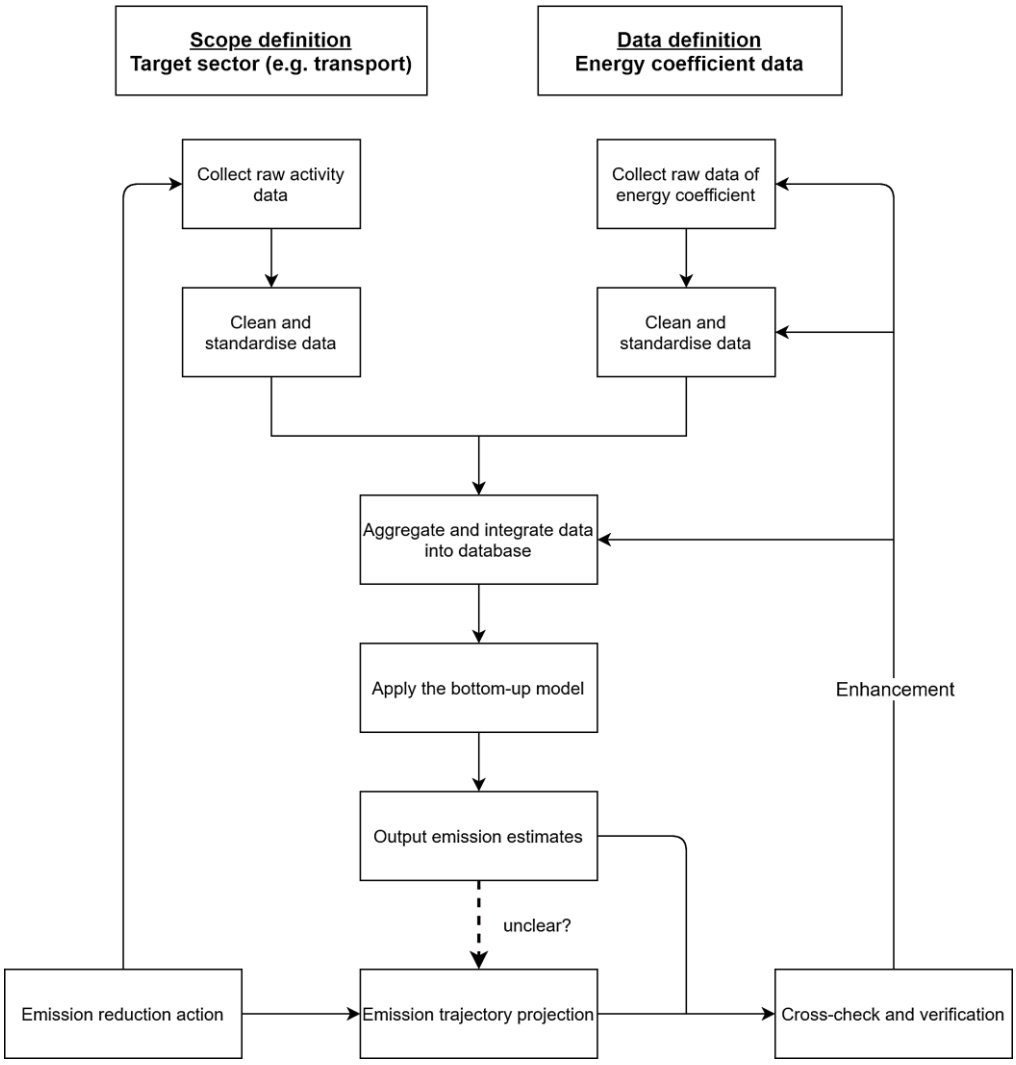

Figure 20: A framework of robust data management and processing

These process steps start from raw data collection, followed by data cleaning and standardising to give tided, reliable and consistent data for the bottom-up model. Then the cleaned data are aggregated and integrated into a database and fed into the bottom-up model to produce the GHG emission estimates. Usually, the emission estimates need to go through a verification process by cross-checking the emission estimates with the outcomes of other modelling methodologies or the third party's estimates. And the difference of different models should be justified. If the difference cannot be justified, improvement in data aggregation may be needed, which may trace back to the data collection and cleaning, standardisation procedures. The framework of robust data management and processing usually work as a cycle to continually evolve. Preparing and standardising data before the model calculation stage is paramount to enabling reliable and robust modelling coefficients. This raised a challenge to the bottom-up approach.

5.3.2 Alternative models

There are two modelling approaches, namely the top-down fuel sale approach and the bottom-up model-based approach, in which carbon emissions within the boundary of Newcastle upon Tyne could be calculated. None of them are wholly accurate, however, in the future, as Newcastle upon Tyne would like to measure the impact of intervention actions taken to reduce carbon emission towards the carbon neutral target, a more sophisticated bottom-up model-based approach will be needed. These two modelling approaches, namely, the top-down fuel sale approach and the bottom-up model-based approach, has its advantages and limitations.

A. Top-down fuel sale approach

The top-down fuel sale approach has been discussed in section 5.1, as it is the approach used in SCATTER for stationary, transport etc. Please refer section 5.1 for more details.

B. Bottom-up model-based approach

In the bottom-up modelling approach, the general emission model of $GHG\ Emissions = Activity\ Data\ \times Emission\ Factor$ is extended with a breakdown framework called ASIF (Activity, modal Share, modal energy Intensity and carbon content of Fuels). The bottom-up model can be described as

$$GHG\ Emissions = (Transport\ Activiy\ \times Mode\ Share \times Energy\ Intensity) \times Emission\ Factor$$

The data and parameters for the bottom-up model are:

Transport activity: This is a measure of traffic flow reflecting the number and lengths of trips, usually expressed as VKM (vehicle kilometres travelled). The VKM is determined by multiplying the number of vehicles on a given road or traffic network by the average length of their trips measured in kilometres (or miles). It can be measured as passenger-kilometre (a unit of measurement = 1 passenger transported a distance of 1 kilometre) and tonne-kilometre (a unit of measurement = 1 tonne transported a distance of 1 kilometre). The VKM may be available from the local or regional transport department who collect such data for transport planning purposes, or from sample surveys (i.e. traffic counts), household transport surveys, etc.

Mode share: This represents the portion of trips taken by different modes (e.g., walking, biking, public transport, private transport, etc.) and vehicle types (e.g., cars, taxis,

buses, motorbikes, trucks, etc.). The mode share can be estimated from traffic counts and surveys, vehicle registration, local/regional/national statistics, etc.

Energy intensity: This is the energy consumption per km travelled by each vehicle type. This is determined by the type of energy used, the make, model and age of vehicles, the road condition, the driving cycle and a number of other factors. Cities may estimate the average fuel consumption of vehicles driving on the street network based on polls, information from inspection agencies or vehicle registration information

The bottom-up model-based approach is based on the breakdown framework of ASIF. The ASIF framework is shown in the figure below and more details of how this breakdown works can be found in the report by GHGP, "Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities" (GHGP, 2014)

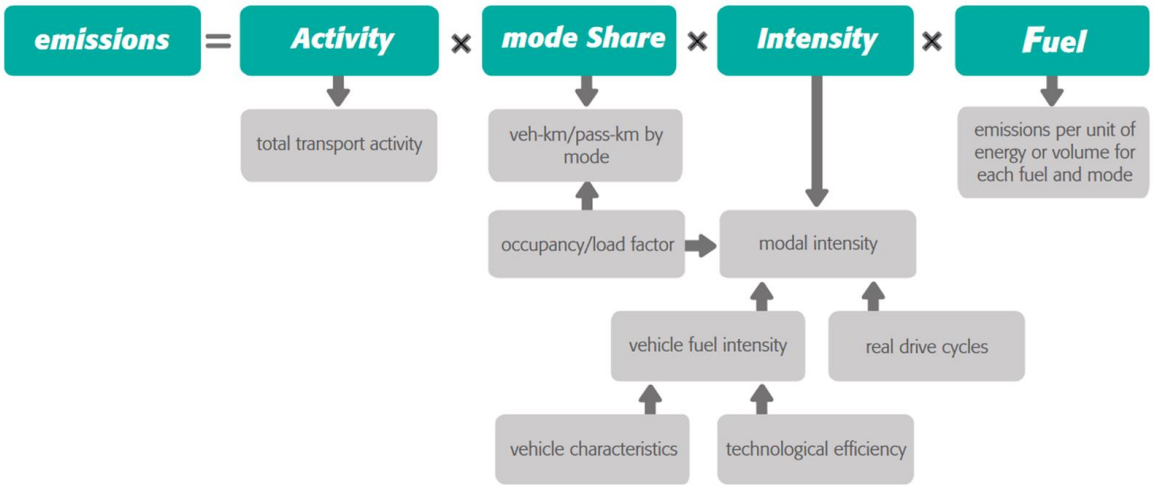

Figure 21 ASIF framework [Source: Figure 7.1 in the "Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities" (GHGP, 2014)]

The advantage of the bottom-up model-based approach is the accuracy and comprehensiveness that detailed activities at a smaller granularity within the LA boundary are used. The bottom-up approach is based on detailed and local data, which is more repressive to the actual activities taking place in a LA than the national statistical data used in the top-down model. However, it is usually time and resource consuming and expensive to collect and process the data.

The main barriers for adopting the bottom-up model-based approach are the complexity of the model, which need detailed data of activities and dedicated parameters for individual Las, since the pattern of the activities may vary from one LA to another. It is also expensive,

because it requires well-designed data collection facility and robust data processing procedure to collect, clean and aggregate the activity data, mode share, energy intensity, etc.

5.3.3 Alternative data sources

The national/subnational data is suitable for top-down approach of emission inventory and is the main data source for the SCATTER, However, in order to implement the bottom-up approach, alternative data source have to be used for improved accuracy of emission inventory.

(A) National/sub-national energy consumption data by BEIS and limitations

The "sub-national total final energy consumption data" released by the BEIS every is an aggregation of the electricity, gas, road transport and residual fuels datasets year (BEIS, 2020), which has been the main data source for the SCATTER. The BEIS data is suitable for a top-down approach but is not so good for bottom-up model-based approach, due to the assumptions made and the course granularity caused by scaling down and mapping the national data onto a local authority territory. Some known limitations are:

- **Unallocated electricity data**. Electricity data may be 'unallocated' if "sufficient address information has not been provided to be able to allocate the meter to a local authority with any degree of accuracy". and unallocated data "can also include consumption for street lighting or traffic lights, where the information provided does not indicate a specific local authority" (section 3.1.1, in (BEIS, 2020)).
- **Exclusion of electricity for electrical vehicles**. In the road transport, electricity for road transport is not included, as there is a lack of geographical information needed to map regional consumption of this fuel.

(B) Alternative local and national data sources for Newcastle upon Tyne

Beside the main source for national-and sub-national measure of energy usage and emission, there are several data sources, from which carbon emissions within the boundary of Newcastle upon Tyne could be measured. In particular, for the transport sector, the following alternative data sources would work well for Newcastle upon Tyne to build its own local-data driven emission inventory,

Based on the list of data source in the spread sheet "**Net Zero - Local Metrics of Performance / Local Proxy data directory.xlsx**" provided by the Newcastle upon Tyne, three data sources are selected for further analysis. It shows that the data sources identified are solid

data source for the local data-driven emission inventory. However, it is expected that some difference exist between different sources of data, therefore careful cross-check and verification is needed when using these data to build the local emission inventory.

Automatic Traffic Counters (ATC) for cars and cycling

Category: Transport, local

Source:

https://app.powerbi.com/view?r=eyJrIjoiOTliZTJmNDgtOWM4Yi00ZjhhLWE3YzEtYjNhMDNiYmVjZmRkIiwidCI6IjA5ZmJiOTc5LTQzMTctNGQyMS05Y2I2LWU1ODgxMTE2OWNkOCJ9

The ATC dashboard is developed by the Traffic Accident Data Unit (TADU) under the joint fund of the five Tyne and Wear local authorities. The ATC can provide the following real-time information for the road activities and this is a reliable and timely accurate measure of the activities in Newcastle upon Tyne.

Average daily traffic - motor vehicles (#)

Average weekday traffic - motor vehicles (#)

Average weekend traffic - motor vehicles (#)

Average daily traffic - cyclists (#)

Average weekday traffic - cyclists (#)

Average weekend traffic - cyclists (#)

Major and Minor Roads Annual Daily Traffic Flow

Category: Transport, national

Source:https://app.powerbi.com/view?r=eyJrIjoiZmY3ZGU0NWEtYTBmZi00MzI4LWJhOTYtNWRmNzRkNjEwMzVjIiwidCI6IjA5ZmJiOTc5LTQzMTctNGQyMS05Y2I2LWU1ODgxMTE2OWNkOCJ9

This is provided by the North East Regional Road Safety Resource and the Traffic Accident Data Unit (TADU) for local authorities in the North East of England region. The data is extracted from the Department for Transport's GB Road Traffic Count Statistics dataset. A well-designed graphic user interface provides a good visualization of the location of data

collection point. It can provide the following information with average daily and for the road activities in Newcastle upon Tyne.

Average annual daily traffic (# / day and % of total) by vehicle types and year (cars and taxis, goods vehicles LGVs and HGVs, buses and coaches, motorcycles, pedal cycles).

DfT Road Traffic Statistics (TRA8902) - Motor vehicle traffic (vehicle miles) by local authority and selected vehicle type

Category: Transport, national data split by local authority level

Source: https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

This dataset produced by Department for Transport provides statistics on car vehicle traffic (vehicle miles) by local authorities by vehicle types in GB, annual from 1993. The vehicle types are Car vehicle; LGV and HGV. The car vehicle, LGV and HGV traffics' vehicle miles for Newcastle upon Tyne in 2018 were 971, 157 and 23 million vehicle miles, respectively.

Food waste

Category: Waste, national by local authority

Source: (a) national by local authority

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918853/201819_Stats_Notice_FINAL_accessible.pdf

(b) local data from major food retailers and caterers.

Newcastle City Council is already building a data base in junction with major food retailers and caterers. This was discussed in audit meeting on 15 July 2021, but this is not yet populated in the proxy local data spreadsheet on "Net Zero - Local Metrics of Performance / Local Proxy data directory.xlsx" provided by the Newcastle City Council team.

(C) Other potential data resources for future exploration

Some potential data resources which have not been included in the "Net Zero - Local Metrics of Performance / Local Proxy data directory.xlsx" by the Newcastle upon Tyne may provide additional information for improving the local emission inventory. They are:

Emission factors

Category: General, national

Source: **https://naei.beis.gov.uk/data/ef-all**

The national atmospheric emission inventory provides the emission factors by source and fuel. And the UK EF Toolkit provides emission factors for more than 270 vehicle classes.

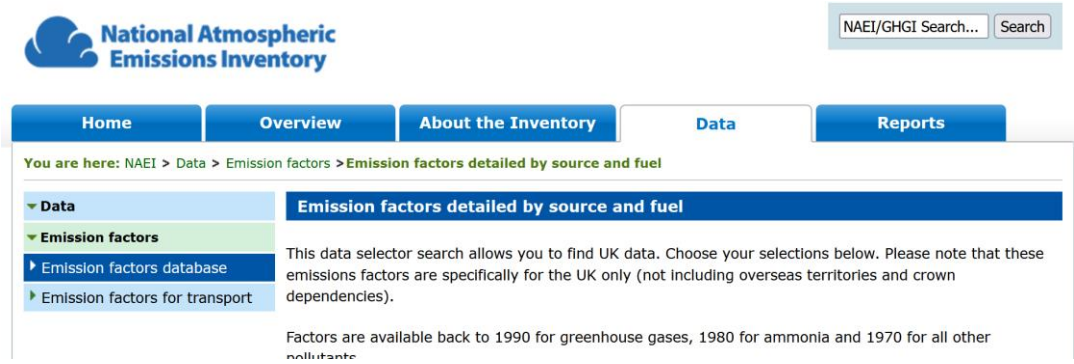

Figure 22 Emission factors by source and fuel

National Travel Survey and Active Lives Survey

Category: Transport, national data split of local authority level

Source: https://www.gov.uk/government/collections/walking-and-cycling-statistics

This provides national walking and cycling statistics, including local authority-level data.

Vehicle licensing statistics

Category: Transport, national and local

Source: https://www.gov.uk/government/collections/vehicles-statistics

This data source provides vehicle licensing statistics by the Department for Transport.

5.3.4 Challenges in emission modelling

(A). Choice of model parameters

The choice of model parameters is a compromise between precision and practicality. When building bottom-up model of emission inventory, bias is a common issue due to the following sources of bias: (1) Reporting bias. Local authorities disclosing their emissions usually assumes to have lower emissions intensities, in particular, when they take measures that reduce the GHG

emissions. (2) Cleaning bias: When cleaning the data, human analysts have had to use subjective judgements to treat outliers. (3) Model Bias: In modelling the relationship between activities, emission factors and emission, the dependent variable (emission) may not be fixed to zero in the statistical models, which can result in a small positive bias to the estimates.

(B). Gaps between emission calculation (regression) and trajectory projection in SCATTER

Emission calculation indeed is a regression process, both the top-down model and bottom-up model is to answer the question: What is the emission (the dependent variable) given an amount of activities (the independent variable). Regression analysis has been shown working as a good methodology to build a model describe the relationship between the dependent variable and the independent variables, then it is possible to predict future outcomes. However, due to the lack of technical documents by the SCATTER, it is unclear how the relationship between the data is modelled and what kind of assumption is made to predict the emission trajectory. This is an obstacle to have a in-depth understand the outcome of emission reduction actions.

The recent progress on the study of data-driven mission inventory (Khan and Awasthi, 2019), data mining approaches are used to develop alternate models for emissions prediction. Data mining is about explaining the past and predicting the future using data analysis and modelling. It is a multi-disciplinary domain that combines statistics, machine learning and database technology, which may address the problem of the gaps between regression and projection.

(C) Features and factors to be considered for Transportation in Newcastle

In the SCATTER report, Newcastle upon Tyne is zero in waterborne, because it has zero cannels. The waterborne emission in SCATTER model is based on UK total fuel consumption from National Navigation, derived from the Digest of UK Energy Statistics (DUKES) and total fuel consumption from inland waters traffic is divided into internal and coastal. Inland transport (6% for 2017) is allocated to LA using the proxy of km canal length. However, the River Tyne goes through the local authority's boundary and there are boats travelling along the Tyne. In reality, the emission in waterborne subsection is not zero for Newcastle upon Tyne. These boats (cruise, police boats, etc) may travel across several local authorities along the Tyne. This is similar to the through-traffic in on-road transport, it has impacts on Scope 1 and Scope 2 of waterborne emission. The River Tyne related waterborne traffic is shared by several LAs. If no data capture facilities are available to collect, identify and differentiate the waterborne

activities, it is recommended to take a population-share base method for Tyneside to improve the emissions inventory for Newcastle upon Tyne.

The aviation part of the inventory for Newcastle City Council has issues similar to the waterborne one. Newcastle international airport is the major (international) airport in the North East of England, and serves an extended hinterland. It is a challenging task to identify and calculate the Scope 3 (other indirect) emission from other sources related to the activities of the airport, including the flight movement (taking off/cruising/landing, ground movements), auxiliary power unit, 3rd party ground support equipment, etc. According to the guidance of "Technical Guidance for Calculating Scope 3 Emissions" of the GPG protocol [37], a populated based methodology may be considered to to improve the distance-based method (as shown in Example 6.1 in the "Technical Guidance for Calculating Scope 3 Emissions" of the GPG protocol [38]), so that the total vacation travel distance related to Newcastle International Airport can be shared across the local LAs served by the airport.

5.3.5 Financial challenges and alternative inventory tools

At present, the SCATTER is free of charge for local athorities to generate the CDP-compatable emission report. However, there are uncertainties if the SCATTER will continually be funded by the central government. As a result, Newcastle City Council is not sure if they will still have free access to the SCATTER.

The potential of using alternative tools for emission inventory should be explored while using the SCATTER tool. Some possible alternative inventory tools are listed as follows:

- The **Tyndall Carbon Budget Report tool** [39], produced by the Tyndall Climate Change Centre at the University of Manchester, provides a way for local areas in the UK to calculate a carbon budget and frame the scale and urgency of climate change action. This can be a first step in longer process of developing common goals and ambitions with local government areas and devolved administrations. There are other online

[37] https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf

[38] https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf

[39] https://carbonbudget.manchester.ac.uk/

resources and organisations that can support the next steps in working towards to the carbon budgets and climate change commitments.

- **Climate View**[40], which is under consideration in Newcastle upon Tyne also. Climate OS is said by the "climate action technology company that combines scientific modelling, machine learning and interface design to help cities to understand and act on the complex climate challenge, clearly" to provide an "integrated platform for cities, municipalities and regional governments to create continually updated optimised Living Climate Action Plans. Newcastle City Council has engaged with it, stating on the company's website that "*ClimateView has allowed us to develop a greater combined understanding of the net zero vision. What it means for the city, its residents, businesses, and organizations, is a clearer pathway towards a decarbonized future.* [Tim Rippon, Policy team (climate change), Newcastle city council[41]]." . The Newcastle Net Zero – 2030 Action is viewable via the dashboard tab on the ClimateView website[42].

- **Climate Action Co-benefits Toolkit** [43] is produced by Ashden to help local authorities identify how action on climate change can deliver many local benefits. A list of the most effective actions is also provided by Ashden with Friends of the Earth [44] to the local authorities.

6 Conclusion and Recommendation

The SCATTER's inventory report for Newcastle upon Tyne (submission year 2021) accompanies the guideline of GCoM's common report framework (CRF) and CDP. The data

[40] https://www.climateview.global/

[41] https://www.climateview.global/cities/newcastle-uk

[42] https://app.climateview.global/public/board/498e0e85-43bd-465d-9815-00319dad9e41

[43] https://www.ashden.org/programmes/co-benefits

[44] https://friendsoftheearth.uk/

management and procedure carried out by Newcastle upon Tyne is verified. However, due to the SCATTER limitations of data source and modelling methodologies, the emission inventory may not capture all the activities within the boundary of local authorities, which implies the inventory may not give a detailed and complete figure of GHG emission of Newcastle upon Tyne. Some modification in both data selection, collection and modelling is needed to improve the Newcastle upon Tyne's emission inventory. In particular, for the most energy intensive sectors, such as the transport, more robust bottom-up models are needed for better accuracy. Newcastle City Council reacted positively to suggestion made to them for checking out data sources and processes of partners, for example by the Newcastle upon Tyne Hospitals (NUTH) NHS Foundation Trust on carbon impact baselines and disclosure. Likewise, they have requested information on how they could obtain historical data (as the data for SCATTER / CDP disclosure is always three years in the past) from the National Grid on the at least regional (North East of England) carbon intensity of electricity being produced in the region which can be viewed through an API live and forecasted ahead, which is the source of electricity used in the city that comes from the Grid.

Transport is one of the main sectors with high contribution to the emission and the area where the intervention may work to the best to achieve the most significant carbon reduction effects This is consistent with national trends where Transport is the main sector with highest contribution to CO2 emission. Transport carbon reduction is the core area for the UK central movement to achieve carbon neutral target and also applicable to Newcastle upon Tyne. This will require the following:

In transport sector, emission models are extensively focused on estimating vehicle emissions inventory by considering activity and emissions factors. Even in science research, only limited number of studies has been performed on the transport GHG emissions projection by using data mining and machine learning methods. With the advances of computer and big data science, artificial intelligence and ensemble learning techniques may provide a solution to improving emission model's performances for road transport GHG emissions modelling.

The estimates are based on the use of a number of different information sources. As a result, the estimates are subject to potential modelling inaccuracies. The level of sectoral detail is constrained by BEIS data available for local electricity and gas use. To estimate a more detailed breakdown would involve further general assumptions about energy use for different sectors, since local data is not available. The main point worth noting about transport sector emissions

is that these have to be by the use of energy (fuel) withing the LA boundary. To do this (more) accurately (not now but when NCC has resources to generate data), a bottom-up approach will be better than using the national averages/datasets.

Based on the verification and methodology analysis, to build a bottom-up model of emission inventory for Newcastle upon Tyne in the next submission, a paradigm shift is needed in defining and collecting data information and developing a model about how energy is generated, used and managed across the city. This requires robust data management a processing procedure of determining modelling methodologies with consideration of resource and financial constraints, implementing a robust data management and processing procedure, and selecting model parameters and verifying data and models. For the transport sector, the related data and procedure are: activity on major roads and any additional minor roads; user type of energy consumption (Council, NHS, universities and colleges, schools, private business etc.) and fuel use (petrol, diesel, electric – important with the increased penetration of EVs). This is not something that the council can deliver on its own. It would require the mobilisation and support of the whole city, including institutions, businesses, community groups and individuals.

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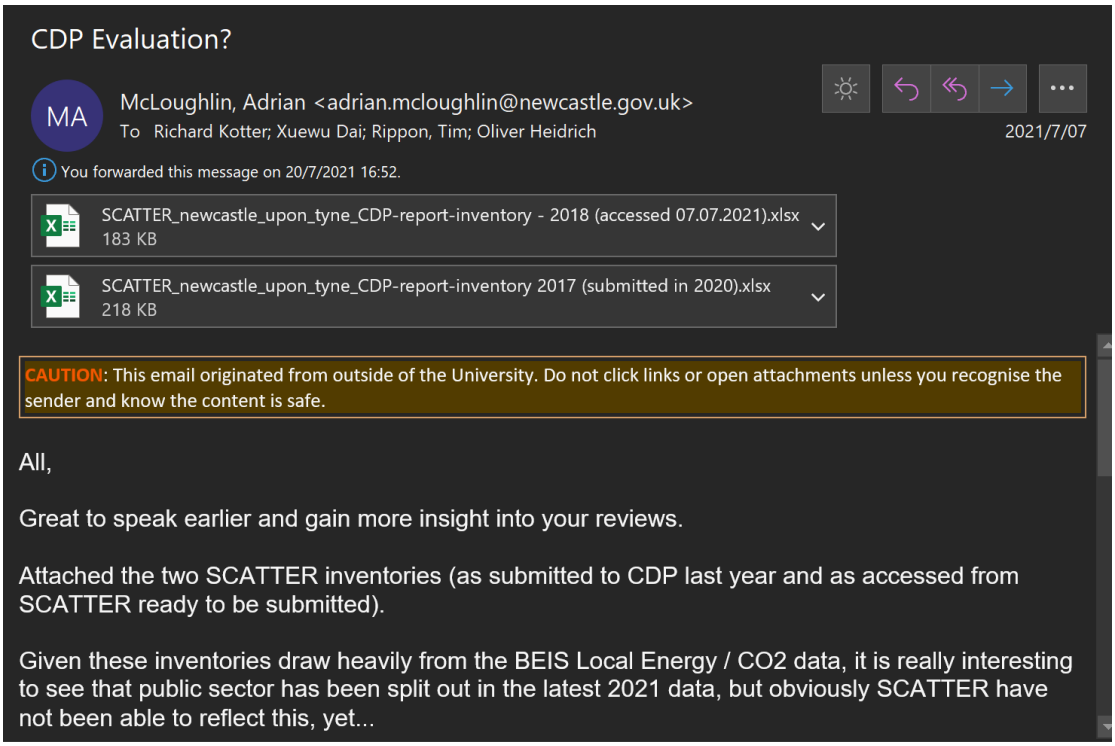
Appendices

Appendix A: Email and document exchanges between Newcastle City Council, Newcastle University, and the Northumbria University team.



CDP Evaluation?

MA McLoughlin, Adrian <adrian.mcloughlin@newcastle.gov.uk>
To Richard Kotter; Xuewu Dai; Rippon, Tim; Oliver Heidrich
2021/7/07

You forwarded this message on 20/7/2021 16:52.

SCATTER_newcastle_upon_tyne_CDP-report-inventory - 2018 (accessed 07.07.2021).xlsx
183 KB

SCATTER_newcastle_upon_tyne_CDP-report-inventory 2017 (submitted in 2020).xlsx
218 KB

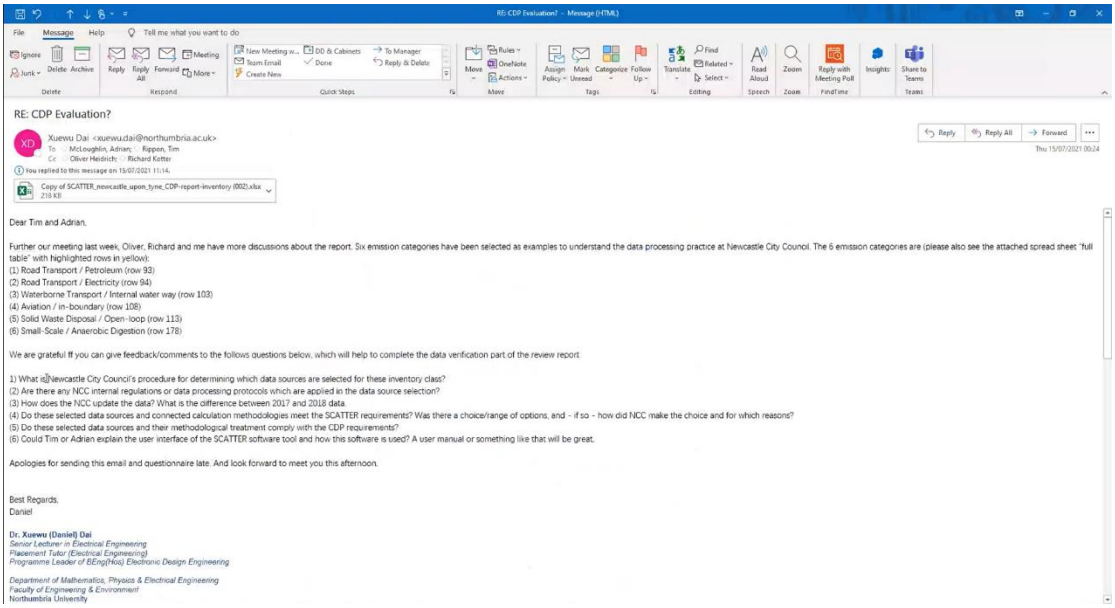
CAUTION: This email originated from outside of the University. Do not click links or open attachments unless you recognise the sender and know the content is safe.

All,

Great to speak earlier and gain more insight into your reviews.

Attached the two SCATTER inventories (as submitted to CDP last year and as accessed from SCATTER ready to be submitted).

Given these inventories draw heavily from the BEIS Local Energy / CO2 data, it is really interesting to see that public sector has been split out in the latest 2021 data, but obviously SCATTER have not been able to reflect this, yet...



RE: CDP Evaluation?

Xuewu Dai <xuewu.dai@northumbria.ac.uk>
To McLoughlin, Adrian; Rippon, Tim
Cc Oliver Heidrich; Richard Kotter

You replied to this message on 15/07/2021 11:14.

Copy of SCATTER_newcastle_upon_tyne_CDP-report-inventory (002).xlsx
218 KB

Dear Tim and Adrian,

Further our meeting last week, Oliver, Richard and me have more discussions about the report. Six emission categories have been selected as examples to understand the data processing practice at Newcastle City Council. The 6 emission categories are (please also see the attached spread sheet "full table" with highlighted rows in yellow):
(1) Road Transport / Petroleum (row 93)
(2) Road Transport / Electricity (row 94)
(3) Waterborne Transport / Internal water way (row 103)
(4) Aviation / in-boundary (row 108)
(5) Solid Waste Disposal / Open -loop (row 113)
(6) Small-Scale / Anaerobic Digestion (row 178)

We are grateful ff you can give feedback/comments to the follows questions below, which will help to complete the data verification part of the review report

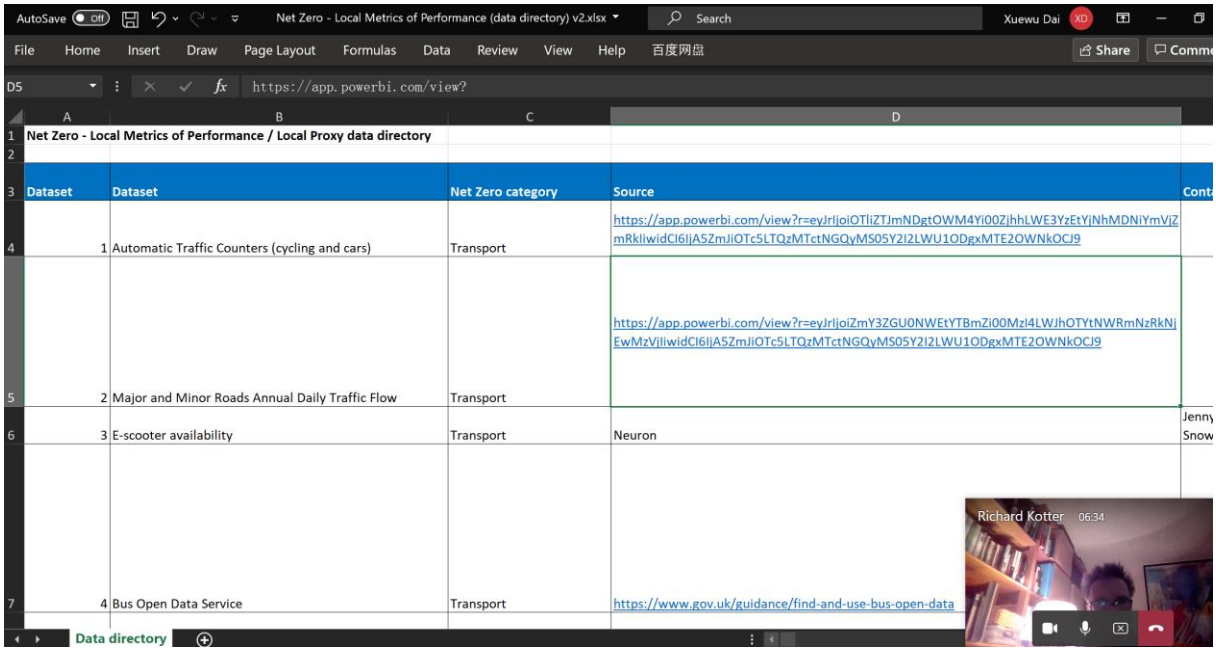
1) What is Newcastle City Council's procedure for determining which data sources are selected for these inventory class?
(2) Are there any NCC internal regulations or data processing protocols which are applied in the data source selection?
(3) How does the NCC update the data? What is the difference between 2017 and 2018 data.
(4) Do these selected data sources and connected calculation methodologies meet the SCATTER requirements? Was there a choice/range of options, and - if so - how did NCC make the choice and for which reasons?
(5) Do these selected data sources and their methodological treatment comply with the CDP requirements?
(6) Could Tim or Adrian explain the user interface of the SCATTER software tool and how this software is used? A user manual or something like that will be great.

Apologies for sending this email and questionnaire late. And look forward to meet you this afternoon.

Best Regards,
Daniel

Dr. Xuewu (Daniel) Dai
Senior Lecturer in Electrical Engineering
Placement Tutor (Electrical Engineering)
Programme Leader of BEng(Hons) Electronic Design Engineering

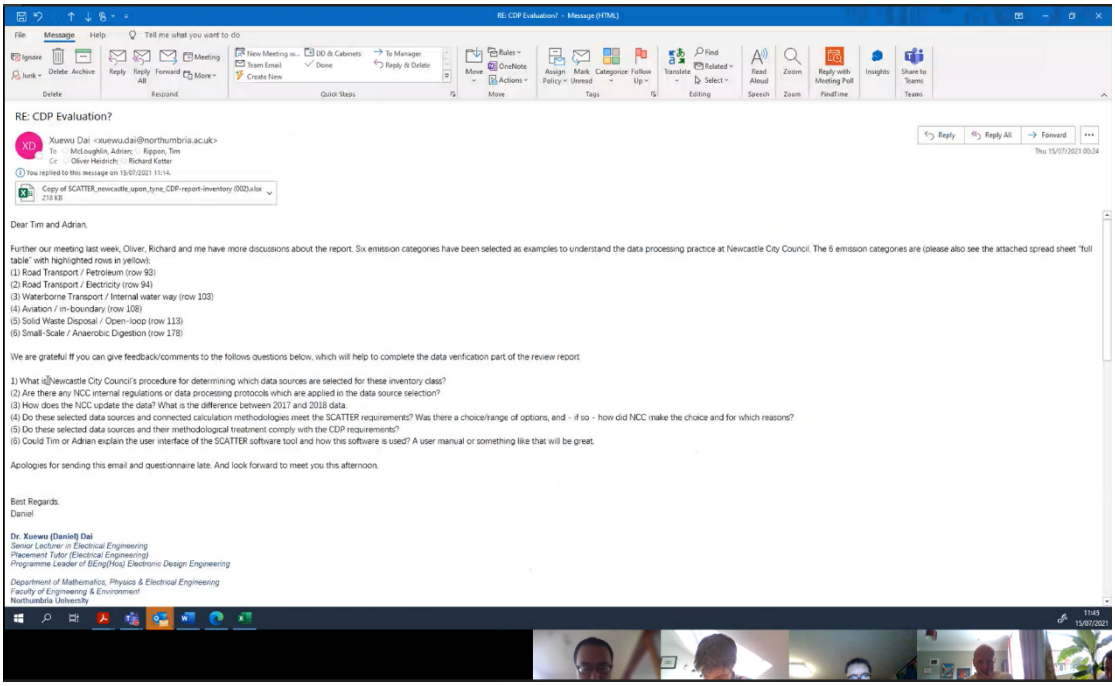
Department of Mathematics, Physics & Electrical Engineering
Faculty of Engineering & Environment
Northumbria University



Net Zero - Local Metrics of Performance / Local Proxy data directory

	Dataset	Dataset	Net Zero category	Source	Cont
4	1	Automatic Traffic Counters (cycling and cars)	Transport	https://app.powerbi.com/view?r=eyJrIjoiOTliZTJmNDgtOWM4Yi00ZjhhLWE3YzEtYjNhMDNiYmVjZmRkIiwidCI6IjA5ZmJiOTc5LTQzMTctNGQyMS05Y2I2LWU1ODgxMTE2OWNkOCJ9	
5	2	Major and Minor Roads Annual Daily Traffic Flow	Transport	https://app.powerbi.com/view?r=eyJrIjoiZmY3ZGU0NWEtYTBmZi00MzI4LWJhOTYtNWRmNzRkNjEwMzVjIiwidCI6IjA5ZmJiOTc5LTQzMTctNGQyMS05Y2I2LWU1ODgxMTE2OWNkOCJ9	
6	3	E-scooter availability	Transport	Neuron	Jenny Snow
7	4	Bus Open Data Service	Transport	https://www.gov.uk/guidance/find-and-use-bus-open-data	

Appendix B: Evaluation and Auditing meeting with Newcastle City Council (Date: 15/July/ 2021)



RE: CDP Evaluation?

Xuewu Dai <xuewu.dai@northumbria.ac.uk>
To: McLoughlin, Adrian; Rippon, Tim
Cc: Oliver Heidrich; Richard Ketter

You replied to this message on 15/07/2021 11:14.

Copy of SCATTER_newcastle_upon_tyne_CDP-report-inventory (002).xlsx
210 KB

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(5) Solid Waste Disposal / Open-loop (row 113)
(6) Small-Scale / Anaerobic Digestion (row 178)

We are grateful ff you can give feedback/comments to the follows questions below, which will help to complete the data verification part of the review report

1) What is Newcastle City Council's procedure for determining which data sources are selected for these inventory class?
(2) Are there any NCC internal regulations or data processing protocols which are applied to the data source selection?
(3) How does the NCC update the data? What is the difference between 2017 and 2018 data.
(4) Do these selected data sources and connected calculation methodologies meet the SCATTER requirements? Was there a choice/range of options, and - if so - how did NCC make the choice and for which reasons?
(5) Do these selected data sources and their methodological treatment comply with the CDP requirements?
(6) Could Tim or Adrian explain the user interface of the SCATTER software tool and how this software is used? A user manual or something like that will be great.

Apologies for sending this email and questionnaire late. And look forward to meet you this afternoon.

Best Regards,
Daniel

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Senior Lecturer in Electrical Engineering
Placement Tutor (Electrical Engineering)
Programme Leader of BEng(Hons) Electronic Design Engineering

Department of Mathematics, Physics & Electrical Engineering
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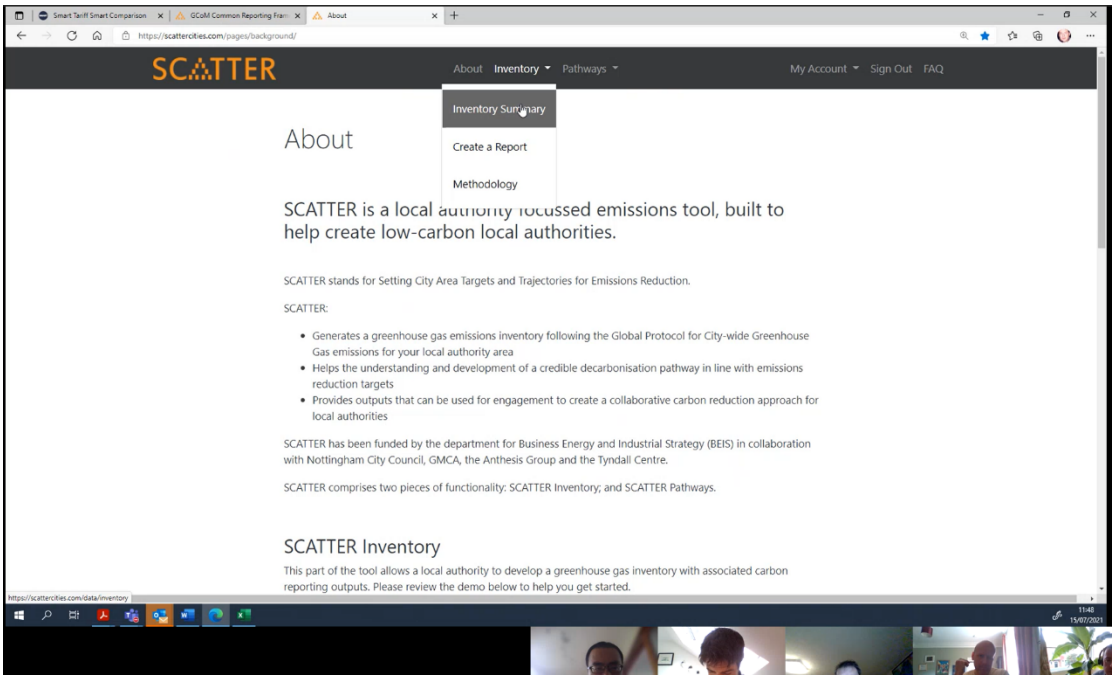


https://scattercities.com/pages/background/

SCATTER

About Inventory Pathways My Account Sign Out FAQ

Inventory Summary
Create a Report
Methodology

About

SCATTER is a local authority focussed emissions tool, built to help create low-carbon local authorities.

SCATTER stands for Setting City Area Targets and Trajectories for Emissions Reduction.

SCATTER:

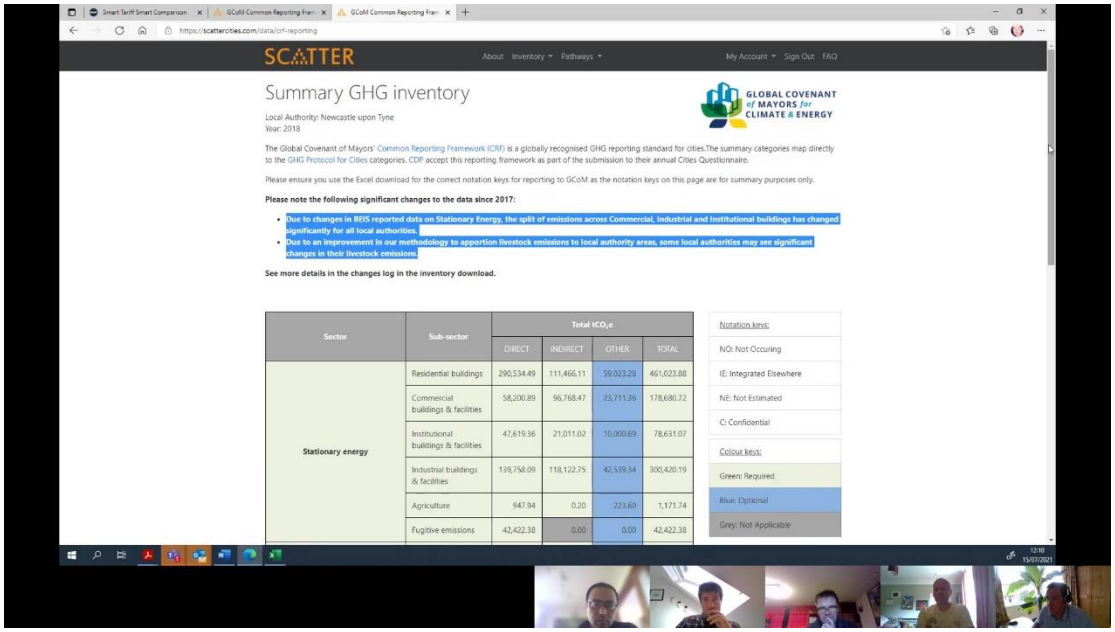
- Generates a greenhouse gas emissions inventory following the Global Protocol for City-wide Greenhouse Gas emissions for your local authority area
- Helps the understanding and development of a credible decarbonisation pathway in line with emissions reduction targets
- Provides outputs that can be used for engagement to create a collaborative carbon reduction approach for local authorities

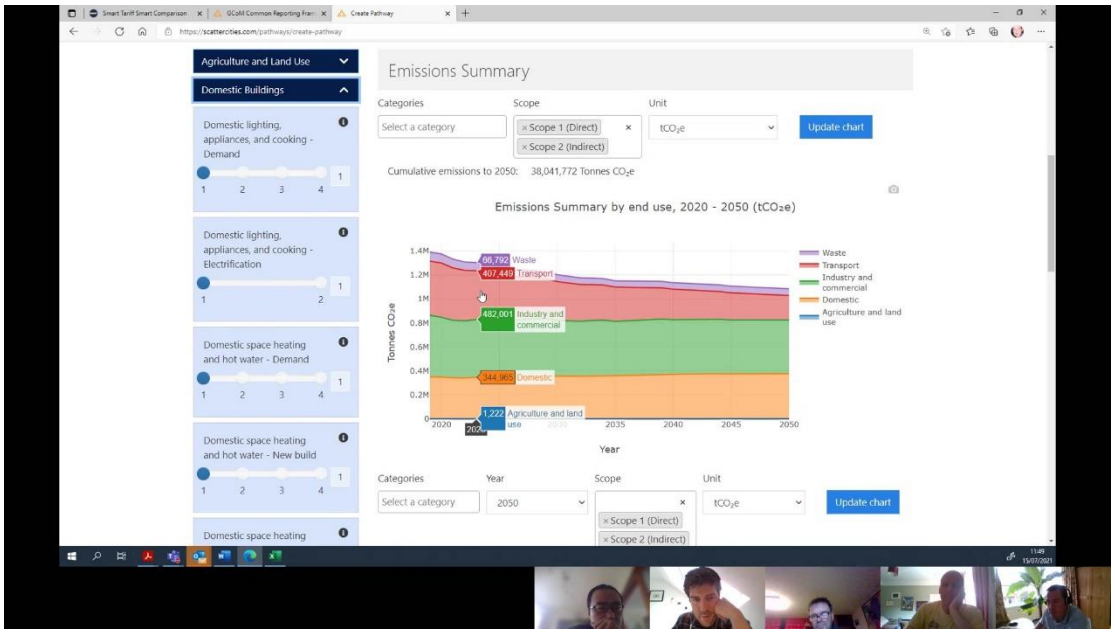
SCATTER has been funded by the department for Business Energy and Industrial Strategy (BEIS) in collaboration with Nottingham City Council, GMCA, the Anthesis Group and the Tyndall Centre.

SCATTER comprises two pieces of functionality: SCATTER Inventory; and SCATTER Pathways.

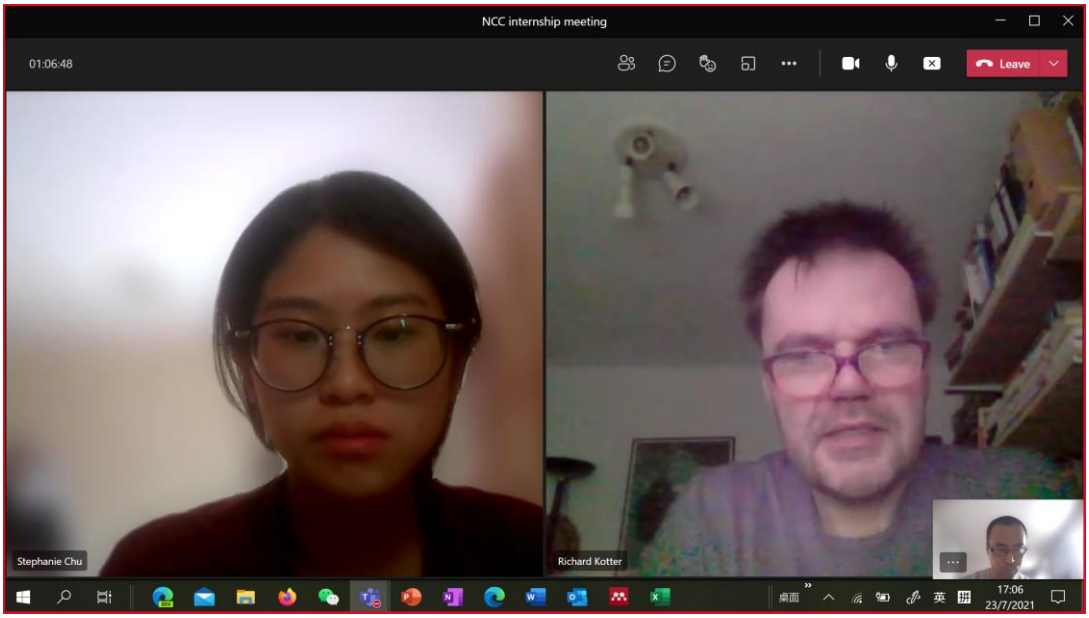
SCATTER Inventory

This part of the tool allows a local authority to develop a greenhouse gas inventory with associated carbon reporting outputs. Please review the demo below to help you get started.





Appendix C: Internal meetings of the independent evaluators


NCC internship meeting
01:06:48
Leave
Stephanie Chu
Richard Kotter
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23/7/2021