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Professor Subhes Bhattacharyya
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Integration of Sustainable Development Goals in climate action plans in the city of Glasgow

Leticia Ozawa-Meida and Abdulrahman Alajmi,

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Integration of sustainable development goals in climate action plans in the city of Glasgow

Leticia Ozawa-Meida and Abdulrahman F. A. Alajmi
Institute of Energy and Sustainable Development, De Montfort University, Leicester, UK

Abstract
Climate actions plans are being developed around the world by different countries and cities to address the negative effects of climate change. Glasgow city in Scotland is also affected by climate change, and its city council has started to implement Sustainable Development Goals to decrease its vulnerability to climate change and to achieve a sustainable Glasgow city. The aim of this study is to perform a sustainability assessment of Glasgow city in terms of environmental, social, and economic quality aspects as well as greenhouse gas emissions using an available sustainability assessment tool. The performed sustainability analysis using the CASBEE-City assessment tool shows that Glasgow city is a relatively sustainable city with adequate scores regarding the quality of life of its citizens and low greenhouse gas emissions. Recommendations for achieving a better sustainability in this city based on the evaluated indicators are increasing urban greenspaces around the city, local electricity and heat generation with low carbon sources, and improving crime prevention by reducing inequalities in income and education.

Keywords: cities, greenhouse gas emissions, climate action plans, sustainability assessment

1.0 Introduction

A large proportion of the world's population has moved to urban areas in the recent century and this trend still continues. It is predicted that the urban residents will reach to around 6 billion by 2045, requiring basic services, such as energy, infrastructure, decent and affordable housing, etc. (World Bank, 2020). Despite cities only cover around 3% of the total world's area, they have a significant effect on the climate change consuming two thirds of the global energy consumption and responsible for more than 70% of greenhouse gas (GHG) emissions (World Bank, 2020).

Climate change is one of the most important threats for sustainable development which significantly affects the basic requirements of people's lives including food, water, and health. Due to high concentration of population and economic activities, expected climate change impacts can significantly affect livelihoods of large number of people in cities, and particularly the poor and vulnerable segments of their populations. Despite the pressures that cities impose to land and natural resources, urbanisation also offers opportunities for sustainable growth by allowing innovation, enhancing local capacities and planning systems, and strengthening urban resilience to climate and non-climate impacts. Cities play an important role not only for contributing to the global efforts to mitigate climate change, but also for tackling urban poverty and building inclusive, resilient and sustainable communities able to adapt to climate change.

Countries around the world have adopted the United Nations Sustainable Development Goals (SDGs) recognising the need of addressing different challenges to improve human well-being, economic growth, social and environmental sustainability. Local action in cities is considered an essential part of the transformation required to enable sustainable development by 2030. However, due to the different dimensional views on progress and the interactions between SDGs and their indicators, synergies and lessons learned from local initiatives are easily missed or poorly understood (Fenton & Gustafsson, 2017).

In the particular context of Scotland, the relevance of the global SDGs was investigated by Long et al. (2018) to determine the data availability, progress and performance of SDGs considering all 169 targets and indicators of the 17 SDGs. A key vehicle for the delivery of SDGs in Scotland is the National Performance Framework (NPF) and its associated national outcome indicators. The authors found that some NPF targets and indicators were well aligned to SDG4 (education) and SDG8 (economy and decent work); other goals, such as SDG5 (gender), SDG10 (inequality) and SDG12 (sustainable consumption and production) were the least represented in the NPF, and some global SDGs were found to be not applicable to the Scottish context. As to climate action (SDG13), the Scottish government is implementing different strategies to promote mitigation and adaptation of climate change through the Climate Change (Scotland) Act 2009 to guarantee the reduction of GHG emission levels in Scotland by 80% by 2050. Climate action is also supported through funds allocated every year by the Scotland government to explore ways for the use of renewable and clean energies (SDG7) by different sectors including industries. Further strategies could also focus on waste reduction disposed in the landfills and the improvement of public transportation.

This aim of this study is to understand how the city of Glasgow integrate SDGs into their Climate Action Plans through examining how its climate change mitigation and adaptation plans may be addressing the SDGs; and evaluating the sustainability and GHG emissions of Glasgow city based on a specific assessment methodology.

Following this introduction, section 2 provides an overview of the city of Glasgow including its GHG emissions, existing and future climate change impacts as well as the climate mitigation and adaptation efforts conducted in the city. The methodology behind the sustainability and GHG assessment using the CASBEE-City tool is explained in section 3, while the results for the city of Glasgow are presented in section 4. Conclusions and recommendations are presented in section 5.

2.0 Glasgow City

The city of Glasgow is one of the main cities in Scotland, situated on the bank of River Clyde in the West Central Lowlands. The city had an estimated population of 633,120 inhabitants in 2019 (National Records of Scotland, 2020), with an average annual population growth rate of 0.3% since 2011 (Population UK, 2020). Since the start of industrial revolution, this city progressed rapidly in population and economy and became a centre of the chemical and textiles industries. Currently, key economic sectors relate to Finance and Business Services, Tourism and Events, Life Sciences, Low Carbon and Engineering, Design and Manufacturing. In 2019,

the city generated £19.9 billion of gross value added (GVA) (Skills Development Scotland, 2020) with 312,500 people economically active (Office for National Statistics, 2020).

2.1 Climate change impacts and greenhouse gas emissions in Glasgow

The average annual temperature in Glasgow is 8.5 °C, with the highest temperatures (14.5 °C) around July and coldest temperatures (3 °C) in January. The amount of rainfall in this city is significant throughout the year, with an average yearly rainfall of 1,171 mm (compared to the annual precipitation average of 885 mm in the UK) (CLIMATE-DATA.ORG, 2020). As many other countries in the world, Scotland is currently affected by climate change. Its effects have been seen in increased temperature, sea level rise, heavy rainfall and floods, and less snow cover. The average land temperature changes in Scotland have been similar to the UK between 2005 and 2015 with an average increase of around 0.9°C compared to the 1961-1990 baseline period, while the regional summer mean temperatures are expected to rise between 0.9°-4.5°C by 2050 under a medium emissions scenario (ASC, 2016). Annual rainfalls in Scotland have also raised about 15% above the average than the baseline period. An increase of rainfall in the winter is predicted for the west of Scotland in the next 20 to 50 years, while in the summer it is expected a drastic decrease in rainfall by 2080 (GCC, 2009a). Winter rains may become up to 15% or 20% heavier which can bring a widespread flooding across the Scotland, leading to serious economic and social problems for the people who live in the risk areas (GCC, 2009a).

In terms of greenhouse gas emissions, Glasgow city generated 2.6 million tonnes (Mt) of CO_2e in 2017 (BEIS, 2020). As an industrial city with significant dependence on the commercial and public sectors, the industry and commerce sectors are the largest contributors (35.7%, 0.93 Mt CO_2e). While there is a large electricity use for heating, cooling, hot water and lighting in non-domestic buildings related to retail, finance, commercial, data processing and storage, and distribution warehouses activities, high gas consumption can be associated with the food and drink sector, leisure sector, large public buildings (such as hospitals) and few large manufacturing facilities. The second largest emitter in the city is the transport sector (33.7%, 0.88 Mt CO_2e). Despite a lower car ownership compared to other cities around Scotland and the UK, there is still a large proportion of private cars and public buses using diesel. Emissions of the domestic sector account for 30.3% of the city's total emissions (0.79 Mt CO_2e), predominantly using gas (68%) and electricity (31%). LULUCF[1] emissions accounted for only 0.3% of the total emissions (6.9 ktonnes of CO_2e).

2.2 Climate mitigation and adaptation strategies in Glasgow

The UK Climate Change Act 2008 requires reducing the country's GHG emissions by 80% in 2050 compared to 1990 levels, including the emissions from the devolved administrations (Scotland, Wales and Northern Ireland). The Scotland's Climate Change Act 2009 also committed to an 80% emissions reduction target by 2050 from 1990 levels, with interim targets of 42% by 2020 and 50% by 2030 (GCC, 2013). In 2019, these targets were amended by the Climate Change (Emissions Reduction Target) (Scotland) Act and committed to reduce Scotland's emissions of all greenhouse gases to net-zero by 2045, with interim reduction targets of 56% by 2020, 75% by 2030 and 90% by 2040 (Scottish Parliament, 2019). In 2010, Glasgow

[1] Emissions or removals related to land use, land use change and forestry.

City Council committed to an emissions reduction of 30% by 2020 from a 2006 baseline set out in its Sustainable Energy Action Plan approved by the EU Covenant of Mayors (GCC, 2013). In 2019, the council declared a climate and ecological emergency, and subsequently Glasgow set a target of becoming a carbon neutral city by 2030 (Glasgow City Council, 2019).

Glasgow City Council have developed several climate mitigation action plans and projects, such as the Carbon Management Plan 2013-2021 along with the Energy and Carbon Masterplan involving various initiatives council-wide (such as boiler and voltage optimisation, smart meters, behavioural change campaigns, lighting upgrades) as well as city-wide in its energy supply and demand sectors (GCC, 2013). Other relevant strategies include "Sustainable Glasgow", a city-wide partnership established in 2010 to help Glasgow to become a sustainable city through a significant reduction of CO_2 emissions. This project focuses on urban regeneration, delivering jobs and training, helping change the city's image, regenerating communities, and tackling fuel poverty (Bellingham, n.d.).

Similar to the adopted approaches to mitigate the causes of climate change, the Glasgow City Region has developed a cross-sector initiative under the name of the Climate Ready Clyde to lead on the region's adaptation strategy and action plan. This initiative has identified a series of actions required to address long-term climate impacts, such as protecting health and social care facilities against flooding and overheating, target action to address impacts on key transport infrastructure, reducing risks to the built environment through low carbon retrofit, protect the natural environment against extreme weather events and wider pressures, such as land use and pollution, and reducing health risks impacts on vulnerable groups, among others (Climate Ready Clyde, 2018). For adaptation against flooding, Glasgow City Council has developed projects with other partners such as the Scottish Water and the Scottish Environment Protection Agency (SEPA). Projects include designing systems for water or rain drainage from local roads and public highways, systems for flood defences, maintenance of watercourses, sustainable urban drainage systems and control of floods as a result of heavy rainfall and tidal and river flooding. Glasgow City Council is also responsible of improve the health and well-being of its residents, particularly vulnerable people. To achieve this, the Council has launched a centre for population health as a helping agency that works with the National Health Service to inform and support action to improve health and tackle inequality for those people living in poverty and cannot easily access resources that can improve their health (Glasgow Centre for Population Health, 2019).

Involving both mitigation and adaptation strategies, it is relevant to mention the "Glasgow City Plan 2", which is part of the city's development plan, focusing on improving the historic and natural environments in the city; developing infrastructure to reduce the need to travel, particularly by car; developing new transport schemes and increasing links between different transport networks; extending recycling services and facilities; promoting sustainable design and construction; and delivering drainage and flooding strategies among others (GCC, 2009b).

3.0 Methodology: Sustainability assessment method for cities

The method for sustainability assessment of cities, which was used in this study is CASBEE (Comprehensive Assessment System for Built Environment Efficiency). The CASBEE

software was developed by the Japan Sustainable Building Consortium (JSBC) and Institute for Building Environment and Energy Conservation (IBEC) as an assessment tool initially for offices and individual buildings in 2002, similar to building assessment systems such as the UK BRE Environmental Assessment Method (BREEAM) and the US Leadership in Energy and Environmental Design (LEED). This method was later expanded to the city scale to include the evaluation of homes, buildings and urban development in 2011 (CASBEE-City) to enable stakeholders to evaluate cities based on SDG indicators and GHG emissions within their specific administrative boundaries (Kawakubo, et al., 2018). The assessment is performed by defining two parameters: quality (Q) which includes economic, social and environmental factors inside the city, and load (L) which reflects the external environmental load by accounting the GHG emission. The built environment efficiency (BEE) is then defined by division of Q over L. A high score for Q and low score for L in a city assessment, results is a high BEE which means that this city has a good environmental efficiency and sustainable condition.

For the quality assessment Q, CASBEE selects items and indicators from the proposed 230 global indicators for the 17 SDGs. Indicators were selected based on different parameters such as data availability, relevance, and if the indicators can be quantified or clearly defined. The Q assessment consists of three main categories: environmental aspect Q1, social aspect Q2 and economic aspect Q3. Each main category is divided into different minor categories and these are subdivided to one or more indicators (scored from 1 to 5). The total score for Q (100-points scale) is the sum of all indicator scores, using a weighting coefficient which is equal to 1 by default, but can be adjusted when the indicator's data are not available. A similar procedure exists for the L load assessment, where it is divided into two main categories: CO_2 emissions from energy sources L1 and CO_2 emissions from non-energy sources L2. For full explanation of the methodology and indicators, see Kawakubo et al. (2018). The CASBEE-City software operates on several Excel sheets: main sheet, score sheet and result sheet. This software and its technical manual can be downloaded at IBEC (IBEC, 2018).

To examine the climate actions in Glasgow, a wide range of publicly available documents were used for analysis, including the action plans and projects described in section 2. These secondary data were useful not only for the sustainability assessment of the city, but also to explain the results presented in section 4.

4.0 Sustainability and GHG assessment results for the city of Glasgow

Quantitative data values for each indicator for the Glasgow city should be inserted to the scoresheet of the CASBEE-City software for scoring and assessment. The required data was obtained mainly by the Glasgow city council statistics, Scotland government, and other sources about Glasgow statistics (Glasgow City Council, 2020; Glasgow Centre for Population Health, 2020; Office for National Statistics, 2020). Table 1 presents the most recent available quantitative data used for different indicators for the city of Glasgow.

The breakdown scores for different aspects of quality Q for the Glasgow city assessment is presented in Figure 1. The average score of the environmental aspect (Q1) is 2.94, assessed by four categories. Among the sub-category scores, resource recycling (Q1.4) scored 3.81

reflecting the city's efforts to improve waste recycling following guidelines of the Scottish Government Waste Plan. It is then followed by the nature conservation score (Q1.1) of 3.59 due to the city's high ratio of green and water spaces (70%), and the local environmental quality (Q1.2) score of 3.36 due to good local air quality, but limited water quality. The environmental policy (Q1.4) has the lowest category score with 1 due to the low CO_2 absorption of greenspaces within the city.

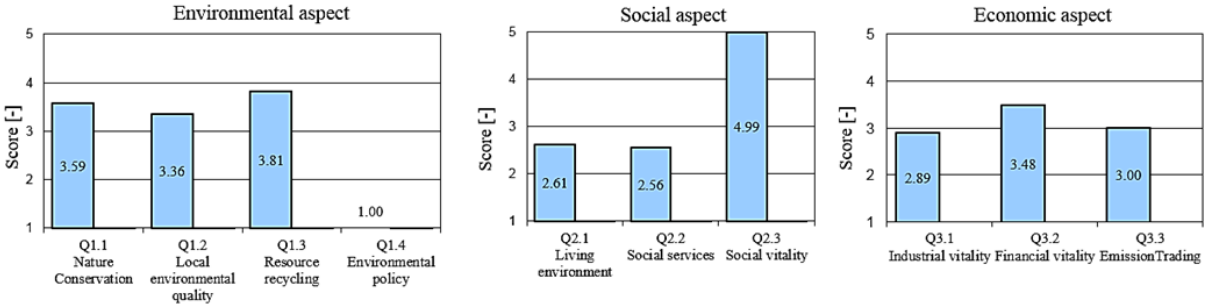
The average score of the social aspect (Q2) is 3.4, divided into three main sub-categories. The social vitality (Q2.3) has a high score of 4.99 based on the city's low ratios of population change due to births and deaths (2%) and migration (1.9%). The living environment sub-category (Q2.1) scored 2.61. Despite having an adequate quality of housing (104 m^2 average surface) and good disaster preparedness (6 hospitals per 100,000 people), road and crime safety measured by number of accidents and crimes per 1,000 people are relatively high in the city. The social services sub-category (Q2.2) had a score of 2.56. While the provision of educational and cultural services seems adequate, a larger number of facilities for childcare and services of elderly people would be desirable.

The economic aspect of this assessment (Q3) seems to have a relatively equal score for its main categories. The financial vitality score (Q3.2) has the highest score of 3.48, followed by the emission trading score (Q3.3) of 3. The financial vitality is measured through tax revenues and outstanding local bonds. A high score is not surprising as Glasgow is the third most important financial centre in the UK and has its own dedicated International Financial Services District. No data was available for the emission trading sub-category. The industrial vitality (Q3.1) sub-category measured in the amount of per capita gross regional product (3.2 million yens) shows a relatively adequate level of businesses and employment in the city.

Table 1. Glasgow data for each indicator in CASBEE-City (version 2012)

Assessment items	value	unit	raw score
Q: Total score for Quality (0~100)			**53.8**
Q: Score for Quality (1.0~5.0)			**3.2**
Q1 Environmental aspect			2.94
Q1.1 Nature conservation			**3.59**
Q1.1.1 Ratio of green & w ater spaces	**70.0**	%	**3.59**
Q1.2 Local environmental quality			**3.36**
Q1.2.1 Air	**0**	days	**5.00**
Q1.2.2 Water	**4.7**	mg/l	**1.72**
Q1.3 Resource recycling			**3.81**
Q1.3.1 Recycling rate of general waste	**25.2**	%	**3.81**
Q1.4 CO_2 sinks			**1.00**
Q1.4.1 CO2 absorption by forests	**0.0**	t-CO_2/person	**1.00**
Q2 Social aspect			3.39
Q2.1 Living environment			**2.61**
Q2.1.1 Adequate quality of housing	**104.0**	m^2	**3.09**
Q2.1.2 Traffic safety	**8.0**	Num. of accidents /1,000 people	**1.37**
Q2.1.3 Crime prevention	**71.4**	Num. of crimes /1,000 people	**1.00**
Q2.1.4 Disaster preparedness	**6.0**	Num. of hospitals /100,000 people	**4.99**
Q2.2 Social service			**2.56**
Q2.2.1 Education service	**13.5**	person/person	**2.88**
Q2.2.2 Cultural service	**1.0**	Num. of facilities /10km^2	**3.71**
Q2.2.3 Medical service	**1.0**	person/1,000 people	**2.54**
Q2.2.4 Childcare service	**0.2**	Num. of facilities /100 people	**1.27**
Q2.2.5 Services for the elderly	**0.4**	Num. of facilities /1,000 people	**2.42**
Q2.3 Social vitality			**4.99**
Q2.3.1 Rate of population change due to births& deaths	**2.0**	%	**5.00**
Q2.3.2 Rate of population chang e due to migration	**1.9**	%	**4.98**
Q3 Economic aspect			3.12
Q3.1 Industrial vitality			**2.89**
Q3.1.1 Amount equivalent to gross regional product	**3.2**	1,000,000 Yen/person	**2.89**
Q3.2 Financial			**3.48**
Q3.2.1 Tax revenues	**15.3**	10,000/person	**3.98**
Q3.2.2 Outstanding local bonds	**14.3**	%	**2.99**
Q3.3 Emission trading			**3.00**
Q3.3.1 Amount of emission trading	**N/A**	-	**3.00**
L: Total score for Load (0~100)			**28.4**
L: Score for Load (1.0~5.0)			**6.2**
L1 CO2 emissions from energy sources			
L1.1 Industrial sector	**1.5**	t-CO_2/person	
L1.2 Residential sector	**1.3**	t-CO_2/person	
L1.3 Commercial sector	**1.0**	t-CO_2/person	
L1.4 Transportation sectr	**1.4**	t-CO_2/person	
L2 CO2 emissions from non energy sources			
L2.1 Waste disposal sector	**1.0**	t-CO_2/person	

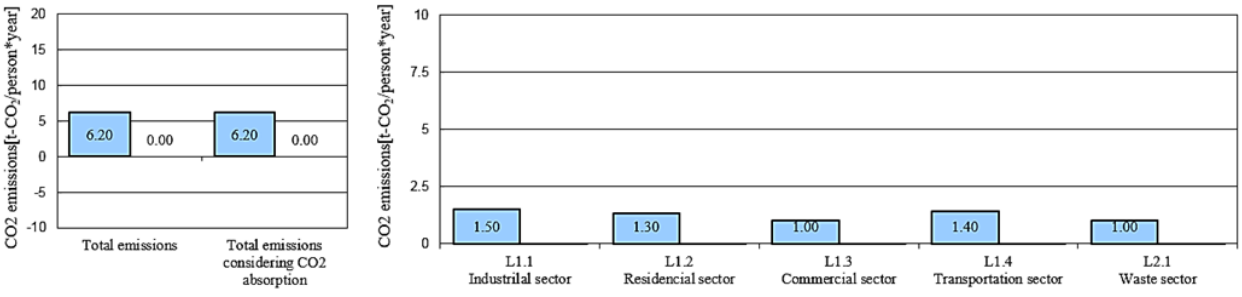
Figure 1. CASBEE-City breakdown of quality Q scores



The breakdown scores for different major categories of the environmental load L for the Glasgow city assessment is shown in Figure 2. Since L deals with the GHG emissions for different sectors, the desired score for this parameter should be as lowest as possible. The annual per capita CO_2 emissions in Glasgow is 6.2 tonnes per person. It was calculated by the sum of CO_2 emissions by different sectors. The emission for each individual sector is calculated based on the published data for the total GHG emissions by that sector in tonnes and divided by the population of this city to get t-CO_2e / person in a year (BEIS, 2020).

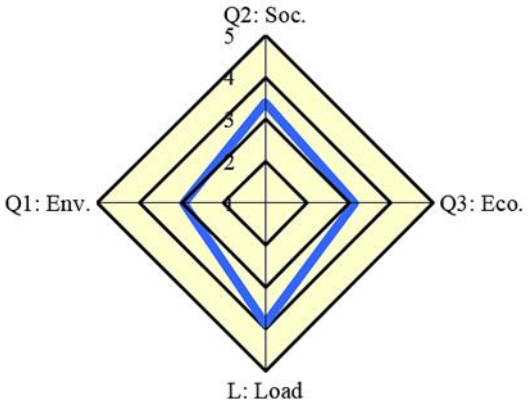
The industrial sector has the highest amount of emissions, 1.5 tonnes CO_2 per person per year due to a high electricity and gas use in industry and businesses. Although the carbon intensity of the UK electricity grid has been reducing as the proportion of wind generation increases, this emission factor is influenced by gas prices, which has led to an increase of coal use for power generation (GCC, 2013). It is then followed by the transportation sector with 1.4 tonnes which is due to the high number of vehicles which still use carbon-based fuels, particularly diesel. The residential sector produces around 1.3 tonnes of CO_2 per person per year. The waste sector has the lowest values with an annual per capita emission of 1 tonne of CO_2. These scores show that energy demand sectors in Glasgow city need to conduct further efforts to reduce their CO_2 emissions.

Figure 2. CASBEE-City breakdown of environmental load L scores



The assessment of different qualities and load for the Glasgow city is shown as a radar chart in Figure 3. The ideal condition of a city would be for the case when the blue lines in the chart reaches to each corner representing the highest score of 5. For Glasgow, all main Q categories scored higher than 3 (out of a 5-points scale).

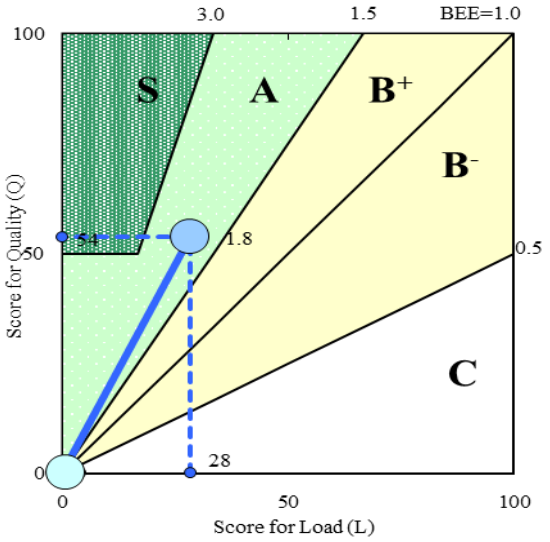
Figure 3. CASBEE-City radar chart with assessment of main categories of Q and L

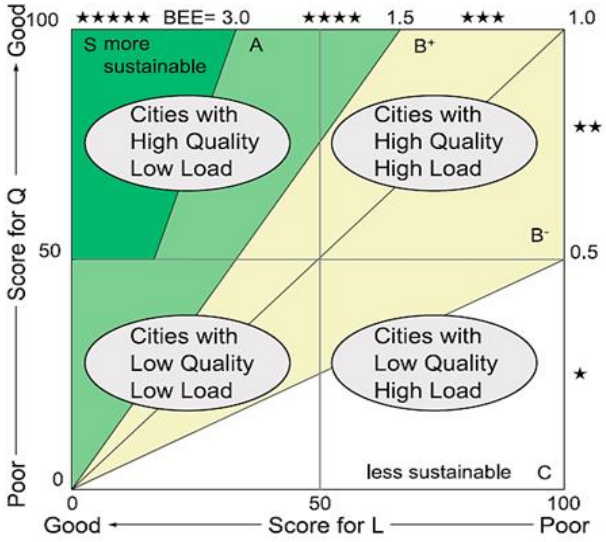


To estimate the Built Environment Efficiency (BEE), the total quality Q and environmental load L scores are calculated in a 100-point scale. The total Q score is estimated by summing the 5-point scores for each indicator and weighting coefficients. For this assessment, the weighting coefficients are set to be equal within the environmental, social and economic categories as set by the default settings. However, these coefficients could be changed based on the interactions among the 17 goals, targets and related indicators (Kawakubo, et al., 2018). The total L score is calculated by applying a logistic function considering both the city and the global average per capita emissions (approximately 5t-CO_2e/person/year) to compensate disparities of annual per capita emissions among cities (Kawakubo, et al., 2018). As shown in Table 1, the values for total Q and total L for Glasgow city are 53.8 and 28.4 respectively. The ratio of these two values results in the BEE for Glasgow which is 1.8.

Subsequently, the BEE chart can be plotted on a 100-point scale, where the vertical axis represents the Q score, and the horizontal axis represents the L score. In this chart, the BEE is expressed as the slope of a straight line which connects the origin point (0,0) and the maximal point for total Q score and total L score. Based on the calculated gradient for BEE, the sustainability assessment of the cities categorises them into 5 rankings: S (excellent) [BEE=3], A [3>BEE>1.5], B+ [1.5>BEE>1], B– [1>BEE>0.5] and C (poor) [BEE<0.5]. Cities with high quality Q and low load L (S, A rankings) are regarded as “relatively more sustainable” cities, while cities with low quality Q and high load L (B-, C rankings) are regarded as “relatively less sustainable”.
Based on this assessment and calculated BEE gradient for Glasgow, this city is ranked in A category as shown in Figure 4(a), which means that it has a relatively sustainable condition due its high quality and low environmental emission load (see also Figure 4(b)).

Figure 4. CASBEE-City results: (a) BEE for Glasgow, (b) BEE categories





5. Conclusions and recommendations

The CASBEE-City assessment methodology and tool are useful for understanding and visualising the current progress of cities towards achieving global SDGs and GHG emissions reduction targets due to the large number of indicators used in the assessment. This type of assessments allows cities to monitor and evaluate the effectiveness of measures and practices being implemented towards sustainable development and climate change mitigation.

In the case of Glasgow City, its low environmental load (L) may be attributed through the deployment of several initiatives and partnership projects of its carbon management plan described in section 2.2. In a similar manner, the high-quality score (Q) comprising environmental, social and economic quality can be attributed to measures deployed through the Glasgow City development plan and projects conducted by the Climate Ready Clyde initiative. Based on the CASBEE-City assessment, Glasgow is classified under a relatively sustainable

city, but there are aspects that the city could still improve to become a more sustainable city. For example, the living environment and social service categories of the social aspect achieved low scores due to low crime prevention (71 crimes per 1,000 people) and limited facilities for childcare (0.2 facilities per 100 people) respectively. To improve these scores, relevant authorities such as the National Health Service, the city council and other institutions could adopt better policies to lessen the reasons which causes crime, such as inequalities in income and education, as well as increasing the number of facilities for childcare. Despite Glasgow has an adequate ratio of green and water spaces for nature conservation, the city's GHG inventory indicates that more greenspaces are needed within the city so the current LULUCF emissions can become carbon removals.

To achieve carbon neutrality by 2030, Glasgow City Council is planning to introduce a low emission zone for the city centre, develop a plastic reduction strategy, a circular economy route map, a food growing strategy, and a wide range of projects within its new local transport strategy, including an electric vehicle strategy and the deployment of zero emissions vehicles for the council's fleet (Glasgow City Council, 2019). All these strategies will gradually reduce the environmental load of the city.

Some limitations of this study were that for some indicators relevant data were unavailable (e.g. amount of emissions trading), which could not be input in the tool. In future research, it would be advisable to find the relevant missing data, and also to adapt the weighting coefficients of the assessment methodology to the local context.

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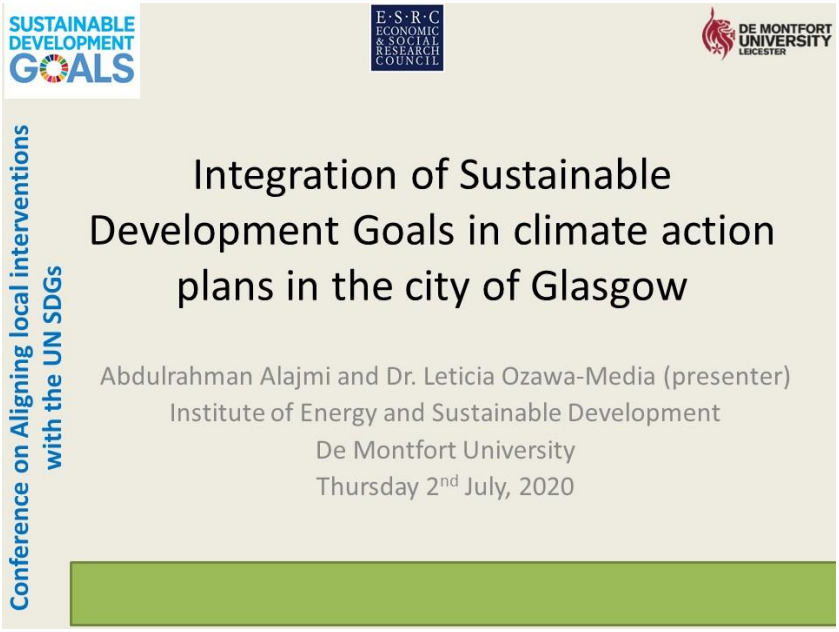
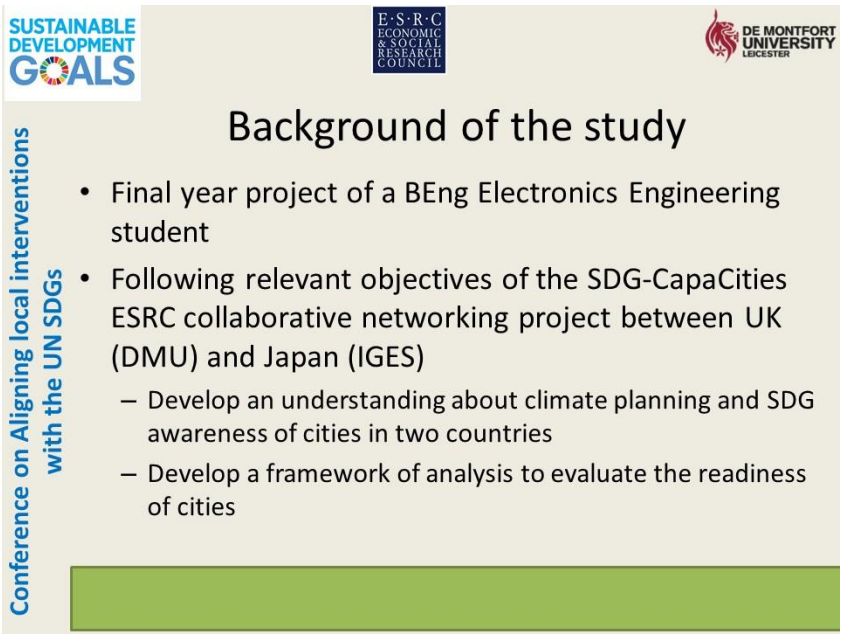
Integration of Sustainable Development Goals in climate action plans in the city of Glasgow,

By Dr. Leticia Ozawa-Meida, IESD (on behalf of Abdulrahman Alajmi and Leticia Ozawa-Meida, DMU)





GHG emissions and reduction targets

- GHG emissions (2017): 2,619 $ktCO_2e$
  - Industry, commercial and agriculture (35.7%)
  - Transport (33.7%)
  - Domestic (30.3%)
  - LULUCF (0.3%)
- Scotland Climate Change Act 2009 reduction targets
  - 50% by 2030 and 80% by 2050 (1990 baseline)
- Glasgow set a target to become a carbon neutral city by 2030

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Glasgow City background

- One of the majors cities in Scotland
- Population (2019): 633,120 inhabitants
- Population annual growth rate: 0.3%
- Scottish economy powerhouse:
  - More than 18,000 businesses
  - Employment: 312,500 people
  - Gross value added: 19.9 billion GBP
- 2019 UK's top Cultural and Creative City
- Average annual temperature: 8.5°C
- Average annual precipitation: 1,171 mm (UK average: 885 mm)

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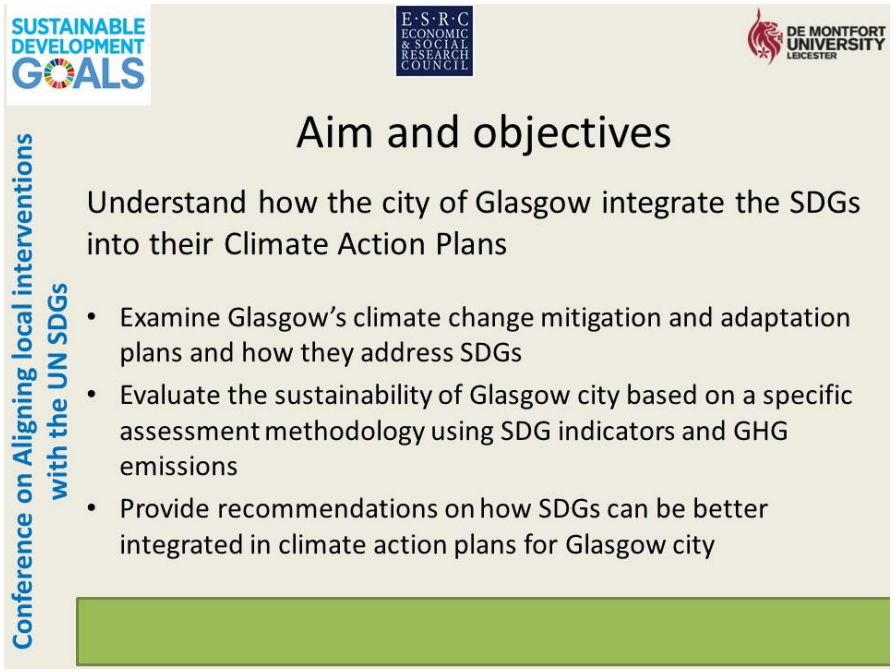
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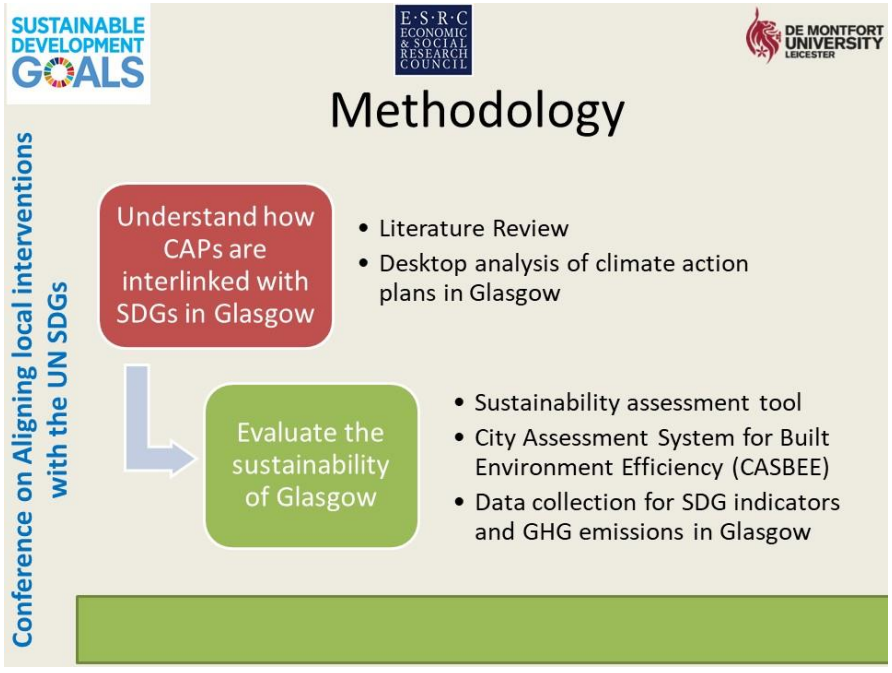
Aim and objectives
Understand how the city of Glasgow integrate the SDGs into their Climate Action Plans
• Examine Glasgow's climate change mitigation and adaptation plans and how they address SDGs
• Evaluate the sustainability of Glasgow city based on a specific assessment methodology using SDG indicators and GHG emissions
• Provide recommendations on how SDGs can be better integrated in climate action plans for Glasgow city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Methodology
Understand how CAPs are interlinked with SDGs in Glasgow
• Literature Review
• Desktop analysis of climate action plans in Glasgow
Evaluate the sustainability of Glasgow
• Sustainability assessment tool
• City Assessment System for Built Environment Efficiency (CASBEE)
• Data collection for SDG indicators and GHG emissions in Glasgow

SUSTAINABLE DEVELOPMENT GOALS

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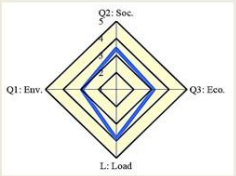
CASBEE indicators for Glasgow



Assessment items	value	unit	raw score
Q: Total score for Quality (0~100)			53.8
Q: Score for Quality (1.0~5.0)			3.2
Q1 Environmental aspect			2.94
Q1.1 Nature conservation			3.59
Q1.1.1 Ratio of green & water spaces	70.0	%	3.59
Q1.2 Local environmental quality			3.36
Q1.2.1 Air	0	days	5.00
Q1.2.2 Water	4.7	mg/l	1.72
Q1.3 Resource recycling			3.81
Q1.3.1 Recycling rate of general waste	25.2	%	3.81
Q1.4 CO_2 sinks			1.00
Q1.4.1 CO2 absorption by forests	0.0	t-CO_2/person	1.00
Q2 Social aspect			3.39
Q2.1 Living environment			2.61
Q2.1.1 Adequate quality of housing	104.0	m^2	3.09
Q2.1.2 Traffic safety	8.0	Num. of accidents / 10,000 people	1.37
Q2.1.3 Crime prevention	71.4	Num. of crimes / 10,000 people	1.00
Q2.1.4 Disaster preparedness	6.0	Num. of hospitals / 100,000 people	4.99
Q2.2 Social service			2.56
Q2.2.1 Education service	13.5	person/person	2.88
Q2.2.2 Cultural service	1.0	Num of facilities / km^2	3.71
Q2.2.3 Medical service	1.0	person*1,000/people	2.54
Q2.2.4 Childcare service	0.2	Num of facilities / 100 people	1.27
Q2.2.5 Services for the elderly	0.4	Num of facilities / 10,000 people	2.42
Q2.3 Social vitality			4.99
Q2.3.1 Rate of population change due to birth & death	2.0	%	5.00
Q2.3.2 Rate of population change due to migration	1.9	%	4.98
Q3 Economic aspect			3.12
Q3.1 Industrial vitality			2.89
Q3.1.1 Amount equivalent to gross regional product	3.2	1,000,000 Yen/person	2.89
Q3.2 Financial			3.48
Q3.2.1 Tax revenues	15.3	10,000/person	3.98
Q3.2.2 Outstanding local bonds	14.3	%	2.99
Q3.3 Emission trading			3.00
Q3.3.1 Amount of emission trading	N/A	-	3.00
L: Total score for Load (0~100)			28.4
L: Score for Load (1.0~5.0)			5.2
L1 CO2 emissions from energy sources			
L1.1 Industrial sector	1.5	t-CO_2/person	
L1.2 Residential sector	1.3	t-CO_2/person	
L1.3 Commercial sector	1.0	t-CO_2/person	
L1.4 Transportation sectr	1.4	t-CO_2/person	
L2 CO2 emissions from non energy sources			
L2.1 Waste disposal sector	1.0	t-CO_2/person	

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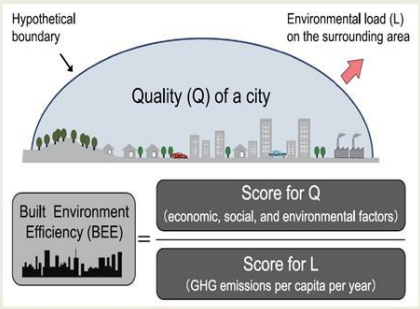
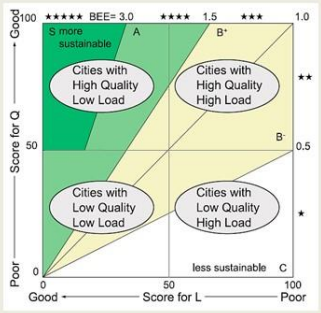
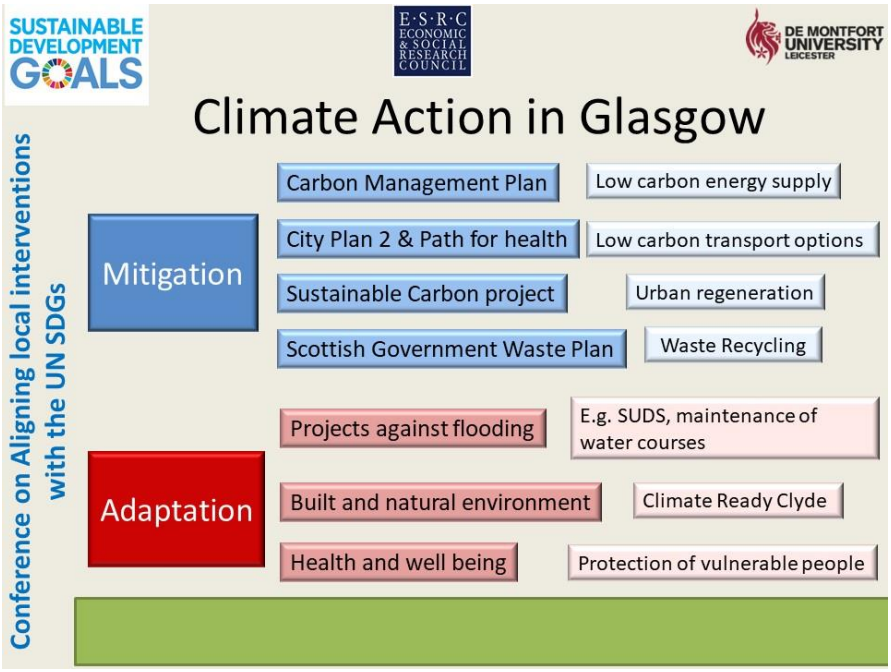
City Assessment System for Built Environment Efficiency (CASBEE) (version 2012)





Source: Kawakubo S, Murakami S, Ikaga T and Asami Y (2018). Sustainability assessment of cities: SDGs and GHG emissions, *Building Research & Information*, 46:5, 528-539, DOI: 10.1080/09613218.2017.1356120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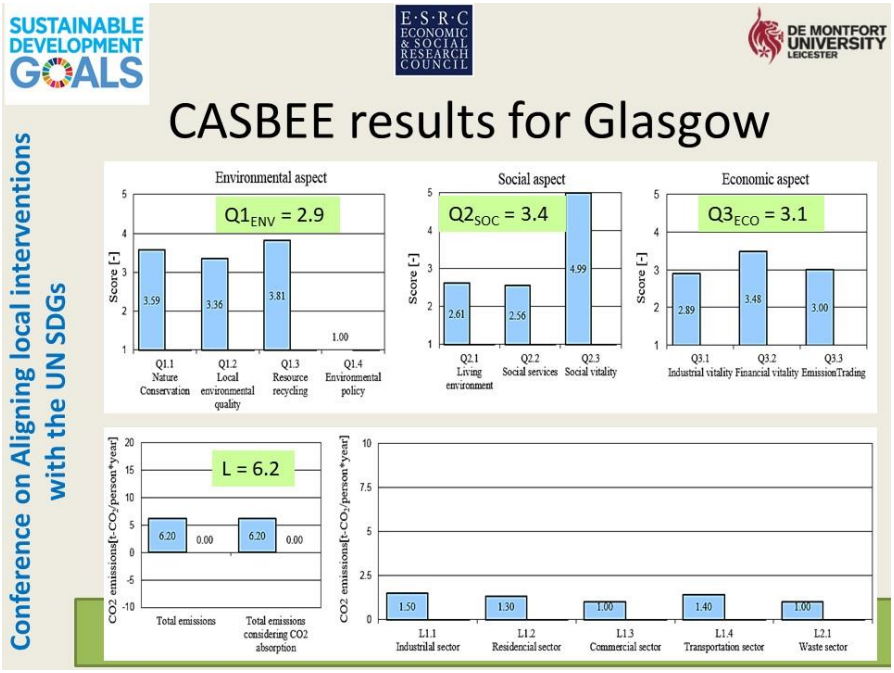
Climate Action in Glasgow
Mitigation
Carbon Management Plan
Low carbon energy supply
City Plan 2 & Path for health
Low carbon transport options
Sustainable Carbon project
Urban regeneration
Scottish Government Waste Plan
Waste Recycling
Adaptation
Projects against flooding
E.g. SUDS, maintenance of water courses
Built and natural environment
Climate Ready Clyde
Health and well being
Protection of vulnerable people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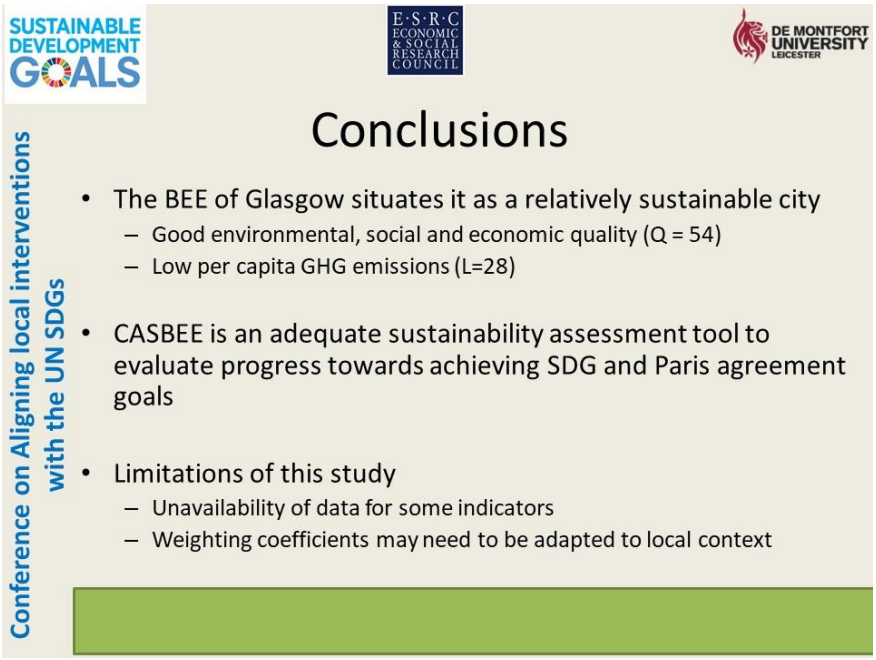
CASBEE results for Glasgow
Environmental aspect
Q1ENV = 2.9
Social aspect
Q2SOC = 3.4
Economic aspect
Q3ECO = 3.1
Score [-]
L = 6.2
CO2 emissions[t-CO2/person*year]
Total emissions
Total emissions considering CO2 absorption
L1.1 Industrial sector
L1.2 Residencial sector
L1.3 Commercial sector
L1.4 Transportation sector
L2.1 Waste sector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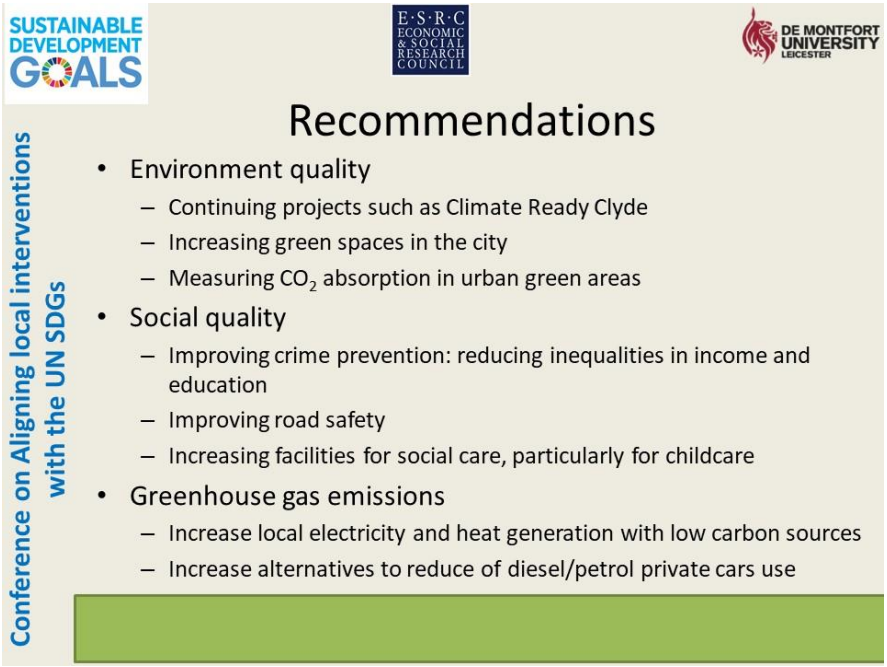
Conclusions
• The BEE of Glasgow situates it as a relatively sustainable city
– Good environmental, social and economic quality (Q = 54)
– Low per capita GHG emissions (L=28)
• CASBEE is an adequate sustainability assessment tool to evaluate progress towards achieving SDG and Paris agreement goals
• Limitations of this study
– Unavailability of data for some indicators
– Weighting coefficients may need to be adapted to local context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Recommendations
• Environment quality
– Continuing projects such as Climate Ready Clyde
– Increasing green spaces in the city
– Measuring CO_2 absorption in urban green areas
• Social quality
– Improving crime prevention: reducing inequalities in income and education
– Improving road safety
– Increasing facilities for social care, particularly for childcare
• Greenhouse gas emissions
– Increase local electricity and heat generation with low carbon sources
– Increase alternatives to reduce of diesel/petrol private cars use

Sustainability result for Glasgow

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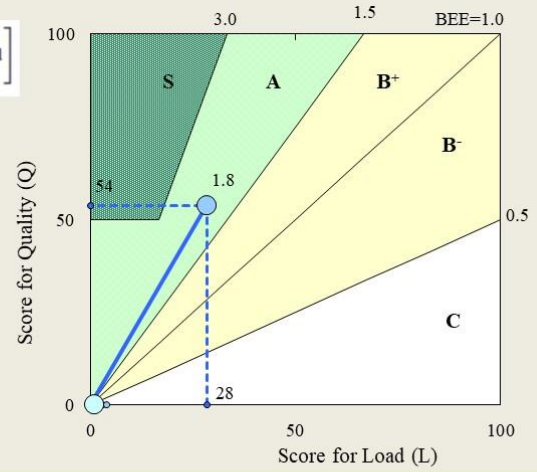
$$\text{Score for Quality} = 25 \cdot \left[\sum_i \left(\sum_j Q_{ij} \cdot w_{ij}\right) \cdot w_i - 1\right]$$

$Q_{Glasgow} = 54$

$$\text{Score for Environmental Load} = 100 \times \frac{1}{1+\exp\left(-a(\log_{10} x - \log_{10} m)\right)}$$

$L_{Glasgow} = 28$

$$BEE_{Glasgow} = \frac{54}{28} = 1.8$$



Thank you for your attention!

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