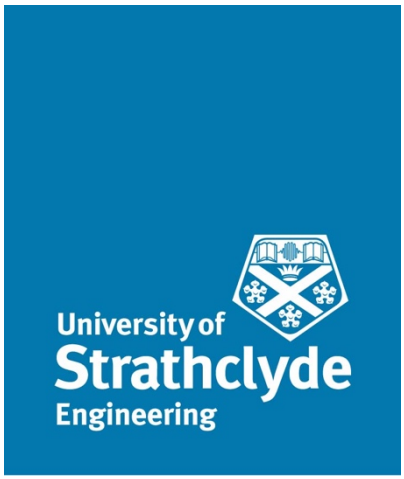

Department of Mechanical and Aerospace Engineering

Citizen Acceptability of Sustainable Developments for Future Cities

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Master of Science

Sustainable Engineering: Renewable Energy Systems and the Environment

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Signed:  Date: 20th August 2018

Abstract

The progression towards future cities is essential to minimise the impacts that increasing populations in cities and urban life has on the environment, ensure social development and advance economies. The European Innovation Partnership on smart cities and communities has set out 11 priority goals, with three focused on improving sustainability of the urban environment and one dedicated to improving citizen engagement and understanding. It is these four priorities most relevant for energy and the environment developments. Through investigation into the technical, economic and social implications of four energy and environment developments, it was determined that the two most pressing for social study were renewable energy systems and low and zero emission vehicles. Specifically, public acceptance of the installation of public charging points in residential streets and the installation of PV panels on derelict land for energy harvesting was investigated.

Through questionnaires and interviews, predetermined focus areas were investigated, and the responses analysed and discussed. It was determined that the public would accept the PV installation more than the installation of charging points. A specific area of interest with charging points was the concept of charging poverty. Individuals already in deprivation may be severely impacted, both financially and socially, by the inability to domestically charge. A further concern with charging points is the management of the points in order to avoid conflict within the community. In the Glasgow area, land use did not seem to pose a large concern as it was repeatedly stated that sufficient area for recreational use is available and therefore derelict land is not a concern. In order to aid acceptance both community benefits and engagement are deemed essential.

A proposed method for incorporating this information into city planning is discussed. The proposal is to conflate the social dimension of developments with policy and technical constraints included in the Glasgow Opportunities Map. This will allow the effective transferal of information regarding social consideration and therefore the convenient incorporation of this into planning processes. Through this, the EIP citizen focus priority can be met when considering sustainable developments.

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Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Project Background

The city is a complex and dynamic environment, the hubs of education, diversity and innovation. With growing populations in the urban environment throughout the world, the impact that the city has on a wider national scale, both economically and environmentally, is gaining importance (Eurostat Statistics Explained, 2017). Cities account for 70% of the EU's total energy consumption and greenhouse gas emissions (European Commission, EIPSCC, 2013). Therefore, governments and councils around the world are innovating plans to ensure that future cities are environmentally conscious, at the forefront of technology and functioning in the best way for citizens within them.

The goals and ambitions set out in the future city plans require substantial development. Specifically, within the energy and the environment sector, momentous infrastructure and innovation development is required to ensure the impact of the city on the environment is lessened. However, these developments come with various constraints, impacts and issues spanning technical, economic and social issues. These issues must be considered in the progression to a future city.

The social issues are often not given as much assessment as the former two matters. The acceptability of the citizens in the city is extremely important as public opposition could stall progression. Through understanding the opinion and concerns that the public has regarding these developments, incorporation of citizen acceptability into city planning could be possible. This would allow integration of public opinion into proposed developments, ensuring that the development can be altered to guarantee acceptance, and that the developments that will aid environment goals, will proceed. This will certify two of the main goals in a future city; environmental consciousness and the well-being of citizens.

1.2 Aim

This project aims to determine issues and concerns that the public has regarding some key developments related to energy and the environment with the respect to future cities. The purpose of this is to determine citizen acceptability of these developments and highlight why this consideration is important. Through this understanding, a proposal for how to incorporate this into city planning can be addressed.

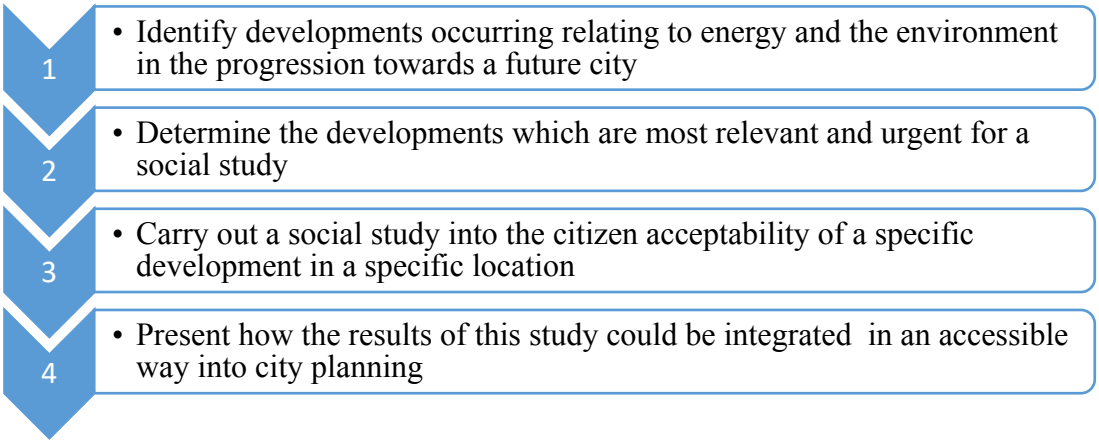
1.3 Objectives

The key objectives which must be completed to attain this aim are outlined below.

- To determine the key developments relating to energy and the environment in the progression to future cities and investigate the technical, economic and social constraints and impacts of these developments.
- To use an effective, unbiased and transferrable method to understand citizen acceptability of a specific development.
- To understand public opinion and acceptance of these developments.
- To present a methodology for how citizen acceptability could be incorporated into city planning for these developments.

1.4 Approach

The approach to this study has been divided into four key steps. For steps one and two, a metastudy will be completed to assess the developments. Within the social study, two methods for data collection are used; questionnaire and interview.



1.5 Thesis Outline

Chapter 1: An introduction to the project, outlining the background, aims and objectives and the approach taken to this issue.

Chapter 2: An outline of what a future city is, why it is required, and some policy goals to achieve a future city.

Chapter 3: Identification of the key developments relating to energy and the environment and their issues and constraints. This identification will allow narrowing of the scope to select specific developments in which a social study is most relevant and vital.

Chapter 4: The social study which aims to delve deeper into the social issue of the chosen study areas through questionnaires and structured interviews. The study areas, methods, results and analysis are outlined.

Chapter 5: Proposal for how to incorporate citizen acceptability into city planning. Outline of the method that could be used, how it would be done and the benefits of this.

Chapter 6: Conclusions.

Chapter 7: Future Work.

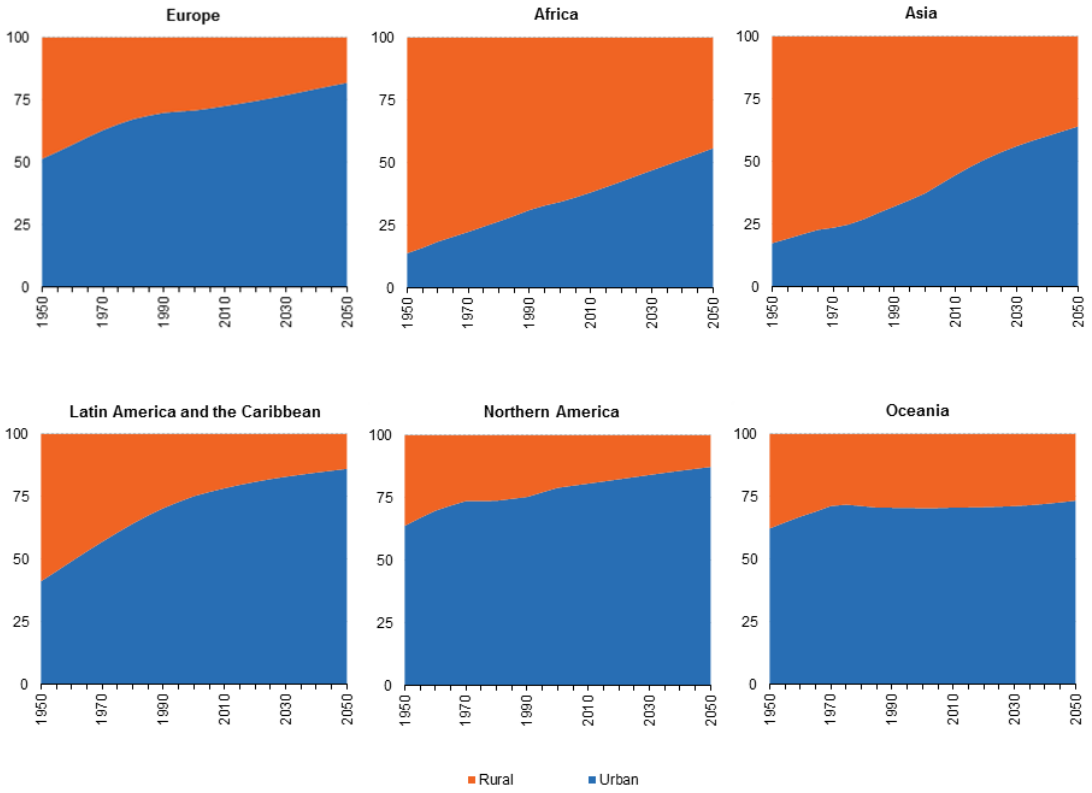
2 Future Cities

Continued population growth within cities and increasing urban sprawl results in huge impacts for the environment and for the citizens living within it. The high levels of consumption of resources and production of waste means that the impact of growing cities is felt on a national scale (Liddle and Moavenzadeh, 2002). Therefore, if cities continue to grow, innovation in smart and sustainable development must occur to ensure the impact is minimised. This leads to the concept of a future city. Encompassed in this idea are proposals for improvement within the urban environment in order to benefit the economy of the city, lessen environmental impact and ensure the well-being of citizens through sustainable development. For the purpose of this study, the latter two are of specific importance.

The city is a key area for high quality education, social, cultural and ethnic diversity (Eurostat Statistics Explained, 2017). Historically movement towards the urban environment created exciting employment opportunities during time periods such as the industrial revolution in the UK (Castles et al, 2013) and now serve as hubs for competitiveness and employment (Eurostat Statistics Explained, 2017). Knowledge spill overs operate particularly well within cites due to proximity of individuals allowing effective and efficient communication of information within the population. This accelerates economic growth and innovation (Glaeser et al, 1992). Industrialised cities are a major contributor to economic growth, as their economies can be approximately 35% more productive than the rest of the country (Liddle and Moavenzadeh, 2002). Therefore, there is significant incentive for living in the urban environment which fuels migration towards cities, resulting in momentous population sizes with sustained growth.

The population within cities is continuing to grow worldwide (Eurostat Statistics Explained, 2017). By the 1950's, more than half the European population lived in urban areas, and as shown in Figure 1, the population growth in urban areas has continued. Currently the urban environment is home to three quarters of citizens in the EU and growth is predicted to increase along a similar trend. Worldwide the rate of acceleration varies with African populations remaining predominantly rural today. However,

consistently an increase in the share of urban population is predicted, regardless of location.



(*) United Nations data are based on national definitions; as such there may be a discrepancy with respect to the Eurostat data used elsewhere in this publication.

Figure 1: Share of urban and rural populations, 1950-2050 (Eurostat Statistics Explained, 2017)

Increasing the population within urban environments affects both the population density and the urban sprawl. As cities have grown larger, they tend to increase their physical size rather than the population density (Liddle and Moavenzadeh, 2002). Therefore, the growth of cities impacts the rural environment by incorporating rural land into the city. However, even though urban sprawl increases to accommodate the increasing population, the concentration of people within cities is still substantial. The volume of consumption and production has widespread, often regional and national impacts as resources are sourced and waste moved to areas out with the urban environment consequently affecting the entire country. The idea of consumption and production is extremely important when considering the mounting impact of cities with growing population.

Specifically, regarding energy and the environment issues, cities currently account for approximately 70% of the EU's total energy consumption and emit a 70% share of greenhouse gases (European Commission, 2013). Although this statistic highlights the negative environmental impact that cities can have, it also proposes an opportunity. If energy efficiency and emissions can be tackled on a city scale, then there will be a significant impact on national energy consumption and emissions. This could help reach policy goals regarding the environment such as the 2050 emissions targets within the EU (European Commission, 2011).

This opportunity is recognised and progression towards cities becoming more environmentally conscious through sustainable development is occurring. However environmental impact is not the only consideration in future cities, as social development and finance are also being taken into consideration. The future city is seen to be a smart city with better monitoring, connectivity and efficiency to ensure improvement. Therefore, the future city and smart city are terms often used together. The European Commission on smart cities states that:

> *''A smart city is a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses.''*

This vision was inspired by the need to tackle issues such as congestion, poor air quality and high energy costs which are major problems for a lot of European cities (European Commission, 2013). Through the European Innovation partnership on smart cities and communities, European cities are providing investment in ICT, energy and transport. It is expected that better mobility, cleaner urban environments and higher energy efficiency will be achieved (European Commission, EIPSCC, 2013). In order to obtain this goal, 11 inter-dependent priority areas were determined, shown in Figure 2. Within these priorities are ambitions and recommended actions which can be taken for specific cities to follow. With regards to Energy and the Environment, the first three priorities; Sustainable Urban Mobility, Sustainable Districts and Built Environment and Integrated Infrastructure and Processes, are the most relevant.

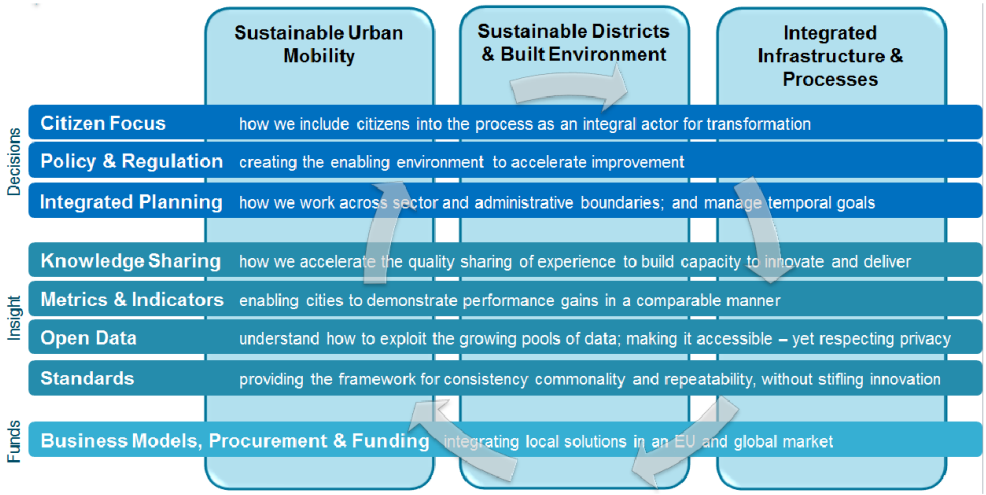


Figure 2: 11 priority areas outlined by the European Commission with regards to smart cities and communities (European Commission, EIPSCC, 2013)

Sustainable Urban Mobility outlines the importance of reducing and avoiding demand for emission-intensive transport modes, a shift from these modes of transport to better integrated and efficient modes, and finally an emphasis on connectivity between zero- and low-emission vehicles and each other and the grid. Therefore, an important advancement within this category is low emission vehicles such as Electric Vehicles or Hybrid Vehicles.

The Sustainable Districts and Built Environment priority aims to:

> *''reduce energy use, environmental impact and carbon footprint, entail competitive industries for jobs and growth and at the same time ensure societal and social development and the well-being of citizens''*

Therefore, local renewable energies, storage systems, demand control and smart energy networks must be integrated into existing infrastructure today to meet this aim.

Through Integrated Infrastructure and Processes, cities will be able to move from a reactive operation to predictive. This will be achieved by utilising the ICT industry in

city planning. Through sensors and monitoring; electricity, heating and cooling, transport and community spaces can be part of a network in which data is presented and can be used for planning for industry, governments and the public.

These three priorities will utilise the innovations within the Energy and Environment sector in the progression to a Future City through sustainable development. However, it is extremely important to consider the social considerations with theses progressions as also included in the 11 priority goals is Citizen Focus.

Citizen focus addresses the concern that although citizens are at the heart of the city, they are insufficiently engaged, motivated or empowered and that there is a lack of understanding of citizens. Incorporation of citizen opinions and the impacts of progression and development within the city on individuals is essential to reach this aim.

Cities around Europe are now incorporating the EC initiatives into their planning and policy. In Glasgow, £24m of funding was acquired in 2013 from the Technology Strategy Board (now Innovate UK) to make city life safer, smarter and more sustainable through research and innovation in technology. Through exploring energy efficiency, data availability, transportation and travel, and citizen engagement it is hoped that Glasgow can reach its potential as a Future City (Glasgow City Council, 2018).

Within the Energy Initiative, several projects are underway, collaborating with companies throughout the industry and academia. Mapping of resident consumption will provide an accessible way for the public to anticipate the energy consumption of a particular property. Retrofit options that could improve the building performance, while determining cost and payback period of the upgrades. To assess the retrofit performance, innovative sensors are being investigated which monitor the building performance better and again feed into the data bank for further research. Demand side management could have extremely beneficial outcomes for the electricity network and so the process is being examined, specifically in council properties, to determine applicability on a larger scale. Mapping of possible opportunities for the installation of renewable energy systems within the city with regards to the policy and technical

restrictions. This will provide communities and the Council with easily accessible data regarding the opportunities for development and deployment.

Through these initiatives, it is clear that Glasgow City Council has solid intentions to improve the city to be more environmentally conscious and sustainable. However, these developments could have significant technical, economic and social implications which must be considered and assessed. As goals to be both more environmentally conscious and have a citizen focus are included in the progression towards a future city, any negative social implications caused by sustainable developments would negate the citizen focus. However, it is important to also understand the technical and economic issues and barriers surrounding sustainable developments regarding energy and the environment.

3 Identification of Developments in Future Cities

As urban environments move towards future cities, there are numerous developments that will occur to meet the aims outlined in the European Innovation Partnership. However, there are several possible constraints associated with each development type that could affect the implementation of that specific development. In this section an overview of possible developments relating to energy and the environment that could be implemented during the progression towards future cities is provided. By considering the plans of the EU and city councils, four main movements relating to energy and the environment were identified; vehicles, local renewables, building performance and demand side management. These problems are then assessed to determine the possible technical, economic and social constraints and the impacts that will result from their deployment. By understanding the technical and economic issues, the developments that are most relevant at the moment can be determined. These developments can then be taken into further study to develop a better appreciation of the social issues. This will allow efficient assessment of which developments will have the largest effect on citizens within the city.

3.1 Developments Overview

3.1.1 Vehicles

Low and Zero emission vehicles have great potential to reduce emissions in cities, improve air quality and overall, lessen the impact of transportation on the environment. Within the EIP for smart cities and communities, they are a part of the sustainable urban mobility priority. Policy throughout the UK is helping to progress the car industry in a movement away from conventional combustion engines, to hybrid and electric vehicles. The European Commission has outlined strategies which encourage not only governments but also industry to promote these vehicles in the market. With new average fleet Carbon Dioxide standards, market investment incentives and plans for alternative fuel infrastructure, it is clear that there are significant changes coming to private transportation (European Commission, 2018). This is reflected in the UK through schemes set out by the Office for Low Emission Vehicles, specifically focused on charging points. The on-street residential charge-point scheme, workplace charge scheme and electric vehicle home-charge scheme all provide monetary support for the

purchase and installation of charging points for use with plug-in hybrid and electric vehicles. The intentions of the European Commission and the policy throughout the world shows a clear purpose for innovations in the transport sector.

Low and zero emission vehicles are a key development in a sustainable future as they can significantly reduce overall emissions in a country and help minimise reliance on fossil fuels. As a low or zero emission vehicle either partly or fully relies on electricity, the dependence on fossil fuels for combustion in vehicles is reduced. Tailpipe emissions such as Carbon Dioxide and Nitrous Oxides are the main emissions from combustion vehicles. These gases are greenhouse gases which are known to have negative effects on the environment and specifically but not exclusively, Nitrous Oxides are reported to significantly decrease air quality. Pollution can lead to tragic health implications such as respiratory problems, eye irritations and in the long term, cognitive and developmental problems. Pollution from vehicles accounts for 184,000 deaths globally per year (Abu-Lebdeh, 2017). Therefore, reduction these emissions is required to reduce environmental impact and improve city living, two aims of a future city.

However, although the benefits of a transition to low emission vehicles are evident, there are several barriers to this transition or consequences that could occur. Although technology investigating alternative fuel vehicles such as hydrogen powered vehicles is progressing, currently the most accessible are hybrid and electric vehicles. Within this category, both plug-in hybrid vehicles and electric vehicles require charging, which could have massive effects on the electricity supply demand balance in the UK and the electricity grid. Also, the technical issues associated with the charging points themselves must be considered.

For the use of plug in vehicles, a domestic charging point would be the ideal form of charging. With public charging, for an individual there are inconveniences such finding a charging point, the length of time to charge the car and cost. The cost of public charging could potentially be higher than domestic in order to turn a profit for the owner of the point. Whereas with domestic charging, the vehicle owner can charge at any time, they do not have to go anywhere to charge the car, and currently the payment rate per kWh for charging a vehicle is the same as using any other appliance in the home. Therefore, currently it is more convenient and financially beneficial to domestically

charge a car. If an owner does not have the ability to domestically charge, then they are possibly less likely to purchase a plug-in vehicle. It was reported that 43% of people in the UK do not have access to off street parking and therefore would not be able to install a charge point in their residence (Elmhirst, 2017). This could potentially deter the purchase of these vehicles. However, as the market moves towards low emission vehicles and with the 2040 ban on the sale of conventional diesel and petrol cars (UK government, 2017), the public will be required to consider purchasing these vehicles. Areas of more affluence with a high number of homes with driveways will not be affected by these issues, but places in poverty characterised by buildings such as tenement or high-rise flats, or homes which rely on on-street parking will be affected most. This could lead to exacerbating already impoverished areas by introducing charging poverty. This charging poverty could stem for individual's inability to domestically charge and therefore being required to publicly charge. Ensuring there are sufficient charging points for the public to charge their vehicles will require a huge installation, which will require parking space and power supply, including new cables and the charge points themselves and time.

Introducing vehicles which use electricity to charge the car will not only increase the demand for electricity, but the demand profile will be significantly affected depending on when the cars are being charged. The stochastic unpredictability of when people will charge their car will make matching the demand with a reliable supply of electricity difficult. Further, the progression towards renewable energy supply sources, which in themselves are irregular, makes the future of matching output from the generation source to demand challenging (Jin et al, 2014). Installing numerous charging points will require cabling upgrades, as well as the increased demand having significant impacts on the networks and distribution centres in the grid. Large scale upgrades to the grid could be required in order to address the increased capacity. Communication between electric vehicles and the grid is the most efficient way to introduce large volumes of plug-in vehicles into the demand profile, and so smart charging and smart grids may be the most likely progression. Smart charging could benefit the electricity supply by creating a more stable power grid with lower fluctuation levels (Liu et al, 2017), although this controlled charging poses further problems which are discussed in detail in demand management. The introduction of vehicles that require charging is not the only sustainable development that will require consideration of the supply demand

balance and of the grid. In fact, these issues occur in all developments outlined in this chapter as the introduction of the four developments will have both positive and negative effects on the supply demand profile. These technical issues all must be addressed before the benefits of low emission vehicles in cities can be experienced.

Economically, the impacts of these vehicles on national scale will be significant. Currently UK citizens pay a fuel duty of 57.95 pence per litre and 20% VAT on petrol and diesel (UK Government, Fuel Duty). If the public move to vehicles powered by electricity, the government will not make the same income from fuel tax. Therefore, as the government is unlikely to absorb this loss the tax is likely to be distributed elsewhere, perhaps to the cost of electricity when charging the vehicle. Combining this with the cost of grid upgrades if required and installation of charging points, a significant economic impact will be felt within the government and so must be considered as the resultant effects could be felt throughout the country in terms of budgets for other services.

In order to ensure this progression occurs to meet the sustainable urban mobility priority, these barriers must be overcome. However, the impact on the public of this somewhat inevitable transition are monumental. The availability of private parking for domestic charging is a massive problem as without this convenience, public charging would be required. The introduction of a kind of charging poverty where places already in poverty are further disadvantaged by being forced to rely on public charging due to lack of private parking, could have significant detrimental effects on communities and individuals. Charging electric vehicles takes longer than fuelling a car and therefore the inconvenience of this may not fit with people's vocation or lifestyle. Although currently, the cost of running an electric vehicle is low, it is likely to increase as they become more popular, as well as the initial cost of the car which may not be affordable. These impacts on the people in cities within the UK are significant and may not only be inconvenient but in some cases the transition with current technology may not be possible at all for an individual. Prior to this progression further consideration and consultation with citizens is required to ensure the implications are minimal.

3.1.2 Local Renewables

Cities typically import energy and export waste (Pantaleo et al, 2013). The introduction of small-scale renewable systems could transform this pattern to make cities more sustainable by producing some energy within the city and reducing waste exports. Many cities have specific energy goals such as Barcelona which aims for 100% energy self-sufficiency by 2050 and Frankfurt which wants to pioneer a 100% renewable energy city by 2050 (Bringault et al, 2016). In order to reach goals such as these, cities must move towards a decentralised energy model where energy is produced locally on a small scale as opposed to large power production plants with transportation systems (Dincer, 2000). This ensures the production occurs closer to consumption and in some cases by the consumer. The installation of local renewables throughout the urban environment in a decentralised model to provide sustainable energy is a progression essential to improve the life of citizens and reduce the national environmental impact of the city. This is part of the sustainable districts and built environment priority of the EIP.

Due to the density and design of built up areas in cities, the renewable energy schemes within cities are smaller with many more constraints than those large generation plants. Local renewable systems consist of either renewable energy systems which operate on a smaller scale in order to fit into the urban environment, or private systems such as renewables in homes or businesses. This power system can be highly beneficial in other ways out with sustainability such as lower vulnerability and greater resilience (Beatley, 2007). Although these systems can bring abundant energy and economic benefits to city energy systems and the citizens within the city, there are some concerns with their implementation in the future city which should be addressed. As each different renewable system poses its own barriers and issues, several different technologies are assessed and discussed.

There are several different renewable energy technologies that are viable in the urban environment, some of which are already being executed. Solar energy within the urban environment has great potential, already recognised in the concept of Solar Cities. Although this concept encompasses several goals such as production of food and materials, is strongly encourages the incorporation of solar energy in city design

(Dincer, 2007). The place for solar energy in cities is not only small-scale PV plants in open area, but also PV systems installed in homes and buildings. In Glasgow, installation of PV panels on council buildings, schools and social housing with planned installation in vacant land around the city (Glasgow City Council, 2012).

However careful consideration must be in place to ensure the output is sufficient and the panel is not shaded by surrounding buildings. Glare from the panels must not affect any air traffic, making location perhaps the most important consideration prior to installation. As described in the previous section, the impact of this development on the supply demand balance is substantial. As opposed to increasing the demand higher than the available supply, as was seen with vehicles, the issue with local renewable is over production creating a surplus of supply. In private systems, if all the energy produced is not consumed, it can be fed back to the grid for use in the national network for a profit to the producer through the feed in tariff making it desirable to have a surplus. If there is a particularly sunny day, a lot of energy will be produced from both private and public systems creating a large surplus. For any energy system which feeds back into the grid, this technical problem must be addressed, often through curtailment or storage.

Wind technology is another viable option in cities, however again the barriers are significant. As with solar PV panels, issues with feed back to the grid apply. Sizing and location, for systems integrated into buildings or landscaping systems to supply the city, is very important to ensure a sufficient output. If the turbine is intended to supply a specific source, then the turbine should be sized to contribute to the demand load of that building. Locating the turbine in an area where the surrounding built environment will not reduce the power output is essential for all types of urban turbine (Campbell et al, 2001).

Although solar and wind are perhaps the most developed technology for use in the urban environment, the use of other renewable systems such as hydro, wave and geothermal are being investigated. These technologies are much more niche and not applicable in many cities. Community hydro schemes are already well established in the UK; however, they are predominantly in rural environments. Scotland's first urban community hydro system, the Donside Hydro, harnesses energy from the river Don in Aberdeen to create electricity to be sold back to the national grid. Completion in 2016

created profit which is being invested into local regeneration in the area (ACE, 2018). The success of this scheme so far is encouraging, however run of river hydro schemes require topographical difference which is lacking in large rivers in cities such as Glasgow where the river Clyde has little topographic difference. Therefore, these schemes are limited to smaller rivers which do possess this requirement. Another consideration is the possibility of flooding with large schemes which would not be acceptable in densely populated urban areas. For cities located in coastal areas, the application of wave or tidal schemes could be possible to help the energy supply in cities.

A particularly innovative process occurring currently in Glasgow is the investigation into using geothermal heat beneath the city to warm homes in Glasgow. Potential heat within mine waters, superficial deposits and bedrock aquifers could provide 40 percent of the cities heating requirements in buildings. A small scheme in the Shettleston area of the city has shown success for 10 years and so larger systems could be possible (British Geological Survey, 2017). This is a further way that could renovate the energy system in the city.

Currently there are several incentives to support the purchase and installation of private solar systems helping with the initial installation cost. As previously mentioned feed-in tariffs which pay individuals a rate in p/kWh for any electricity supplied to the grid are available for private energy systems (Ofgem, 2018). Therefore, for an individual it is economically advantageous at the moment to have these small-scale renewable energy systems. However, as they increase in popularity it is likely that the financial help will reduce as well as the feed-in tariff, which over time, will make them less attractive. As small systems will always help to reduce the amount of electricity that will need to be bought from the grid for a particular building as a portion of the demand will be met from the system, they will continue to be a good option. Therefore, it is very likely that their progression will continue in urban environments. For non-private systems like solar PV systems planned in Glasgow or the geothermal scheme, access to or purchase of land is required. Also, for these developments there will be significant purchase and installation costs which will have to be incorporated into budgets. In the public eye, this may not be the best use of funds when compared to education, health care or other issues that may be viewed as more pressing.

The social deliberations from small scale renewable energy systems are not fully negative. Profit from private or community schemes from feed-in tariffs may provide monetary aid to areas, and as with the hydro scheme in Aberdeen, profits could be returned to the community through positive developments and social schemes. However, if energy systems are installed with the intention to contribute directly to the grid, installed by the council, the people close to the development may not see any direct benefit, only disadvantage from the loss of space and inconvenience of installation. The space for these energy developments could be utilised for other purposes that could potentially better benefit communities. Historically opposition to renewable energy systems on a large scale has been evident with NIMBY (not in my back yard) a prominent movement. The transferal of this attitude to urban setting is possible which would create a significant barrier.

The impact that small scale renewable systems in urban environments could have in the movement towards future cities is huge. The technical and economic issues that are present must be considered and deliberated prior to the installation of any of these systems. Interestingly the social implications of this development present many more opportunities for positive consequences. These social considerations will be a heavily decisive factor in the deployment of renewable energy systems in the urban environment.

3.1.3 Building Performance

An important development in the progression to future cities is addressing the buildings within the city. Ensuring buildings are energy efficient is something that could greatly reduce the demand for energy in a city and improve living standards for citizens. Retrofit and upgrades to existing structures is essential and mindful construction in emerging projects can guarantee that energy used for lighting, heating, cooling and appliances is not wasted and that the buildings operate in a comfortable range for the individuals using them.

The UK governments' climate change mitigation strategy includes the introduction of zero carbon targets for new homes. Energy efficiency standards such as Passivhaus are

being introduced to address this issue in buildings across the city. Passivhaus creates energy efficient homes which reduce heating demand by optimising solar gain and reducing thermal transmission loss (Sameni et al, 2015). This movement not only applies to new build homes, but to existing dwellings. In 2008, it was reported that dwellings in the UK accounted for 27% of all UK CO_2 emissions, and with 75-85% of these dwellings forecast to still be in use in 2050, the energy efficiency in existing dwellings in the UK must be addressed (Dowson et al, 2012). Retrofit measures taken in the UK include wall insulation, loft insulation, double glazing windows, hot water tank insulation, draught proofing, introducing new boiler systems, better heating controls and energy efficient lightbulbs. The implementation of these measures will improve the energy efficiency of the dwelling by reducing thermal losses therefore minimising the required heating load. Also, by using energy efficient lightbulbs and appliances, the energy consumption of the dwelling will be reduced significantly.

However, the application of these measures poses some questions. Some buildings may not be applicable for retrofit due to the structure such as large stone walls (Dowson et al, 2012), or due to protection such as with listed buildings. The large range of dwelling types within the UK means each building must be individually assessed and analysed to ensure that the correct retrofit is taking place. However, the process of retrofitting is not the only issue, but also the results of the retrofit. Often poor installation or a retrofit that does not fit the dwelling result in overheating or poor comfort levels for the occupant.

The cost of the upgrade can be significant and, in some cases if the building is already at a relatively high energy rating, retrofitting may not be cost effective when considering the improvement from the buildings current state (Dowson et al, 2012).

The inconvenience of the upgrades on dwelling can be off-putting to residents. However, as the results are aimed at improving overall dwelling standards, there is positive incentive for citizens. As the outcomes are occasionally not as expected, comfort vectors in the dwelling could be unacceptable, resulting in further work to fix the issues, costing more money and more inconvenience.

Including building performance progression in future cities is essential to not only improve energy efficient and reduce CO_2 emissions, but to improve the life of the citizens within the city. Strong consideration must be made into the quality and precision of installation across a range of dwelling to ensure that the building performs at the highest level but are also comfortable for the residents. This is applicable across retrofitting and new construction.

3.1.4 Demand Management with Smart Energy Networks

The implementation of demand side management in future cities is a development which could significantly improve energy usage and ease the technical impacts of the introduction of other developments. In order to implement demand side management, the introduction of smart energy technology is required to manage the energy network. Therefore, these two progressions will be discussed in conjunction.

Smart technology is an extremely important aspect of a future city. ICT systems are being used in a new way within the city environment, to provide real time cross thematic data collection, processing and sharing to ensure the highest operation efficiency in the city (Khan et al, 2013). Smart technologies are not only being used within the energy sector, but throughout all aspects of a smart city, including mobility and economy. Key to a smart transformation of the energy network is the smart grid. Introducing distributed control and monitoring systems alongside the existing grid, will enable an intelligent system with full visibility and control for utilities companies (Farhangi, 2010). For the public this means introduction of smart meters into homes to monitor energy usage and collect data which is already occurring today.

The use of smart meters in buildings throughout the city imposes issues which should be considered. The deployment and maintenance of the smart meters in homes, is not only a massive operation, but one which will require significant funds. Collecting and transmitting the energy consumption data and storing this data is tedious and must occur continuously and in real time (Depuru et al, 2011). For the overall smart energy network and grid, introducing the smart technology to the current network will again require funds, time and support.

A great apprehension with smart meters and smart networks is privacy and security due to the collection, monitoring and sharing of data and information. There are concerns that data may highlight the presence of individuals in the residence or business, therefore opening the dwelling to the possibility of crime. The collection of data by disagreeable sources for use in ways which may not be in the consumers' best interest could lead to further issues (Depuru et al, 2011). Therefore, protecting the users' confidentiality is essential resulting in anonymity and data protection solutions being at the forefront of emerging smart technology (Malina et al, 2015)

Through smart technology, demand side management includes controlling the time and type of electricity demand occurring throughout the country in order to match this to the available supply. Therefore, if sufficient supply is not available at a specific time, or the demand is too high to be met, then the demand will be decreased through management of usage. Demand side management has several categories which impact the demand differently in terms of permanence of the change and impact on the demand. Figure 3 below taken from (Palensky and Dietrich, 2011) outlines these categories.

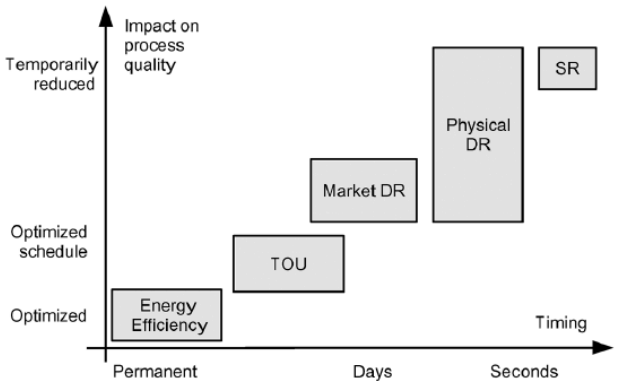


Figure 3: Categories of Demand Side Management

Energy efficiency has the optimal impact on the demand, as ensuring equipment and appliances are efficient, or ensuring buildings are not wasting energy, confirms that immediate and permanent changes to the required electricity demand occur. Part of tackling energy efficiency is encompassed in improving the standards of buildings through building upgrades. Time of use tariffs and penalties encourage users to not utilise excessive energy during times of high demand, therefore reducing peaks in the demand profile. For example, expensive tariffs may be in place after 5pm as this is

typically when demand peaks in the UK. Therefore, this discourages people from adding extra loads to the network such as electric vehicles as this will cost more than charging later than evening or in the morning. Demand Response is split into two sub-categories; market and physical. Market DR incorporates real-time pricing and incentives which will change to reflect the energy market, i.e. in times of high generation, prices will be low. Physical DR addresses instances where there is malfunction in the grid with requests for demand management. Finally Spinning Reserve is the quick end of the DSM spectrum (Palensky and Dietrich, 2011). These five factors allow better management of energy demand and therefore provide a more sustainable approach to energy consumption, not only within the city, but throughout the entire country.

Technically and economically the issues and constraints for demand management are associated with those related to smart metering and smart networks outlined above. Ensuring the technology is available to impose all categories of demand side management is crucial. The largest effect of demand management is the social impacts. Imposing demand side management could have significant economic impact for individuals as well as posing an inconvenience. It removes the free will of individuals to use energy when they require without penalty and is likely to come with opposition.

Demand management and smart energy networks help to address issues brought up by other sustainable developments. As previously mentioned a significant consideration throughout sustainable developments, is the impact on the supply demand balance and the impact on the grid and whether it will require upgrade to accommodate these changes. Although smart grids would incorporate grid upgrades, by introducing a smart grid and demand management, the requirement for massive amounts of extra capacity is reduced. Therefore, using these systems in the progression to a future city or smart city, is imperative to mitigate impacts and costs of the introduction of plug-in vehicles, renewable energy systems and building upgrades, and to connect with other smart systems in the city. However, the social impacts along with further technical and economic issues of smart grid and demand management themselves cannot be overlooked.

3.2 Matrix

A matrix has been produced which presents the finding of the three constraints with regards to the development types. To develop an understanding of the social constraints that could impact these developments, the possibility of occurrence in the near future is assessed. A development which could occur soon will have the most significant impact on the public today and therefore more relevant for a social study, and so imposing a time constraint on the developments. This matrix allows easy identification of the progressions within a future city that most urgently require the consideration of the citizens within the city. It will also provide a way to easily focus within the categories to a specific change in each development. It is these developments that will be researched further in this study to provide an insight into the citizen acceptability.

Development	Criteria		
	Technical	Economic	Social
Low and Zero Emission Vehicles	• Electricity demand - Supply demand balance - Demand profile • Grid upgrades • Charging points - Space - Cabling	• Cost of technical • Fuel tax	• Parking space availability • Accessibility to domestically charge • Personal cost - Running car - Buying car
Local Renewables	• Feedback of surplus to grid • PV panels - Location - Shading - Glare • Wind Turbines - Sizing - Location	• Feed in tariffs • Purchase and installation • Purchase of land	• Land use • Who actually benefits • Personal cost - Private systems • Inconvenience of building works • NIMBY
Building Retrofit and Upgrades	• Applicability of retrofit • Correct options applied • Outcome of retrofit	• Cost of upgrade	• Inconvenience of upgrade • If poor upgrade applied, then poor comfort
Smart Energy Networks, DSM	• Introducing smart technology to the current network • Smart meters in every home	• Cost of installation of new technology	• Security and privacy • Personal cost of TOU • Removes human will

Table 1: Matrix of Developments

3.3 Summary

To meet goals set by councils, governments and the European Commission regarding energy and the environment, four specific developments were identified. These developments provide extensive benefits to not only the urban environment, the countries as a whole. However, within these developments there are several technical, economic and social considerations, constraints and barriers which must be addressed.

The technical and economic barriers are often viewed as ones which must be overcome in order to reach these goals, through innovation in technology and better funding. However, the social issues are of equal importance. As emphasised in the EIP on smart cities and communities, citizens are insufficiently engaged or understood in cities (European Commission, EIPSCC, 2013). Therefore, if the technical and economic issues are addressed then these developments will have the potential to progress. However, this would be neglecting the citizen focus priority. Incorporation of the social implication into considerations of these developments are absolutely vital in understanding of individual opinions of these developments essential. Only through this will the priority be satiated.

Therefore, further study into social considerations is necessary and advancement regarding how to incorporate the opinions of the public into the progression to future cities is required. Through now understanding the development types and the technical and economic barriers, this study can be achieved.

4 Social Study

To determine the impact, opinion and acceptability of the public, a survey-based study was conducted. This allowed an expansion on the social issues that could occur due to developments. The areas of study identified were considered, and interviews and questionnaires carried out to determine the public opinion of these developments in the progression towards a future city. The social impacts on the people within the cities for the chosen developments could potentially be huge. There are several social issues which could arise dependent on the lifestyle, background and location of different individuals. People of different demographic backgrounds who live in different areas, with different occupations could be impacted significantly and completely differently to another individual. This study addresses the opportunity to effectively understand the opinions, concerns acceptability and willingness of citizens to incorporate the development into the urban environment as set out by the European Innovation Partnership on smart cities and communities (European Commission, EIPSCC, 2013).

4.1 Identification of Study Area

Following the investigation throughout the previous chapter, it is decided that the developments to take into further social study will be vehicles and local renewables. These developments were chosen as they are two developments already occurring with significant momentum today. Although there are technical and economic barriers for both, they have already begun progressing and therefore are already a key advancement towards future cities which a large volume of people may have knowledge or opinions on.

There are already massive policy progressions to ensure that the movement towards plug-in vehicles occurs. Therefore, this development is inevitable despite the various barriers. It is gaining momentum with individuals purchasing these vehicles and as a result the implications are presently arising. If the social implications are to occur, their consideration in developments is essential and therefore urgently requires investigation.

As with vehicles, policy supporting the installation of renewable energy systems in cities is already in place and therefore consideration of the social implications is required. Although there are several technologies, for some, their applicability in a wide range of urban environments is unsure. The technology that seems to be at the forefront of both private and public developments is solar PV and therefore it will be the main consideration in this study with regards to small scale renewables. An interesting aspect of this development is that there is the opportunity for direct benefit to communities and individuals as a result. Therefore, this invites an interesting dimension for social study.

Although there are social impacts with both demand side management and building performance, they were not chosen for this study. Demand side management, although extremely important for the progression to future cities, is not a concept many people would be familiar with out with the installation of smart meters in homes. For building performance upgrades, the social impacts are not as substantial as with the other developments. Even though the social impacts should still be considered in these developments and the opinions of the citizens in the city should be considered, for the purpose of this study, the issues are not as pressing and therefore will not be included.

The two chosen developments; vehicles and local renewables, will be investigated in more depth, identifying the impact these developments in the future city could have on residents. A specific area of each development type that would be incorporated into city planning for future cities was identified. This provided a basis for outlining how important citizen acceptability is in the progression to a future city and for suggesting how to incorporate this into city planning.

4.1.1 Public Charging Infrastructure

The continued propagation of electric and hybrid-electric vehicles into the UK automotive market poses some social consideration and has several impacts that could occur. The need for public charging infrastructure could significantly increase due to the unavailability for

some people to domestically charge. The demand for public charging points to satisfy not only the needs of people who are unable to domestically charge, but also to provide charge points for when driving significant distances, or recharging away from home, will significantly increase. Consequently, within the progression to a future city, installation of public charging points will be prevalent throughout the urban area. A study to determine the public opinion of the installation of this infrastructure is important to ensure the urban environment has a citizen focus. This information could then be incorporated into decision making when planning an installation.

This study assesses how the candidate would accept the installation of charging points near their residence. It measures whether they would accept this development and delve into the reasons for this response. The issues surrounding ability to domestically charge and reliance on public charging was addressed. The frequency of the proposed idea of charging poverty where people without the ability to install a private charging point will be at a practical and financial disadvantage was investigated. It also evaluates the impact that this development could have on the community.

4.1.2 PV

The benefits that local renewables could bring to the urban environment are significant. However, the impact of installing these systems throughout the city should be considered before installation. For the purpose of this study, within local renewables, the focus will be on solar PV which is not installed in buildings, i.e. is installed by companies, councils or governments with the purpose of feeding back to the national grid. This is because, as previously mentioned, PV is the most prominent small-scale renewable system in urban environments, with plans for this specific development already in progress in Glasgow. As installation of private systems, in homes or businesses, are done at the choice of the occupant, the need for a study into this is less pressing. The installation of local PV plants poses interesting social considerations. As these developments could occupy large portions of land throughout the city, they will require city planning, providing an opportunity for

assessing how citizen acceptability could be incorporated into the decision making for these processes.

This study aims to understand if the member of the public would accept the opportunity to utilise vacant land for energy harvesting in the form of a PV array. As with public charging points it assesses their acceptance, their reasoning and any modifications to the development that would change their reception. An interesting factor with this is the consideration of land use, as with this development, a portion of land in the community will need to be utilised.

4.2 Methodology

For this social study, two forms of data collection were used; questionnaire and interview. The questionnaire consists of structured questions to assess acceptability and the reasons behind the opinions. This method serves the purpose of reaching many people to obtain a quantitative response suitable for analysis. The interviews allowed the questions to be altered based on the responses and reactions of the interviewee. This created a better assessment and understanding into the acceptability and reasons for their response. Through this method, only a small number of responses were possible due to time constraints. Therefore, by using both methods together, a large number of reliable quantitative results and interesting qualitative responses were received.

4.2.1 Questionnaire

Design Format

The questionnaire was designed to provide results that are able to be quantified for statistical analysis. The questionnaire begins with a statement of rationale, explaining the reasoning and context behind the survey. The general demographic information gathered was postcode, occupation and age. This will allow analysis of the responses based on these parameters and determination if these factors affect acceptability of the developments.

The questions aimed to assess the individual's opinion and acceptance of specific study areas regarding the two selected developments. These focus areas, which are discussed more below, allowed the questions to be structured around the retrieval of relevant information.

The questions follow a closed format to ensure ease of completion for the individual, and limit the time required to complete the questionnaire. Questions are based on a yes/no structure or rating system which addresses the necessary data collection and is best to allow non-parametric statistical analysis (Boynton and Greenhalgh, 2004). For the rating questions, respondents were asked to rate their acceptability from 1-5 with 1=strongly oppose, 2= oppose, 3= no opinion, 4=accept, 5= accept and encourage. In order to overcome any semantic differences, additional information was provided when required to aid understanding. The acceptance of the development was reassessed multiple times throughout both questionnaires to determine if any topics broached changed the acceptability. Finally, an open-ended question provided an area for further comments to give space to voice concerns or reasoning to previous answers. Also, although the questions were closed format, additional space in each question was available for justification of response or additional information should the respondent choose to do so. The full format of the questionnaires is available in Appendix 1.

Charging Point Questions

Initially it was established if the candidate owns or would ever consider purchasing an electric of plug in vehicle. Through understanding this it should indicate their general standpoint on this sustainability movement. Following this, three focus areas were identified for questions to be posed; acceptability of the development, consideration of ability to domestically charge, concerns of conflicts within the community. Through determining the ability of each individual to domestically charge, the impact that this has on the acceptability of the development can be assessed. This is important to determine as it is possible that individuals with the ability to domestically park their vehicle may not see the need for on street parking, but also may not see the issues that could arise if some spaces

were reserved wholly for plug in vehicles. Through this, an investigation into how widespread charging poverty could be, was conducted. By then using the postcode, it can be determined if this charging poverty is more prevalent in areas already in poverty, and therefore if the cost to publicly charge would exacerbate the existing poverty. A suggested one charge point per three residences is used to generally determine social issues regarding effective use of the charging points. This would result in 8 hours of use per day per residence. Fast charging currently takes 5 hours to fully charge so this would allow each residence to nearly fully charge two vehicles per day. However, through this question, it can be determined if people believe this would cause issues with neighbours and other residences therefore impacting the community.

Do you have, or would you consider purchasing a vehicle which required charging such as an electric vehicle or a plug-in hybrid?
Rate your acceptability of the installation of public charging points in your residential street? 5= strongly accept and encourage, 4= Accept, 3= No opinion, 2= Oppose, 1= Strongly Oppose
Do you have an area to privately park a vehicle, i.e. a driveway or garage?
If so, you may have the capability to install a private charge point. Would this affect your opinion of the installation of public points?
A vehicle typically takes 5 hours to fully charge. If there was 1 charge point per 3 residences, do you see this development causing any conflict in the community such as argument over occupying the space when not required or vehicles that do not require charging using the space?
Considering this, does your acceptability of the development in your residential street change? If so, please rate from 1-5.
Any other comments. Please use this section to outline any concerns or thoughts you have which have not been considered in this survey.

PV Questions

For the purpose of this questionnaire the individual is encouraged to think of an area of land near their residence. They are then asked their acceptability of this land being used for energy harvesting through PV panels. Initially land use is investigated. Both current land use, and potential future use is posed. Firstly, it is determined if the land is used for anything currently, then it is posed that the development could incorporate both the PV and these activities. Through asking these questions, possible reasons for being against this development were determined. The ACE hydro scheme where profits were fed back into the community showed high levels of public acceptability, therefore this idea was incorporated into the study to determine if people showed a higher acceptability of the development when a direct benefit to the local people could be seen.

Rate your acceptability of the installation of a PV plant in order to harvest solar power for electricity on a section of derelict land near your residence? 5= Strongly accept and encourage, 4= Accept, 3= No opinion, 2= Oppose, 1= Strongly Oppose
Is the section of derelict land used for anything else, for example recreational use such as sports and games or dog-walking? If so, does this affect your acceptability of the development?
If the development could be altered to incorporate these uses, would your acceptability change? If so, please rate from 1-5.
Do you think the land could be used for a more beneficial development for the community?
If the electricity produced was sold and the money fed back into your community, would your acceptability change? If so, please rate from 1-5.
Any further comments. Please use this section to outline any concerns or thoughts you have which have not been considered in this survey.

4.2.2 Interview

Design Format

A semi structured interview approach was used in order to ensure the required information was received, but also to allow the interviewee to introduce further information. The questions asked were based on the same structure as in the two questionnaires therefore addressing the same study areas and providing results able to be quantified in the non-parametric analysis. In order to obtain this required information, some concrete structured questions were posed. However, alterations and deviations from the questionnaire structure were taken through additional open-ended questions, depending on the circumstances of the interviewee and how the interview was proceeding. Therefore, in contrast to the questionnaire and the concrete questions, there is no fixed response for these questions, somewhat allowing the interviewee to determine the progression of the interview (Ayers, 2008). The open-ended question provided qualitative information for analysis beside the statistical examination. In order to analyse this data, qualitative analysis techniques were undertaken, commencing with familiarisation of the data, followed by identification of a thematic framework and classification of the relevant information into the study and focus areas previously identified (Pope et al, 2000). This classification then allowed comparison of the issues and concerns between the interviews and questionnaires. Transcripts of all interviews are available in Appendix 2.

4.3 Results

4.3.1 Statistical Relevance

In total, 20 completed charging point questionnaires and 19 completed PV questionnaires were returned for analysis and four interviews were conducted. Therefore, the sample size of this study was relatively small due to time and resource constraints and so the results are not indicative of the population.

This study only considers two developments, it does not represent a conclusive overall acceptance of sustainable developments in future cities. Specifically, the results only apply

to only Glasgow and the surrounding areas, and therefore variance may be present in different cities. The group of individuals comprised of mainly individuals within the 20-30 age range. This could severely impact the outcome if age is a determining factor in acceptance of sustainability.

Although the results of this study are not a conclusive result of acceptance of sustainable developments in future cities, it represents a small number of individuals with the methodology and analysis approach transferrable to a larger study. It also allows a basis for discussion of the social consideration applicable to these developments, thus highlighting the need for the incorporation of these social consideration into planning of developments.

4.3.2 Questionnaire

The results of the questionnaires and of the basic questions in interviews were analysed and are presented below. A full table of all questionnaire responses are available in Appendix 3. As the questionnaires, and interviews to an extent, were structured, answers to the key areas of investigation were retrieved and are presented. The categorisation of acceptance into the five categories and the Yes/No system facilitated the retrieval of responses able to be quantified and analysed for presentation as statistics. Any additional comments provided by the individuals are outlined for later discussion in the analysis.

Charging Points

The main areas for investigation within the charging point study were the acceptability of plug-in vehicles, the acceptability of the installation of charging points in a residential street, domestic charging ability including an investigation into how this is affected by location and finally an investigation into possible conflict that could occur due to the development. The results of the research into these areas are outlined throughout this section.

The majority of individuals would consider purchasing a vehicle which required charging, with only 25% responding that they would not, as shown in Figure 4. This indicates a general positive attitude towards the progression of electric and plug-in hybrids. As this positive attitude is present, it may suggest that the benefits of possessing these vehicles are becoming widely known and indicate that people are not initially aware of the challenges that may occur. Some individuals provided reasoning for deciding that they would not consider purchasing an electric vehicle such as; concerns over whether they really are environmentally friendly and the initial cost to purchase the vehicle. Reasoning was also provided for the positive response including a belief that these vehicles are environmentally friendly and the possibility that the running cost of the vehicle could be less than a conventional petrol or diesel engine.

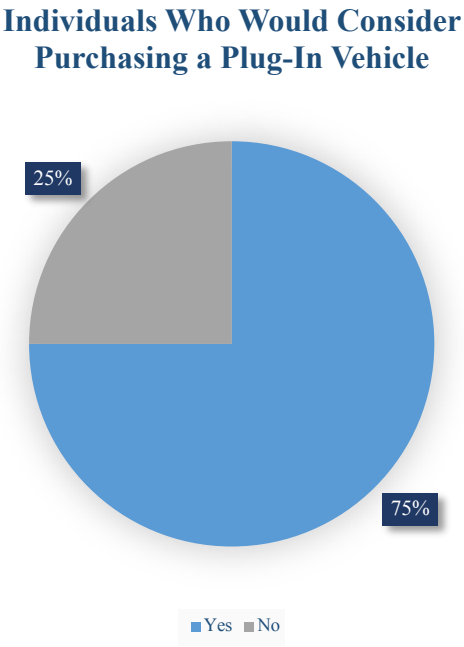


Figure 4: Percentage of individuals who own or would consider purchasing a plug-in vehicle

The installation of charging points in a residential street received a mainly positive response. In order to allow statistical analysis, the responses were categorised into the five levels of acceptance. The results of these responses are indicated in Figure 5. These responses were then further categorised in to three ratings; Don't Accept (responses of

opposition), Neutral (response of no opinion), Accept (responses of acceptance). The results of this categorisation with regards to acceptance of development are shown in Figure 6. It is apparent that predominantly there is acceptance with only 12% of people stating that they would not accept this development. Their reasoning for this was investigated in the subsequent questions of the study, although it is interesting to note that the entirety of the 12% previously stated that they would not purchase an electric vehicle.

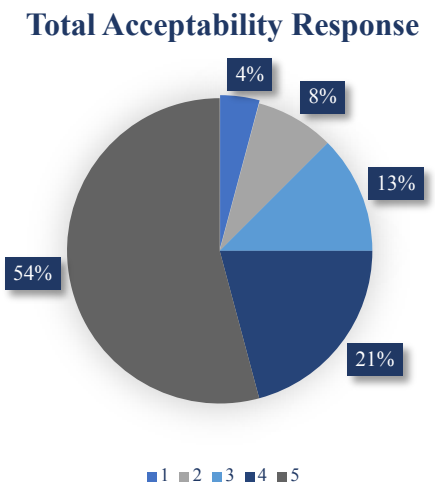


Figure 5: Acceptability response of charging point development.

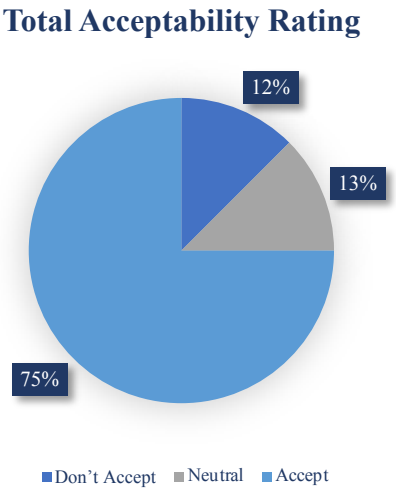


Figure 6: Acceptability rating of charging point development.

An investigation to determine if there is a correlation between acceptability of this development and age of the individual was conducted. The Acceptability Response and Acceptability Rating was used and displayed in Figure 7 and 8 respectively.

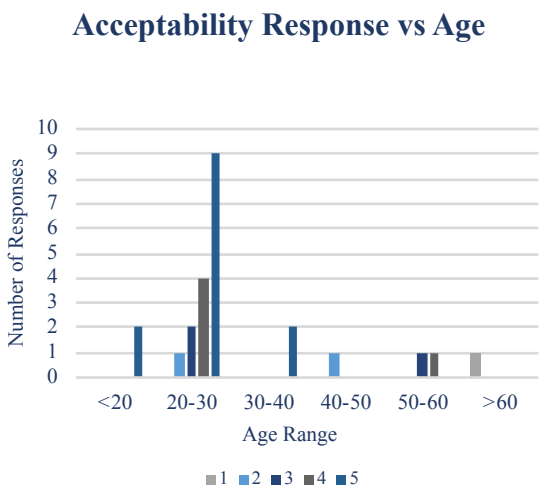


Figure 7: Acceptability response of development with age.

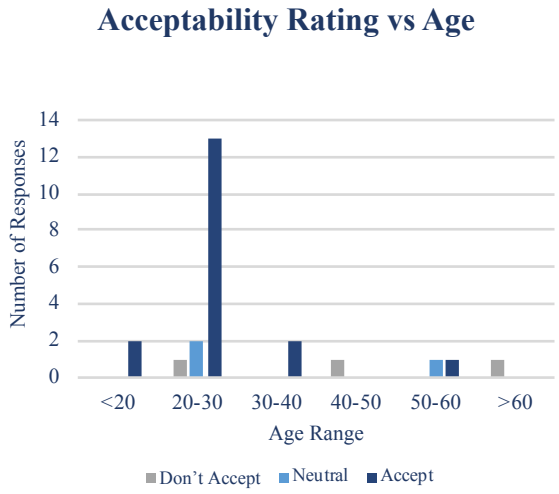


Figure 8: Acceptability rating of development with age.

These graphs clearly indicate that there is little correlation between the age of an individual and their response. There is no clear association that would suggest that the age range is a deciding factor in how an individual would accept this development as acceptance, opposition and neutral response is present throughout the younger and older individuals.

The ability to domestically charge your vehicle was previously identified as an issue which may affect an individual's acceptability of the development and therefore this issue was examined. The percentage of the study group who have the ability to domestically charge their vehicle was determined based on current ability to privately park vehicles as if an individual has this capability, they have the potential to install a domestic charge point. The results of this insight are shown in Figure 9.

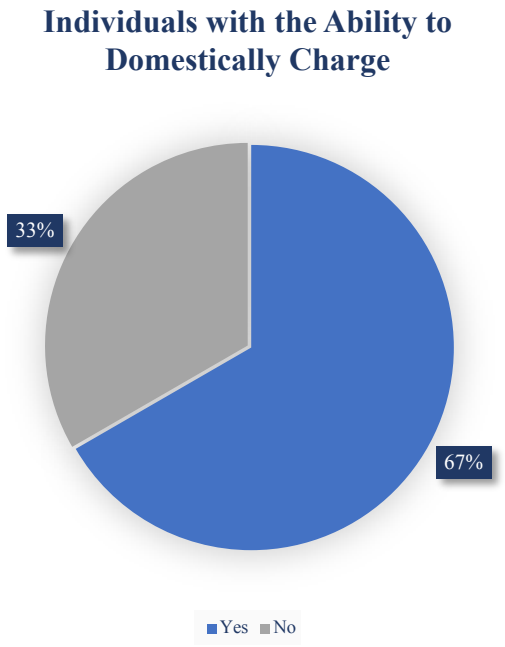


Figure 9: Percentage of individuals with the ability to domestically charge a plug-in vehicle.

67% of individuals do have the ability to domestically charge, however 33% do not and therefore would have to rely on public charging points such as the ones proposed in this development. It was then determined if this ability, or absence of ability affected the individual's acceptability of the development, shown in Figure 10. Overall 67% of the study group say that this factor does not affect their acceptability of the development.

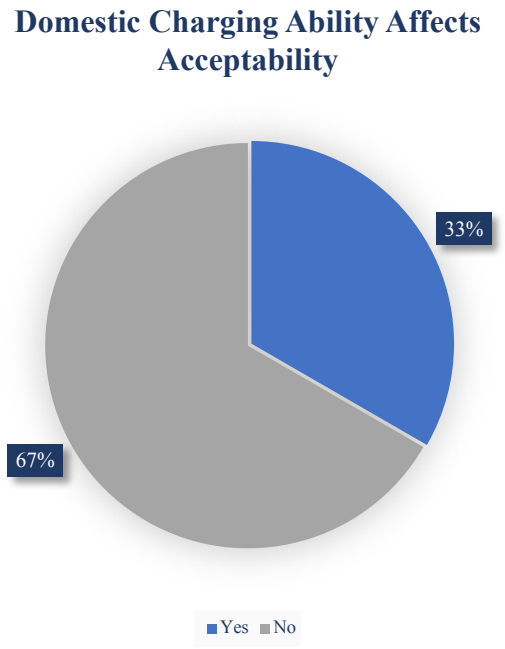


Figure 10: Percentage of individuals who respond that the ability, or lack of ability, to domestically charge would affect their acceptability.

To better understand how the ability to domestically charge affects an individual opinion, the group was separated into groups, those who can domestically charge and those who cannot. The responses for these two groups are shown in Figures 11 and 12. There is a higher acceptability for the development with people who do not have the ability to domestically charge which would be expected as they would have to rely on the development. However, both groups present the same percentage of individuals who oppose the development. The discontinuity comes from individuals who do have the ability to domestically charge, having 19% with a neutral response. Therefore, it appears that individuals who do have an area to privately park their vehicle are not as opinionated as

individuals who don't. Both groups present the same percentage of opposition response, which could be accounted to reasons such as concerns over exacerbating existing parking issues, a reason for opposition given by some individuals in the study. This would impact all residents, not only those without domestic charging ability as on street parking may be necessary for visitors or homes with more than one vehicle. All negative responses to the development were from individuals who responded that they would not consider purchasing a plug-in vehicle. Therefore, this initial negative outlook to the plug-in vehicle movement could account for continued opposition regarding the development.

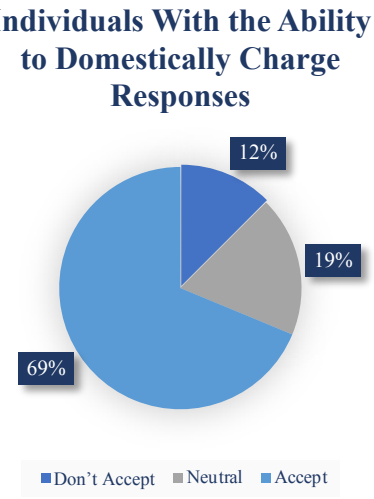


Figure 11: Individuals with the ability to domestically charge acceptability of development responses

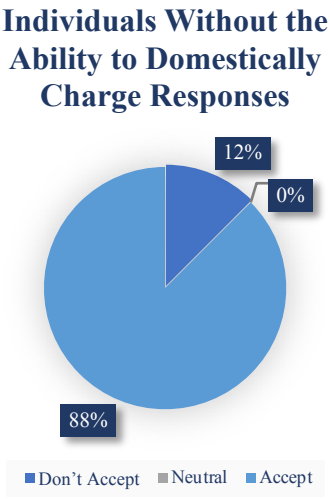


Figure 12: Individuals without the ability to domestically charge, acceptability of development responses

An interesting concern with this development is the idea of charging poverty which considers the location of residence of individuals with regards to domestic charging ability. People who do not have the ability to domestically charge would have to rely of public charging points which could be more expensive to charge the vehicle. Therefore, people who cannot domestically charge are at a financial disadvantage, leading to the idea of charging poverty. As shown in Figure 10, 33% of individuals in this study could be subject to charging poverty as they do not have the ability to domestically charge. In order to determine if this charging poverty could exacerbate existing hardship, the Scottish Index

of Multiple Depravity (SIMD) was consulted. This database considers areas in Glasgow and rates them from 1-10, with one being most deprived and 10 being least deprived, based on several factors such as income, health, employment, education and housing. The map of the Glasgow area of this database is shown in Figure 13, with dark red indicating area of most deprivation, and dark blue indicating areas of least deprivation.

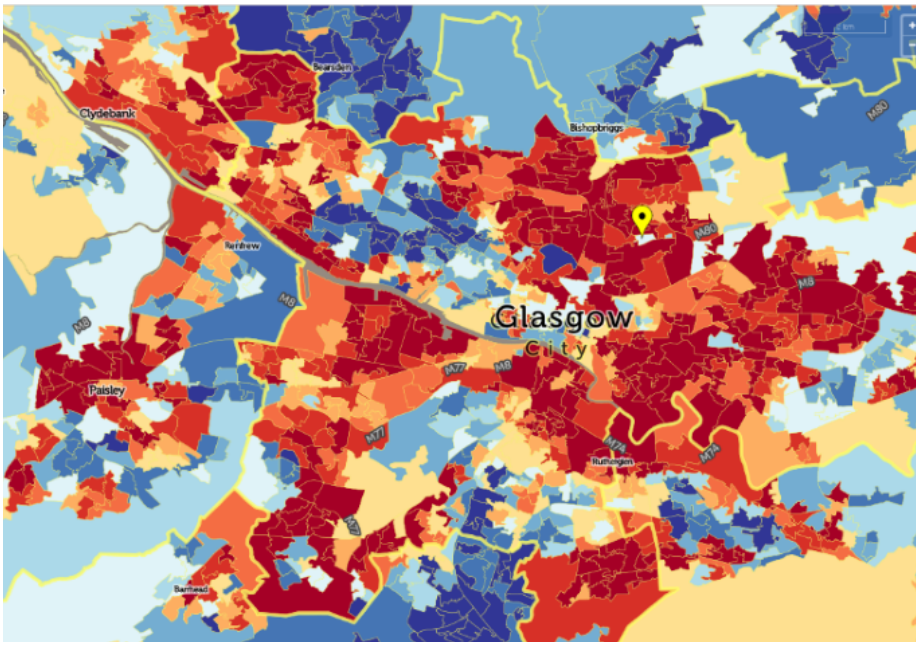


Figure 13: SIMD reference map for Glasgow (Scottish Government, 2018)

Through using this map and the postcodes provided by individuals in the questionnaires, the number of individuals who cannot domestically charge who live in areas classed as deprived was determined. The results of this are shown in Figure 14.

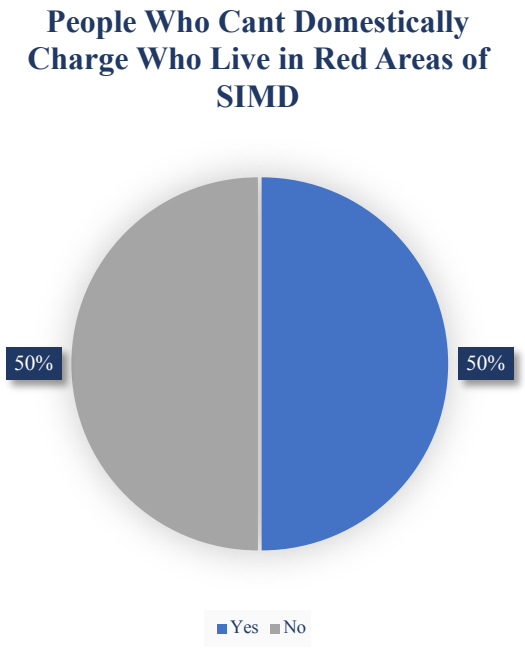


Figure 14: Individuals who cannot domestically charge, percentage analysis regarding postcode and deprivation

Half of the individuals who do not have the ability to domestically charge live in areas which are classes as deprived. This equates to 16% of the study group who could experience exacerbated poverty through introducing charging poverty to their lives.

A further consideration with this type of development, and an issue which merited investigation in this social study, is the possibility of conflict between neighbours regarding the effective and fair use of the charging points. The results of this consideration are displayed in Figure 15.

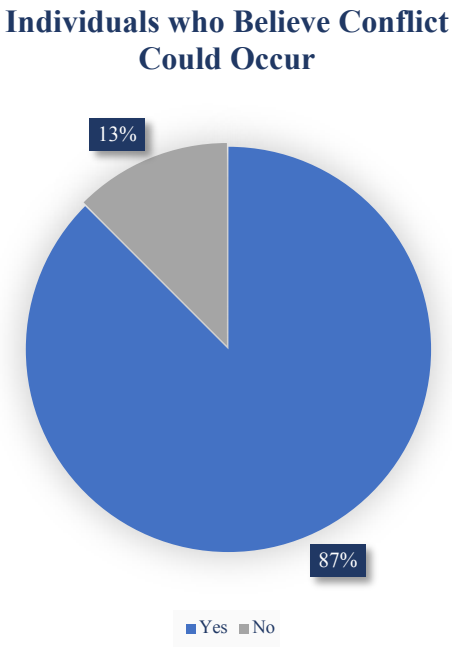


Figure 15: Percentage of individuals who believe that conflict could occur due to the development.

A large majority of individuals believe that conflict could occur due to this development. In order to determine if this would be a concern that would affect their acceptability of the development, their acceptability change was determined.

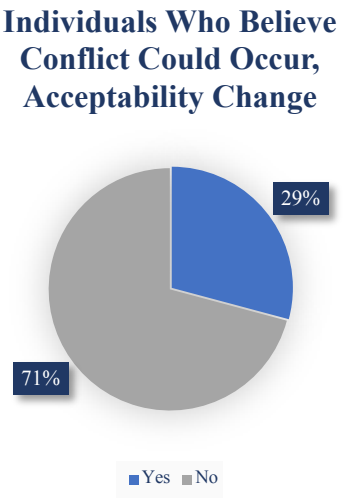


Figure 16: Individuals who believe conflict could occur, determination of acceptability change

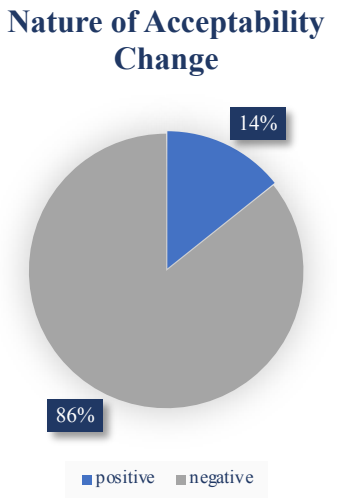


Figure 17: Individuals whose acceptance is affected by conflict possibility, nature of change

As can be seen in Figure 16, although the majority of individuals believe conflict could occur, only 29% of those people believe that this would change their acceptability. Therefore, although conflict could occur, it does not change most people's acceptance of the development. Of the individuals who said that conflict would alter their acceptability of the development, 86% said that their response becomes more negative due to this consideration, shown in Figure 17. This is expected as possible conflict could cause tension between neighbours and affect any sense of community and therefore it would be predictable that people would be less likely to accept the development because of this possibility. However, there is small proportion who responded that they would be more accepting of the development considering the possibility of conflict. This could be due to an opportunity to develop community relationships as a way of avoiding conflict. Better communication and understanding between neighbours could be a result of possible conflict as people make the effort to communicate effectively and understand each other in order to avoid disagreement.

Out with the structured interview questions, an area for additional comments was provided. These supplementary remarks are important to consider as may provide additional insight into concerns with the development. These are shown below;

- Currently there are issues with parking and this issue could be exacerbated by adding charging points.
- Concern over the installation of charging points when the demand for them is not present
- Could the cost of installation be transferred to them through the cost of the vehicle?

PV

The acceptability of the installation of PV on areas of derelict land was assessed and the results of the responses are displayed in Figure 18. As with in the charging point study, the responses were categorised into a rating system, which is displayed in Figure 19. There is a high acceptability for this development with no individuals stating that they would oppose the development.

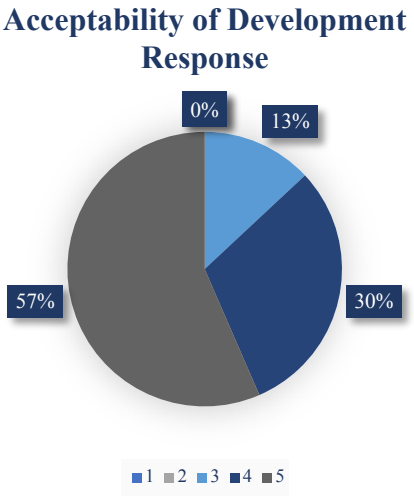


Figure 18: Acceptability responses of PV development

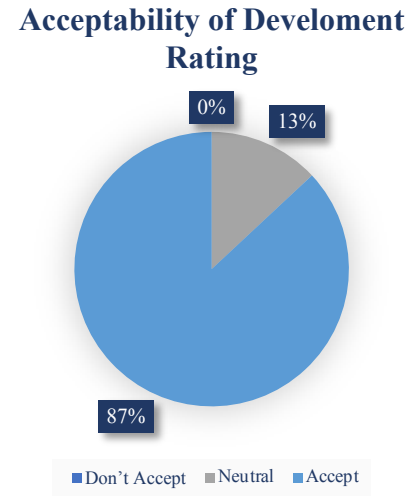


Figure 19: Acceptability rating of PV development

For further investigation, an age assessment regarding responses and rating was conducted and is displayed in Figures 20 and 21 respectively. It can be seen that the neutral responses were solely in the 20-30 age range, whereas all other ages were fully accepting. This could possibly indicate an age correlation for this particular development.

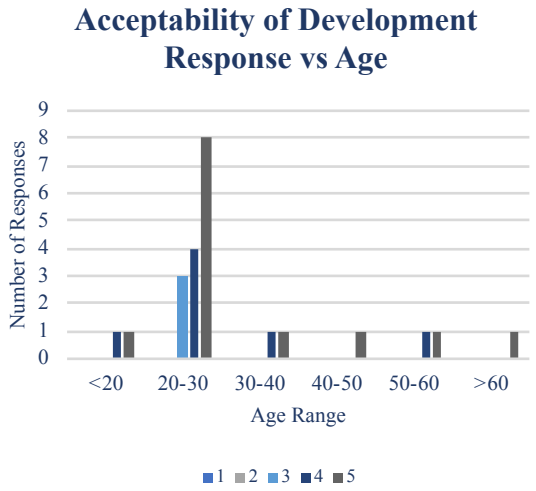


Figure 20: Acceptability Reponses of PV Development with Age

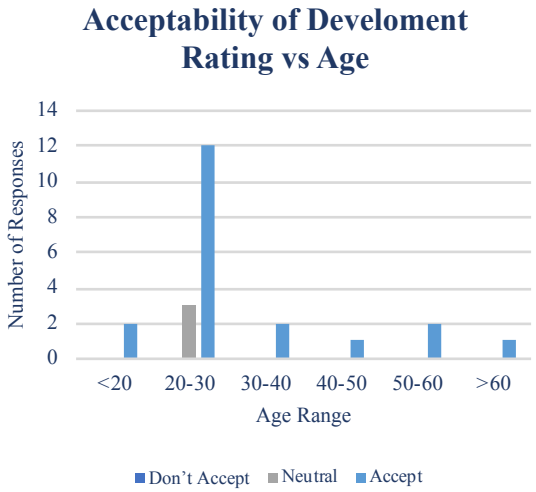


Figure 21: Acceptability Ratings of PV Development with Age

The main area of investigation for this development, as previously discussed, is land use. Initially it must be determined if the area of land, although derelict, was used for any recreational activities such as dog-walking. As shown in Figure 22, the division of responses is close to equal. Perhaps more importantly, it was investigated whether this affects the individual's acceptability of the installation of PV panels on the land. Although 52% of people said the land was used for recreational activities, only 33% of these individuals responded that this affected their acceptance as shown in Figure 23. Therefore, the use of derelict land, even when used for recreation, would be mainly accepted.

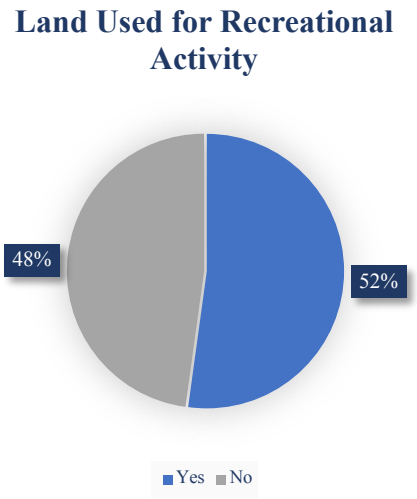


Figure 22: Percentage of individuals who respond that the area of derelict land they are considering is used for recreational activities.

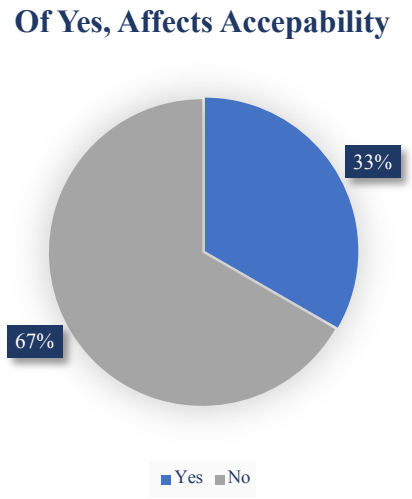


Figure 23: Individuals who respond that the land is used for recreational activities, percentage in which acceptability is affected.

It has been determined that any small-scale usage of the land would not affect acceptability of this specific development. However, it is important to determine if the land could be used for anything better than the PV panels, perhaps something that may initially be viewed as more beneficial to the community. This is important as although people may consider that the land should be used for a development, they may consider that there is something more beneficial that could be developed in the area. The results of this are shown in Figure 24.

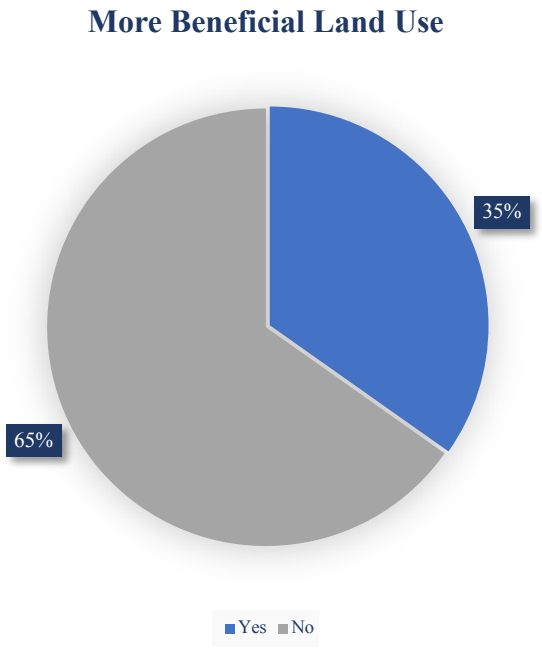


Figure 24: Percentage of individuals who believe there is a better use of the land than PV panels

65% of individuals believe that there would not be a more beneficial use for this land. Consequently, it can be seen that the majority of individuals believe that using areas of derelict land for PV panels is a useful and beneficial consumption of land.

The possibility that incorporation recreational uses into the development was examined to determine if this would help individuals accept the development more. The results of this are outlined in Figure 25.

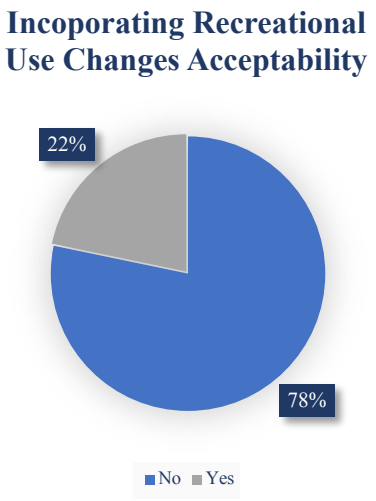


Figure 25: Percentage of individuals who respond that the incorporation of recreational uses in the development would change their acceptability.

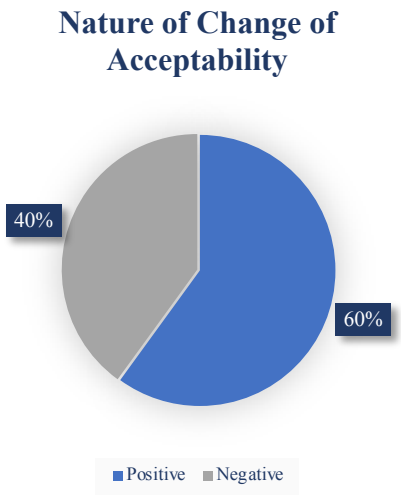


Figure 26: Individuals who respond that the incorporation of recreational uses in the development would change their acceptability, nature of change

It can be seen that this proposal does not affect the majority of people's opinions with only 22% of individuals indicating that their acceptability would change. The nature of the change is outlined in Figure 26, shown to be mainly a positive change. However, some individuals did respond that they would be less accepting of the development if recreational activities were included.

A reassessment of acceptability of the development was taken with the incorporation of recreational uses was conducted, and the results shown in Figure 27.

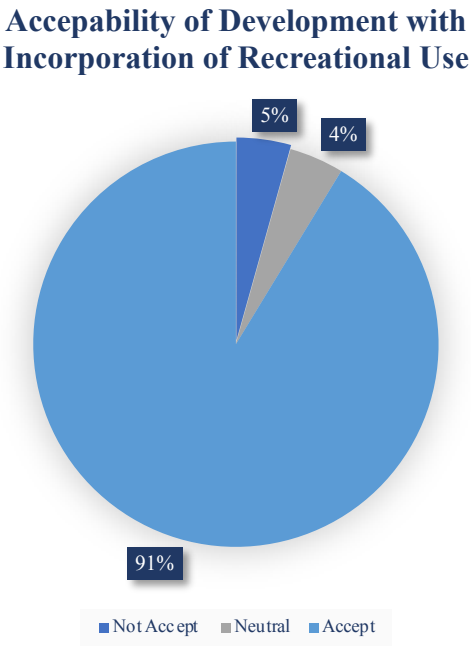


Figure 27: Acceptability response reassessment with the incorporation of recreational uses

Through comparison between Figure 27 and Figure 18, the acceptability increases with this consideration. However, there is now 5% of individuals who would not accept the development. Therefore, although the popular opinion is that the incorporation of recreational uses in the PV development would make them more accepting, for some this would make them oppose it. There is a reduction in the neutral responses suggesting individuals who initially had no opinion regarding the development, now either accept or oppose. Overall this consideration creates a more positive and accepting response to the development.

The concept of financial feedback is an area that was determined to merit consideration previously as it could potentially aid acceptability. Therefore, any change in acceptability and the nature of this change is assessed as shown in Figure 28 and 29 respectively.

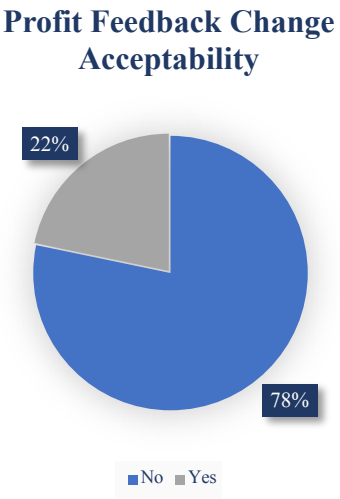


Figure 28: Percentage of Individuals who state that profit feedback would change their acceptability of the development

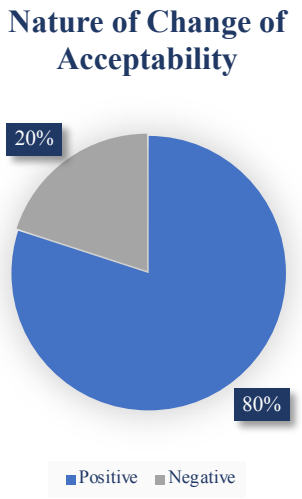


Figure 29: Individuals who respond that profit feedback would change their acceptability, nature of the change

As with the incorporation of recreational activity, only a small proportion of individuals indicate that their acceptability would change, and the majority of these individuals record a positive change. A reassessment of acceptability of the development was conducted and the results are shown below in Figure 30.

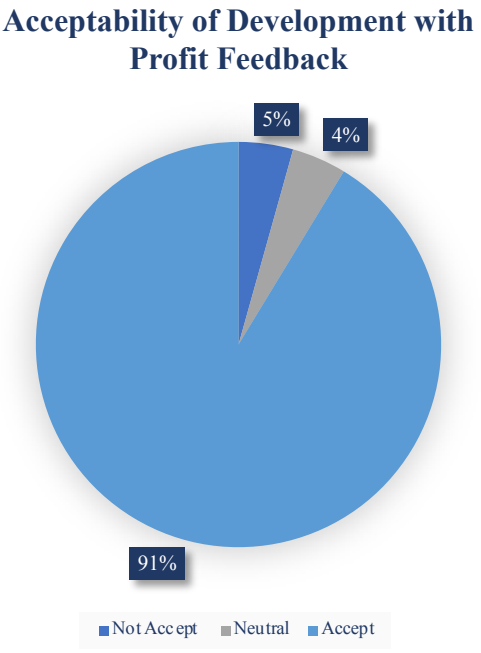


Figure 30: Acceptability reassessment rating of the development when considering profit feedback

This reassessment result in higher acceptability, but again a small opposition appears. When compared with Figure 27, both including recreational activity and profit feedback would have the same effect on acceptability of the development.

As with the charging point questionnaire, extra information was provided by the individuals and are outlined below:

- Unsure if PV panels are the most cost-effective technology to harness energy, especially in the Glasgow climate
- Lots of areas in Glasgow that the loss of derelict land not important and a lot of this land is not attractive so would help renovate it
- Financial feedback could help deprived areas
- Suggestion of the implementation of educational centre to raise awareness of renewables and aid in acceptability

4.3.3 Interviews

Throughout the interview process, the questions included in the questionnaire were posed to the interviewee. This semi-structure design provided a qualitative core to the interview outputs which were included in the questionnaire results section for inclusion in the statistical analysis. These statistical responses are also included in the results tables in Appendix 3. Due to the nature of the interviews, additional qualitative information was collected regarding the individuals' opinions concerns and suggestions. An overview of each interview is given below, the full transcripts of the interviews are available in Appendix 2.

Interview 1

This interview is with a delivery driver between the ages of 50-60 who lives in G21. The individual stated that they would not buy an electric vehicle as the reliability of the vehicles are not what they should be. However, if this was to improve in their opinion, they may possibly consider it in the future. The individual does have a driveway and therefore would be able to comfortably install a private charging point in their residence. They think that if someone purchases an electric vehicle, they should install a private point. After highlighting that a lot of people do not have this ability, they admit that their own ability affects how they would accept the installation of public points as they would not be required to use them. The conversation then moved to conflict due to use of these points which they immediately identified would be an issue mainly due to when people would have to charge and decisions of who has charging authority. The reliance on a good neighbour relationship, which they say is scarce nowadays, would not be good enough and decisions regarding who could use the point would revert to a first come first served basis. The individual then suggested that it may be a good idea to have designated charging point car park areas for people who cannot domestically charge. This may take away some of the conflict, but they believe that a management system would still be required and were concerned about who would control this. It is their opinion that the responsibility of managing and ensuring there are enough charging points should be down to the companies who install them as they are who is profiting from their use. However, they also highlight

that the government must have more input. There is a lot of significant issues that would come with bringing these vehicles, on a large scale, into the UK market, and if the government is introducing policies which encourage or required individuals to buy them, then they have a responsibility to ensure that they can operate them.

They highly accept the installation of PV panels on the area of derelict land, which has structural issues so is not currently used for anything recreational. Although the incorporation of new recreational uses would be a good thing, they would also accept the land just being closed off and used solely for the panels. However, the feedback of money into the community was definitely viewed more positively. They believe that this could be a major factor that would help acceptance of the development. They also believe that it is essential to ensure the community is involved in each step along the way to ensure that bad rumours do not spread. If the community is made fully aware of any impacts to themselves and the numerous benefits of the development, including profit feedback, then their acceptance will follow.

Interview 2

This interview is with a student, below the age of 20 who resides in G12. A positive reaction to the installation of charging points was evident along with a desire to buy an electric vehicle in the future. They did not think there would be an issue of conflict but that there would only be issues in the initial stages. As people got more used to their own and their neighbour's schedules, the issues would stop. Overall, they were not concerned that this installation could cause any problems.

As with charging points, a positive reaction was given to the installation of PV panels. However, they stated that in areas where other land for recreational use was available, the acceptability may be higher but in areas where this land is not close to other free land, people may be more opposed to using that land. They believed that age was definitely a determining factor, stating that the current generation is aware of the problems we face and so would be more accepting. The profit feedback was viewed very positively, and they

believed it would help people who were less concerned about the environmental impact to accept the development as they could see a direct benefit.

Interview 3

Interview 3 is with a retired individual, over the age of 60 who lives in G21. The individual explicitly stated that they would not consider purchasing a vehicle which required charging as they viewed themselves as too old for technology. They strongly opposed the development as they thought it would take up too much space in the street and would look messy. However, after underlining that a lot of people do not have the ability to privately park as they do, they admitted that if they did not have this ability then they would be more accepting. On the topic of conflict, they thought that issues would arise from organising a schedule for when and who could charge as this would be difficult. As one of their concerns was space in the street, the idea suggested by interviewee one, of a designated parking area for charging, was posed to them. They responded that although this would be a better idea, they would be concerned about parking their car far from their home. They likened the charging point development to communal drying areas in tenement flats, which they remember causing a lot of problems for them as people would hang washing to dry and leave it here for long periods, therefore preventing others from using the area. They said that they can imagine similar issues arising with charging points through people being selfish. Additionally, they added that they would not like the idea of people having to remove their car from charging during the night if their time slot was over and that vandalism of the points could be an issue.

With the PV development the response was much more positive as they believed it could help provide cheaper energy to people. Even if some areas are used for recreation, they still supported the development as they think there are enough parks and recreational spaces in the area that sections of derelict land would not be a loss. However, the incorporation of these uses with the panels would be a positive thing as with using the development for education, as long as it was safe. Returning to the idea of cheaper electricity, it would be positive if not only cheaper electricity for people struggling with fuel poverty was possible,

but also that it would be very encouraging to see these developments occurring as it would show people in fuel poverty that progress was being made to help them.

Interview 4

This interview is with a labourer, between the ages of 20-30 who lives in G22. If purchasing a vehicle which required charging was financially beneficial, then they would consider it. Although they are aware of the environmental benefits, it would not motivate them if it was not financially advantageous. They accept the development and account this to the fact that if they did have a vehicle that required charging, they would rely on public charging. When addressing the issue of conflict, they believe this could be a major issue as there is already problems with finding parking spaces on the street and have designated parking spaces could exacerbate the problem.

For PV panels, they accept the development and the incorporation of recreational uses or profit feedback, although they think it could be a positive aspect and would help acceptability throughout the community, it is not a major motivator for them as they are happy to accept the development without these factors.

4.4 Analysis

In this section, the results from the social study are analysed in order to understand the outcomes. Initially the acceptability of the two developments and possible reasoning for the results is addressed then specific areas of interest are investigated.

4.4.1 Acceptability of Sustainable Developments

Of the two developments addressed in this study, the installation of a small-scale PV farm on derelict land presents a higher acceptability than the installation of charging points in residential streets. However, both developments present high acceptance which contradicts the expected. Traditionally societal reaction to new technology is a negative one, with acceptance usually considerably low (Pasqualetti, 2011). A majority acceptance response was unexpected but has promising significations for the overall sustainability movement.

Investigation to determine if age is a decisive factor yielded mixed results and the age bias present in the study group significantly impacts the ability to assess this. For the charging points study, no correlation was seen and for PV, only a small suggestion that age could influence acceptance was detected. However, in Interview 2, there was a strong feeling that age was definitely an influencing factor, therefore warranting further consideration regarding whether age impacts the acceptability of sustainable developments. The Millennial generation is often regarded as being more environmentally conscious with their daily choices (Smith, 2014). This concept could translate to acceptability of sustainable developments, however much more research and investigation into this insight would be required. If this bias was concluded, it could account for the high acceptability levels in this study.

Although acceptance of both developments is high, there is a difference in the level of acceptance. Perhaps the main determining factor in this disparity of acceptance of the two developments is the larger sustainability movements in which the developments are

contained. The installation of PV panels can be viewed relatively independently as for the general public, there is little link to other progressions, so it may be easier to initially accept the development. However, charging points are part of a much larger sustainability movement, that of Low Emission Vehicles. Therefore, initial opposition to the progression of hybrid vehicles and electric vehicles could translate into opposition for the development. This is evident in the results of the social study as everyone who registered that they would not accept the charging point development, had previously responded that they would never consider purchasing a vehicle which required charging. This is important as for a developer, when considering social acceptability, they may have to consider issues out with the specific development.

The proximity of the developments to the individual is a consideration that could affect acceptability. In the study the charging point development is suggested to be close to residences as the development would occur on the residential street. However, for PV, the development was suggested to occur in an area of derelict land, which could be a significant distance from the individual's residence. Therefore, this could have massive influence on the acceptability. In Interview 3, the reason for not accepting the development is that it would take up space in the street and make it look messy, clearly indicating that they were considering the impact that the development occurring on their doorstep would have. Therefore, there could be a proximity correlation with acceptability and sustainable developments. The popular opinion of not in my back yard comes into play here as opposition from a specific individual may occur for developments close their home, but at a slightly further distance may be accepted. Proximity is well known to be a determining factor in acceptance, although uncertainty regarding whether opposition increases or decreases with proximity to the development (Wustenhagen et al, 2007). The results of this study would suggest that opposition increases with proximity, in other words, the closer a development is to an individual, the less accepting they will be.

4.4.2 Charging Poverty

From investigation into postcode, domestic charging ability and by using the Scottish Index of Multiple Depravity, an investigation into charging poverty was possible. It was found that 33% of individuals could be subject to charging poverty and for half of these (16% of overall study) this charging poverty would exacerbate existing poverty. With the 2040 ban on the purchase of conventional combustion cars in the UK, individuals will soon not have the option to purchase a vehicle which does not require charging. Therefore, they will be effectively forced into this poverty due to the government's efforts to be more environmentally conscious. The introduction of this new dynamic of energy poverty could have devastating consequences for citizens. Fuel poverty in the European Union already causes many issues with individuals unable to heat their home to acceptable level or provide lighting. This stems from the integral factors in their home where the building is thermally inefficient and is coupled with low incomes (Bouzarovski, 2014). This example is mirrored in the idea of charging poverty with individuals unable to charge due to not having an area to privately park their vehicle, and individuals already dealing with deprivation. Aiming to make these vehicles the dominant mode of private transportation, although supportive of environmental goals, could have overwhelming negative impacts on citizens living in the city.

Until the imposition of the 2040 ban, the purchase of plug in vehicles will be restricted to individuals who would not experience this charging poverty as the prospect of poverty would be a deterrent. This could consequently impose a new social status through symbolism of what the vehicle represents. In Heffner et al (2007), the reason for purchase of the hybrid electric vehicles is analysed in order to understand the denotations (social meaning) and connotations (personal meaning) that are associated with this purchase. It was determined through interviews that the main motivations for purchasing these vehicles were; concern for the environment, personal finances, reduction in support for oil producers and embracing new technology. This led to connotations of intelligence, awareness, sensibility, maturity and concern for others. This symbolism of low emission vehicles projects a new social status that people who possess these vehicles, maintain these

attributes whereas owners of standard combustion cars are less mature, sensible or environmentally conscious. This social status would neglect practical reasons for not owning a plug-in vehicle such as the barriers outlined previously. However, these vehicles could implement a new social status, adding additional fuel to social class systems in society. Therefore, the implications of charging poverty on individuals in areas of deprivation are not contained to financial disadvantage but extend to social deprivation.

4.4.3 Conflict

The results of this study indicate that the possibility of conflict occurring due to the charging point installation is cause for concern for some individuals, with the majority believing that conflict could occur. It was highlighted by some individuals, including in Interview 4, that there are already significant issues with parking in residential streets, without charging points. Adding another factor to the problem would only exacerbate these issues further. The efficient and fair use of the point was an issue that continued to be broached in both interviews and questionnaires. Co-operation between neighbours would require effort and understanding and ultimately may not result in satisfactory outcomes for all individuals involved. The impact that conflict could have on the sense of community for residents affected by this issue is massive. Losing this sense of community could considerably decrease the happiness and satisfaction of individuals living in the urban environment and as a result removes the citizen focus in the progression to future cities.

4.4.4 Land Use

In the urban environment, there can be a lack of free space and derelict land. Effective and conscientious utilisation of available land is essential. Therefore, land use was an important consideration for the installation of PV panels. From this social study, this does not seem to be a significant concern. Acceptability of the development was high, even when the land was used for recreation activity, and including these activities only made a slight impact. Reasoning for this was provided by several individuals including in Interview 2 where it was stated that there were enough places in the city for these recreational uses. However,

they also highlighted that in areas where space for activities is not available, land use may be an issue. This study was conducted in Glasgow and the surrounding area which may indicate why land use is not a massive concern for individuals. It was recently reported that 13.5% of the city is covered by accessible greenspace (McCall, 2017), a significantly high percentage compared to other UK cities. Therefore, in areas where there is less green space, land use and the incorporation of recreational activities in the development may be a larger concern.

4.4.5 Community Benefits

The social study indicated that several individuals believe that one of the most helpful tools in encouraging acceptance of the PV development would be if there was a benefit to the community. Through the questionnaire, a slight increase in acceptability was present with the suggestion of financial feedback into the community. However, through additional comments and the interviews it was evident that any benefit to the community, including community involvement and education, would aid acceptance. In Macnaghten, 1997, it was determined that sufficient publicity and public education would encourage public support for sustainability initiatives. This is a concept reflected in the findings of this study. It is evident that for individuals to accept a development, they want to know information about it and how it will affect them. This type of involvement in proposed developments is therefore an essential step in the sustainability movement.

Having developments such as charging points and PV panels provide an exciting opportunity for education of young people about the environmental issues we face and possible solutions to these problems. Overall this opportunity would be invaluable as educating the younger generation could secure the future for the sustainability movement.

4.5 Summary

A summary of the social study is outlined in this section including the main conclusions determined through the results obtained.

The focus of the social study was on two different developments that could occur, and are already occurring in some places, in the progression to future cities. The installation of charging points in residential streets was chosen as the transport industry is advancing to low emission vehicles through awareness of environmental implication and through policy encouragements. It was identified, in Chapter 3, that perhaps the largest barrier and issue that will arise through the change in the private transportation sector is the availability of charging points. Although domestic charging is likely to be at the forefront, individuals who lack this ability will rely on public points which must be convenient and accessible. The second development chosen was determined to be applicable for this social study as it is a development occurring today. Glasgow city council already has plans to install PV panels on areas of derelict land around the city, and there for the consideration of the social implications of this are pressing.

Both questionnaire and structured interview were used in order to obtain quantitative and qualitative results regarding acceptability of these developments. The questions were structured around specific focus areas within the two developments. For charging points this included domestic charging ability and conflict and for PV panels, included land use and community benefits. In total, 20 completed charging point questionnaires and 19 completed PV questionnaires were returned and four interviews conducted, therefor only representing a small focus group.

The recorded acceptability of the PV development (87%) was higher than the acceptability of the charging point development (75%). It was determined that 33% of individuals do not have the ability to domestically charge, which would result in 16% of all individuals experiencing exacerbated poverty due to charging poverty. 87% of individuals believed

that the installation of charging points in streets would create conflict, however only 29% said this would affect their acceptability, the majority negatively. With regards to the PV installation, of the individuals that responded that the area of land they were considering was used for some recreational activities, only 33% said this affected their acceptability. Incorporation of these activities and financial feedback to the community had the same effect, increasing acceptability of the PV development to 91%.

The acceptability of these new developments is high which presents a positive outlook for the sustainable progression to future cities. However, several factors were considered that could have influence on these results. It is possible that as the majority of individuals in this study are between the ages of 20 and 30, this could impose a bias and account for a high acceptability. Proximity of the developments to the individual could alter acceptability, as in this study, it appears that the closer the development is to an individual's residence, the less accepting they are. Influence from the wider movements which contain these developments may cause imposed bias as if opposition for the wider movement is present, this opposition may be carried into consideration of this development.

Analysis into the impact of the results for charging poverty, conflict, land use and community benefit were conducted. Imposing policy constrictions such as the 2040 ban on the sale of conventional combustion could require individuals to purchase plug-in vehicle and therefore impose poverty onto individuals already struggling with deprivation. Not only will this have devastating financial implication for the public it could lead to the imposition of additional social status. Introducing conflict into the community in urban environments could significantly reduce the sense of community felt by residents and in turn reduce citizen satisfaction. Land use did not appear to be a significant issue in the Glasgow area but could be a huge factor in areas with less green areas for recreation. Community feedback and benefits was viewed as one of the most influential factors in advancing acceptance of these developments whether it be through financial feedback or educational opportunities. Including individuals who will be most affected in the

development in each of the planning stages will help to avoid initial opposition and allow informed decisions on both the planning and citizen sides.

These developments have the potential to have massive environmental benefits and their incorporation into future cities, in some way, is essential to ensure a sustainable future. However, the impact on the citizens within the city is mixed. The opportunity to aid communities is present through feedback and education. However, the negative impression on poverty and conflict cannot be overlooked and therefore these concerns, and any further concerns that may arise for a specific development, must be incorporated into the planning process.

5 Incorporation of Public Opinion into City Planning

It is evident through the results and analysis in Chapter 4 that citizen acceptability of sustainable developments in future cities is a complex, situation and location dependent issue with many parameters and considerations. It is important to deliberate the public opinion when considering these developments in order to ensure the city is designed and operates in the best way for the people living in it. This would satisfy the citizen focus goal in the 11 priority areas for future cities (European Commission, EIPSCC, 2013) to ensure cities are for the citizens living in them. However, incorporating the public opinion into planning for these developments could be an issue as ensuring effective citizen participation has proven to be challenging. Public hearing and surveys elicit information of varying success (Kathlene and Martin, 1991). Accessibility and transference of this information and data to the people who require it is problematic. In this chapter, a proposed method for incorporating the public opinion into planning is proposed and discussed.

5.1 Introduction

The suggested method for incorporating public opinion into city planning for sustainable developments is to conflate the social dimension with existing factors in the Glasgow Opportunities mapping tool, available through Future Cities Glasgow Interactive Map. This tool evaluates policy and technical constraints for PV developments on available land in the Glasgow area. Expansion of this tool to incorporate not only policy and technical constraints but also social constraints through public opinion would allow effective consideration of citizen acceptability.

5.2 Glasgow Opportunities Map

The opportunity map was developed for Glasgow City Council in order to inform decisions regarding the deployment of small-scale renewable systems throughout the urban environment. Specifically, this map focusses on the installation of freestanding solar PV farms on derelict land, therefore appropriate for the second study area of the social study included in this project, although it would be applicable to other technologies, such as charging points (Clarke et al, 2015). The map utilises Geographic Information System (GIS), with layers of information corresponding to different constraints, resulting in an interactive map encompassing a variety of relevant considerations. The policy and technical constraints for the installation of this technology are displayed in an interactive map which is publicly available for use. A combination of the policy and technical constraints results in a rating system for each area of land.

5.2.1 Policy

Within policy constraints, five areas of consideration have been investigated, environmental policy, development policy, visual intrusion, biodiversity and visual impact (Clarke et al, 2015). For each policy area, a scoring system is used and applied to each land area. The scoring system includes four ratings; possible, intermediate, sensitive and showstopper with possible indicating areas most suitable to the development and showstopper indicating that the development would not be possible. Environmental policy, development policy, and biodiversity are applicable for the deployment of any renewable energy technology, whereas visual intrusion and visual impact are specific to solar PV.

Environmental policy incorporates the policy designations outlined by Glasgow City Council, with the considerations and rating system outlined in Table 2.

Possible	Green corridors, Local nature reserves, and all non-designated areas.

Intermediate	Conservation areas, Listed buildings, Ancient woodlands, Tree preservation orders, World Heritage site buffer zone
Sensitive	Sites of special landscape importance; Gardens and designed landscapes; Scheduled ancient monuments; Local sites of importance for nature conservation.
Showstopper	Sites of Special Scientific Interest (SSSI), City-wide sites of importance for nature conservation; World Heritage site

Table 2: Environmental Policy rating for Glasgow Opportunities Map

Development policy incorporates the Glasgow City Council policy designations covering the city, with the scoring based on how big a hurdle the policy designation as viewed by planners. The scoring for this policy consideration is shown in Table 3.

Possible	Regeneration areas, Strategic economic investment areas, Master plan areas as well as all non-designated areas.
Intermediate	All other designations
Sensitive	Housing land supply with consented developments

Table 3: Development Policy rating for Glasgow Opportunities Map

Visual intrusion addresses the glare from PV panels which could cause temporary loss of vision and therefore is extremely important with regards to flight paths and areas with traffic. As PV panels can cause this glare, it imposes a policy restriction, and therefore the Civil Aviation Authority (CAA) guide for PV systems was consulted in order to obtain the rating system for visual intrusion, as shown in Table 4.

Possible	All other areas
Intermediate	Between 1 and 5 km radius to the south of an airport or heliport or within 100m of a motorway
Sensitive	Within a 1 km radius semicircle to the south of an airport or 100m from a runway

Table 4: Visual Intrusion rating for Glasgow Opportunities Map

Biodiversity policy restrictions address endangered species habitats which may not be covered in environmental policy. Information from the Land and Environmental Services department at Glasgow City Council was used to determine the parameters outlined in Table 5.

Score	Description
Possible	No species on the protected list believed to occur
Intermediate	UK Protected species possibly occur, requires environmental survey and mitigation measures
Sensitive	European protected species possibly occur, requires environmental survey and serious mitigation measures

Table 5: Biodiversity rating for Glasgow Opportunities Map

Visual impact focuses on overlooking residential areas, as PV panels are not tall, loss of view in urban areas is not a consideration. Subjective judgement was used to determined areas which the development would significantly change the character of view from the housing. The scoring for this parameter is sown in Table 6.

Score	Description
Possible	No residential areas overlook the site
Intermediate	Residential areas overlook the site

Table 6: Visual Impact rating for Glasgow Opportunities Map

By evaluating each area of derelict land in the city with regards to these five policy restriction, an area which is most for PV panel developments concerning possible policy constraints can be established.

5.2.2 Technical

Following the policy considerations, a number of technical parameters that could impact the suitability of the land for PV panel installation are outlined. Four areas were investigated and scored; Grid connection distance, Grid congestion, Overshadowing and Terrain. Scoring for the technical parameters includes favourable, likely and unlikely.

Grid Connection Distance is an important consideration as installations over 12kW cannot be connected to the Low Voltage network and therefore the development is required to be a suitable distance to a substation for connection to the grid. The suitability scoring for this consideration is outlined in Table 7.

Favourable	Within 750 m of a primary substation.
Likely	between 750 and 1500 m of a primary substation
Unlikely	further than 1500 m from a primary substation

Table 7: Grid Connection rating for Glasgow Opportunities Map

Grid congestion considers that even if the proximity to a substation is suitable, connection may still not be possible due to overloading of the substation. SPEN has published a GIS

heat map scoring circuits for analysis of this parameter, and therefore this scoring systems is utilised and adapted to result in the scoring used in this map shown below in Table 8.

Favourable	Combined heat map score under 10
Likely	Combined heat map score equals 10
Unlikely	Combined heat map score greater than 10

Table 8: Grid Congestion rating for Glasgow Opportunities Map

Overshadowing addresses the issue of shading from surroundings affecting the sunlight that could strike the PV panels. The annual shade footprint indicates areas that will be shaded by surrounding at some part of the year. This consideration does not replace calculations of energy output which would be required prior to any installation, but instead indicates areas that are worthy of consideration through the rating system shown in Table 9.

Favourable	Falls outside the estimated annual shade footprint
Likely	Falls within the estimated annual shade footprint

Table 9: Overshadowing rating for Glasgow Opportunities Map

The terrain consideration accounts for the problems in the quality of land which may affect installation. Using the shape, slope, access to site and flood analysis, suitability of the land is scored, shown in Table 10.

Favourable	Flat ground, no access issues, or risk of flooding.
Likely	Heavily sloping or broken ground, restricted access, unsafe buildings,

	medium risk of river or coastal flooding or high risk of surface water over large area.
Unlikely	No direct access, site under water or with high risk of river or coastal flooding

Table 10: Terrain rating for Glasgow Opportunities Map

Through evaluating the area of land for each of these constraints, sections of derelict land in which the installation of PV panels would be technically feasible can be determined.

5.2.3 Combined Factors

Analysis of both policy and technical restrictions and constraints provides a comprehensive assessment of the suitability of land throughout the Glasgow area for this installation. Through combining each factor, an inclusive map is created, as shown in Figure 31. All Glasgow opportunities maps are taken from the interactive mapping tool on the Future Cities Glasgow site.

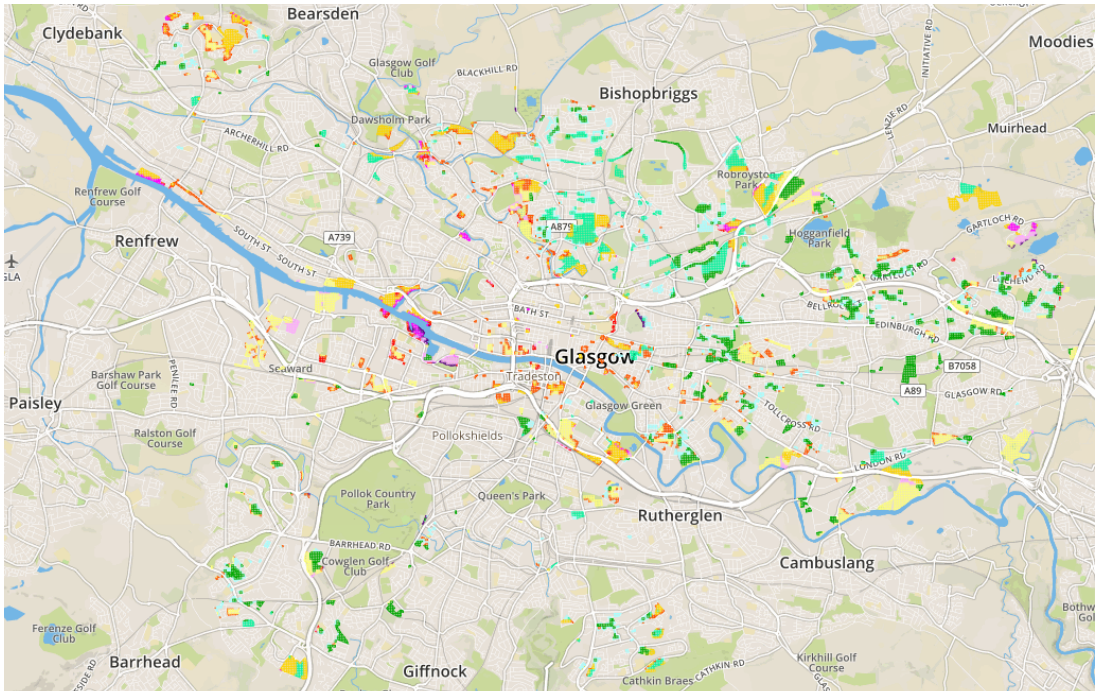


Figure 31: Glasgow Opportunities Map showing all ratings for the Glasgow area

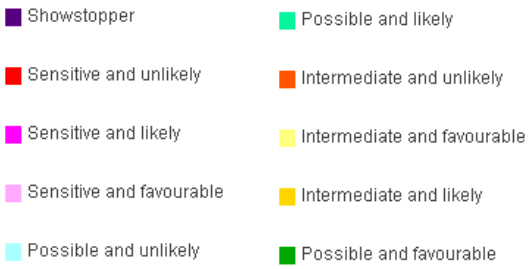


Figure 32: Colour coding for Glasgow Opportunities Map indicating ratings for policy and technical constraints

The various colours indicate the different combined rating, with the key outlined in Figure 32. The terms outlined in Tables 2 through 10 are used to indicate suitability of the available land considering both policy and technical factors throughout Glasgow. All ratings are shown in this figure, however filtering of a specific combined rating can be done.

A closer view of the North East of the city is shown in Figure 33, in which it can be more easily seen how the areas are outlined and colour coded.

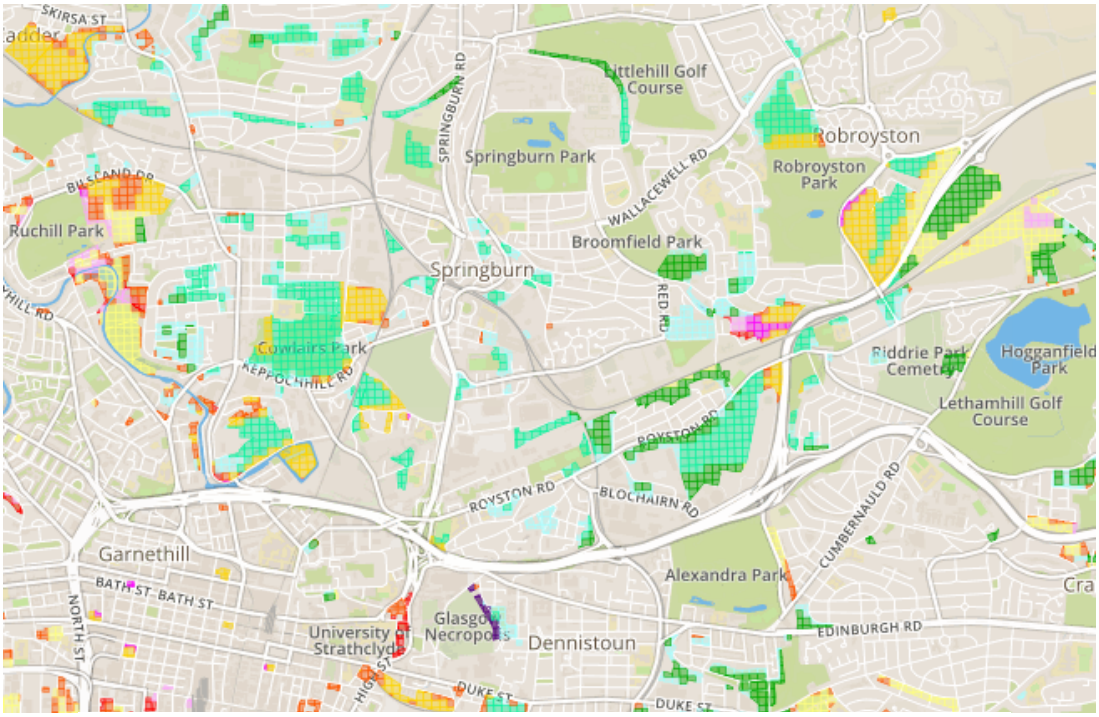


Figure 33: Glasgow Opportunities Map showing all ratings for the North East of Glasgow

With this figure, all ratings for both policy and technical constraints are present. However, if this area is filtered to represent only the most suitable, i.e. areas which are possible and favourable, the areas which would be desirable for this development can be determined, as shown in Figure 34.

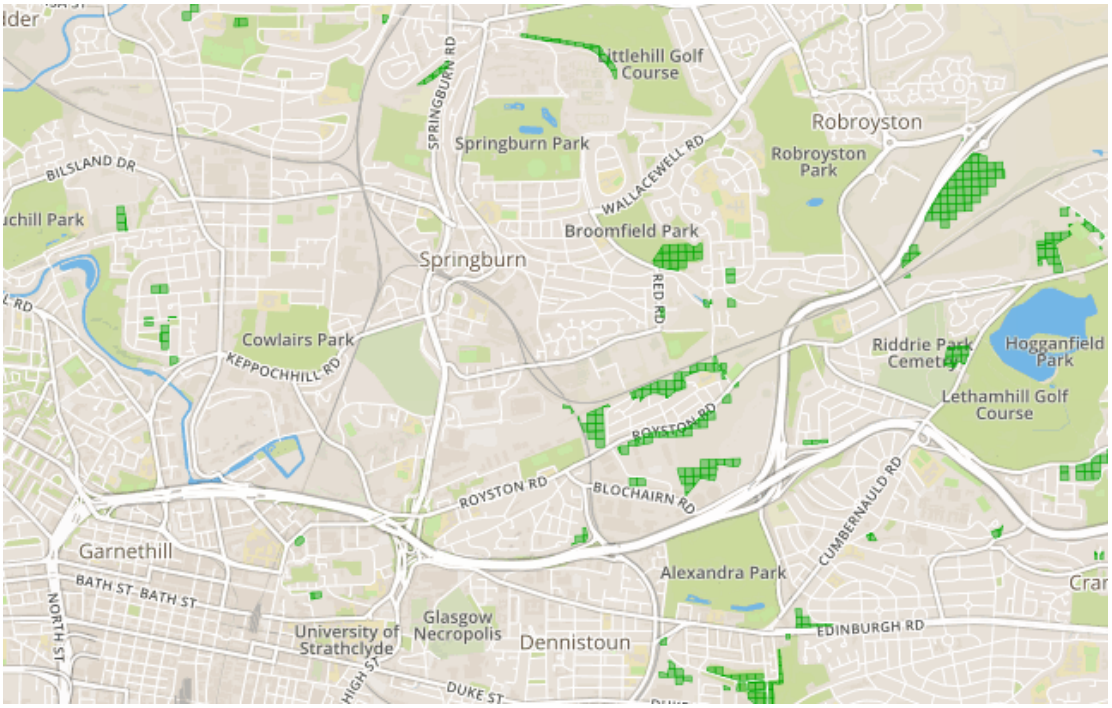


Figure 34: Glasgow Opportunities Map showing Possible and Favourable ratings for the North East of Glasgow

Therefore, in Figure 34, the areas in the North East of Glasgow in which PV installation would be most suitable area outlined. This information can then be used by developers to determine which areas to install PV panels on.

5.3 Introducing Social Considerations

The proposal is that social considerations, like the ones addressed in the Chapter 4, should be incorporated as a further layer in the map. Therefore, for each area of land, the policy, technical and social constraints could be displayed. This would indicate to developers

which areas the development would be easily accepted by the community and which areas community consultation would be required.

In order to implement this proposal, a large-scale social study would be required to obtain the results required for presentation in the map. This could be done in the style outlined in this project to understand the acceptability of the residents regarding the installation of PV panels on the area of land being assessed. The social study should focus on individuals who would be affected by the development such as those who live near the land. As a social study is extremely time consuming, it may be useful, at least initially, to apply the social consideration only to areas which are rated as possible and favourable regarding policy and technical constraints.

Like the policy and technical permutations, a colour coding rating system would be required for effective display in the map. A possible rating system for use is outlined in Table 11. This rating system would be applied to areas which are rated possible and favourable, therefore removing the dark green colour from the map changing the possible and favourable rating to those outlined in Table 11.

Accept		The development received positive feedback with a majority of affected individuals responding that they would accept a PV installation
Accept with suggestions		The majority of affected individuals accept a PV installation, however many suggestions for modification were put forward
No opinion		The majority of individuals affected have no opinion on a PV installation
Do not Accept		The majority of affected individuals would not accept a PV installation

Table 11: Suggested rating system for social consideration in Glasgow Opportunities Map

5.3.1 Example Area

In order to illustrate how this could be applied, an example area was used. Again, focussing of the North East of Glasgow, an area marked as possible and favourable was selected to the south of Broomfield Park shown in Figure 35. As this area is marked as possible and favourable for the installation of PV panels, a social study would then be conducted in the surrounding area. The results of this study would then be categorised into the rating system outlined in Table 11, and the area colour coded depending on the results. If the results indicated that people would accept the development, the area would appear in the map as shown in Figure 36.

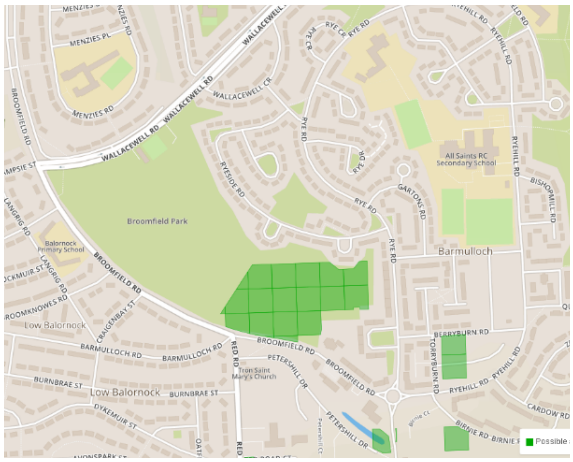


Figure 35: Possible and Favourable area to the South of Broomfield Park

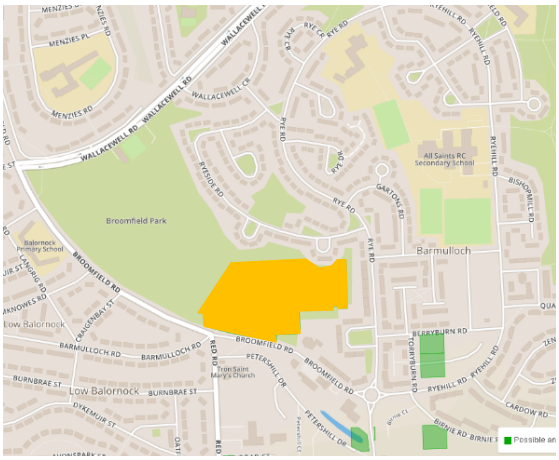


Figure 36: Possible and Favourable area to the South of Broomfield Park with Social Consideration included

This methodology would be applied to all areas in Glasgow which are rated as possible and favourable in order to ensure public opinion is incorporated into decision made regarding the land use and possible PV developments that could progress.

5.4 Summary

Through utilising this approach, an effective and easily accessible method for including public opinion into planning would be available. If the information is easy to access and interpret, incorporation is more likely to occur. Through evolving the Glasgow Opportunities Map, public opinion of these developments can be combined with the technical and policy constraints ensuring the city will have a citizen focus.

6 Conclusion

In order to ensure that citizen engagement and understanding is improved in the progression to future cities, incorporation of public opinion into sustainable developments is essential. Through questionnaires and interviews, the acceptance of the installation of public charging points in residential streets and the installation of PV panels on derelict land for energy harvesting was investigated.

These developments have the potential to aid in ensuring a sustainable city and world, but the impacts on citizen must be considered. It was determined that the impact on citizens is mixed, with both positive and negative outcomes. Poverty and conflict caused by the charging points could have devastating financial and social effects on citizens. However, PV panels provide the opportunity for educational and community improvement. Therefore, through understanding the opinions of the public with regards to these developments, the planning process may be assisted, or potential modifications could be applied to aid acceptance.

Although understanding opinions and concerns is essential, availability of this information and the incorporation into planning could be problematic. The proposed expansion of the Glasgow Opportunity Map would allow city planners to easily access how individuals affected by a development would accept it.

By understanding the opinions of citizens in urban environments, sufficient engagement can be achieved, therefore satisfying the citizen focus priority set out by the EIP on smart cities and communities. This could in turn help developments relating to energy and the environment progress, therefore ensuring sustainable urban mobility and sustainable districts and built environments are achieved in the progression to a future city.

7 Future Work

The concept of including social considerations in planning in urban environments is one which present many opportunities for research. To build on the research conducted in this project, several prospects for future work are suggested below.

During the analysis of the outputs of this study, it was identified that a correlation between the acceptability of sustainable developments could exist. A study to identify if this is true could be conducted.

A case study based on the work in this thesis but focusing on a specific area and development would be advantageous. This wold allow a more in-depth analysis and would provide opportunity to clarify proximity considerations. This would also present an occasion to test the proposal for incorporation of acceptance into the Glasgow Opportunities Map.

Finally, this study only focuses on two development types and is contained to the Glasgow area. Therefore, endless opportunities are present to investigate the social aspects of the multitude of sustainable developments involved in the progression to future cities around the world.

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9 Appendices

Appendix 1- Questionnaires

Charging Point Questionnaire

Personal Details	
Occupation	
First part of Postcode	
Age range	<20☐ 20-30☐ 30-40☐ 40-50☐ 50-60☐ >60☐

This survey serves as part of a social study in a MSc Thesis investigating citizen acceptability of sustainable development in future cities. This study aims to assess how you would accept the installation of charging points near your residence. It will measure if you would accept this development, if there are any changes that could alter your response and delve into the reasons for this response. It will also evaluate the impact that this development could have on the community.

Do you have, or would you consider purchasing a vehicle which required charging such as an electric vehicle or a plug-in hybrid?

Rate your acceptability of the installation of public charging points in your residential street?

5= strongly accept and encourage, 4= Accept, 3= No opinion, 2= Oppose, 1= Strongly Oppose

Do you have an area to privately park a vehicle, i.e. a driveway or garage?

If so, you may have the capability to install a private charge point. Would this affect your opinion of the installation of public points?

A vehicle typically takes 5 hours to fully charge. If there was 1 charge point per 3 residences, do you see this development causing any conflict in the community such as argument over occupying the space when not required or vehicles that do not require charging using the space?

Considering this, does your acceptability of the development in your residential street change? If so, please rate from 1-5.

Any other comments. Please use this section to outline any concerns or thoughts you have which have not been considered in this survey.

PV Questionnaire

Personal Details

Occupation	
First part of Postcode	
Age range	<20☐ 20-30☐ 30-40☐ 40-50☐ 50-60☐ >60☐

This survey serves as part of a social study in a MSc Thesis investigating citizen acceptability of sustainable development in future cities. This study aims to understand if members of the public would accept the opportunity to utilise vacant land for energy harvesting in the form of a PV array for solar energy. It will measure if you would accept this development, if there are any changes that could alter your response and delve into the reasons for this response.

For the purpose of this study, please consider an area of derelict land near your residence.

Rate your acceptability of the installation of a PV plant in order to harvest solar power for electricity on a section of derelict land near your residence?

5= Strongly accept and encourage, 4= Accept, 3= No opinion, 2= Oppose, 1= Strongly Oppose

Is the section of derelict land used for anything else, for example recreational use such as sports and games or dog-walking? If so, does this affect your acceptability of the development?

If the development could be altered to incorporate these uses, would your acceptability change? If so, please rate from 1-5.

Do you think the land could be used for a more beneficial development for the community?

If the electricity produced was sold and the money fed back into your community, would your acceptability change? If so, please rate from 1-5.

Any further comments. Please use this section to outline any concerns or thoughts you have which have not been considered in this survey.

Appendix 2- Interview Transcripts

Interview 1

Occupation: Delivery Driver

Age: 50-60

Postcode: G21

Charging Points

Would you ever consider purchasing a vehicle which required charging?

Not at this moment in time, No. I don't believe that the reliability of the vehicles is what it should be, and I believe they are too new to the market at this time. In a few years once they have proved more reliable then I would consider it.

How would you accept the installation of charging points outside your house?

For public use?

For the residents on this street and for anyone passing through.

I think for any residents on my street who wishes to purchase an electric vehicle should have the charging points within their property domain. I don't think it should be installed outside my property when I don't have an electric vehicle.

Initially how would you accept your acceptability of the installation (rating 5-1 explained)?

3

So, to confirm, you would have the ability to charge a vehicle on your property as you have a driveway?

Yes

And do you think this affects your opinion?

Yes

If you could consider the situation that you did not have a driveway, would you be more accepting?
Possibly

If you did not have the ability to privately charge your vehicle, would you be more accepting?
Yes, as I don't have the ability within my own property to do it

If you did not have the ability and the development did not go ahead, you could possibly have to rely on charging points at your workplace or in the city centre, would this not be enough?
No, I don't think it would be

A vehicle typically takes 5 hours to fully charge. If there was 1 charge point per 3 residences, do you think this would be enough?
No, I don't. You may have two residents who need to charge their vehicle at the same time and therefore you would be relying solely on a good neighbour relationship to work it between that period. If you have for example an eight-hour period where both residents are at home and want to charge their vehicle, who takes priority.

With one charge point per three residences, this would equate to 8 hours of charging per day, do you think this time would be enough?
Yes, but I don't think that would work. If you have three neighbours relying on the good neighbour relationship that they will all get on, then who would be the person that would be allocated the eight hours between midnight and 8 in the morning and must bear in mind when they start work and it goes on and on? Neighbours start to fight, and it reverts to a first come first served basis, so I think it is a very bad idea because you're relying on these relationships which unfortunately currently doesn't always happen.

If this development was to go ahead, would you think a management system for the charging point would be required to dictate when and who could charge?
Possibly but then who would control that.

Considering the impact that these charging points could have on the sense of community in your street, does that change your acceptability of the development from the initial 3 that you gave?
Yes, 1

In the area that you live in there are a lot of places where people do not have ability to domestically charge as they do not have a driveway. It is common for people to park their car on the kerb if space is available. If the installation of charging points on residential streets is not the solution, do you have any ideas about what could be?
Well I think a designated parking area that would be there for any of the residents to use 24 hours a day, but again how you would manage or control that would be a problem.

A sort of car park?
Yes. For example, an area with 6 parking spots that can be used by any of these residents or, if you could control it to an extent, by anyone. And if the charging points were all being used, it would be up to the companies to install more to ensure that there were enough.

You would put the responsibility that there were enough charging points in the area on the companies who install them?
Yes, because they are the ones who are making the money off it, so it would be financially beneficial to make sure that there were enough charging points.

Do you have any other concerns about this topic?
As I said I think everyone who can, should have their own charging point and when this is not possible there should be a designated charging area.

I think there needs to be more input from the government, they need to make sure people are able to charge their cars if they are implementing the policy that makes people need to purchase a plug-in vehicle (referring to 2040 ban on combustion sales).

PV

How would you accept the installation of PV panels in an area of derelict land (1-5 rating explained)?

5, the land I am thinking of has been derelict for a good number of years and the land is subsiding, so it has not been really available for construction on for any properties or any other building so why not utilize the land to help in the movement of saving the planet.

You mentioned that the land is subsiding, but it the land used for any recreational use such as dog-walking?

Yes, it is used for people walking their dogs but there are signs warning about the subsidence 'keep off'.

So, although your acceptability is quite high, and the land should not be used for recreational purposes, how would you feel about this land being developed to incorporate both the PV panels but also add recreational uses such as paths, do you think that would be a good thing?

If they could do that with the land to use it in a responsible manner but I think that would be a good thing. However, I would also accept the area being closed off for just the PV panels as that is how it has been for around 40 years.

And you don't think the land could be used for anything more beneficial to the community?

No, because I remember them looking at the land a few years ago it is was unsuitable for construction.

There is scheme in Aberdeen where money made from a hydro power scheme is fed back into the community, do you think this would be a good thing?

I think if they are actually feeding the money back into the community then this would be a benefit for any of the local projects in the community.

Would you have any concerns regarding vandalism of the development?

I think there is issues with anything that is new or out of the norm. The youth/ vandalism element with always be there but that is present with everything. But in this instance that could be minimal. Young people in the UK are fully aware of the need to adapt and move forward and solar energy is something I am fully aware is part of the future.

If this area of land was more utilized than you have previously said, do you think this could bring more opposition in the community to save the land?

I think there will always be the small element of people that don like or don't want to accept change, but I think at the end of the day if they were to see some of the positive benefits that were to come out of it i.e. funding for the local community and projects, and if it is sold on a positive note, bearing in mind that the land has been derelict for a number of years, and the piece of land I'm talking about there is a park within 100 yards that is used by the local community for do walking and kids playing. And this piece of land there is signs saying keep out so the people who actually use it for anything are essentially breaking the law. I can't say that this land would be a loss to the community, so I think if it's sold with all the benefits and the community is helped in some way (feedback money) then I think it's very positive and that would sell it to the local community.

You have mentioned about selling the idea to the community, and I'm sure you're aware of the typical not in my back-yard oppositions of these types of developments, so do you think that educating people about the development and involving the community in each step is key to ensuring acceptance?

Yes, absolutely. If they were to have meetings in the local community, inform the people of proposed plans, what they want to do, the cost, any inconvenience that would be cause, how it would benefit the local community and if there was feedback to help the community

in the long term. I think that if it is fully explained at local meetings and the people that it impacts are kept fully aware and up to date. People now are fully aware of the benefits and the future for wind farms and solar panels, obviously there will be some opposition because people are people, but if it is fully explained then it can be sold in a very positive way.

Any additional comments?

I think it's very important not to let negative rumours spread through the community and to ensure education and awareness is kept throughout the installation and running of the development.

Interview 2

Occupation: Student

Age :< 20

Postcode: G12

Charging Points

Would you ever consider purchasing a vehicle which required charging?

Yes, I would. I'm not biased towards petrol or diesel

Do you think that these vehicles could be the way forward and they will be what most people will be purchasing?

Yes, I think so. With the government's actions lately and goals towards like 2040.

So, you think the environmental factor could be the main motivator?

Yes

Can you rate your acceptability of the installation of charging points on your residential Street (rating explained)?

5, I feel like the main issue people have when they have these vehicles is where to charge them and so I think that if there were more charging stations, they could become more popular.

So, you think have these stations more available would help the progression of these vehicles?
Yes

Do you have an area that you could privately park a car?
No

People who do have this area would be able to install a private charging point. Without this capability you would be relying on public points, do you think this affects your acceptability?
Yes, points would need to be widely available for people who do not have the ability to privately park.

Typically, a vehicle takes around 5 hours to fully charge, if there was 1 charge point per 3 houses, which would work out at 8 hours per house, do you think that would be sufficient time?
Yes

Do you think there would be any issues with management and who gets to use the point's and when? Do you think this could cause conflict?
Maybe but I think it would only be initially with people settling in and finding a routine. Once it's not brand new then I don't think it would cause much issue.

PV

Please rate your acceptability of the installation of PV panels on the area of derelict land you are thinking of (rating explained)?

5, I think it's a good idea, it is a step in the right direction with regards to renewable energy.

Is this land used for anything else such as dog walking?
Yes

Does this affect your acceptability of the installation of the PV panels?
No. I think it depends on the specific area and place. If there is a lot of space in that area for these activities, then it would have as much of an effect but if it's the only place then it could cause some problems. The proximity of it to other areas such as parks is important because if it's close to a park then losing that land for these activities isn't that bad.

How would you feel about the development if the other uses were incorporated into the development such as paths?
I think if people were able to walk through the development then they could be more aware of it. It could educate so growing up it could change people's whole outlook of fossil fuels.

Do you think that having awareness about the development, what it is and why could people accept it?
Yes, definitely. I think having this development would get people out of the initial mindset that we are in just now of petrol and gas and oil being your go to.

So, do you think people being opposed to this development occurring in their neighbourhood could be helped by awareness?
I don't think it would be that big of a problem. I think with the current generation being more aware would start to show

Do you think your age makes you more accepting and aware of the issue?

Yes, I definitely think it has to do with age.

How would you feel about some of the money made from the generation was fed back into the community?

I think this would definitely help. If the benefits could be seen it could help get through the initial starting stages of the development and help acceptability. I think seeing a direct benefit to the community could help people who are not as aware of the environmental impacts on board.

Interview 3

Occupation: Retired

Age: >60

Postcode: G21

Charging Points

Would you ever consider buying a vehicle which required charging?

No, too much technology. I'm too old for all that technology.

Do you think the environmental impacts would change your opinion?

No

How would you accept the installation of charging points in your residential street (rating explained)?

1, there enough things in the street, it would take up too much space and would look messy.

Do you have an area to privately park your car?

Yes

Due to that you would be able to install a private charging point. For instance, if you did not have this, you would have to rely on public points, would that affect your acceptability?
Yes, if I didn't have my own driveway I would be more accepting

If there was to be the installation of these charging points in the street, do you think it could case conflict with neighbours?
Yes definitely. You would have to be allocated a time, but it would have to suit you. If you are out at 6 in the morning and but so is everyone else how would that work. Or if your time ended at 2 in the morning would you have to get out of bed to move your car so someone else could use it. I think that could be a big problem.

So, you said your main reasoning for opposing was that it would clutter up the street. How would you feel about designated parking areas for charging?
Yes, I think that this would be a good idea, but I think it would still cause conflict. It's like when you have a communal area for drying washing. Whoever puts their washing out first gets to use it and if they do not move it then no one else can use the line that day. This could happen with the charging.
I would also be concerned about parking my car far from my home.

Any additional comments?
I think to be honest it would be best, where people can, to have their own points.
How long does it take to charge a car?
It can take around 5 hours to fully charge.
So that means that if you're sharing then someone would have to get up in the middle of the night.
I think you always get a selfish person who will plug their car and just leave it.
I think there could be an issue with vandalism too. If you look at bus shelters, they are always getting vandalized.

With charging points at my home, I would be concerned about people stealing my electricity by plugging in their car when I am not using it. There would have to be a way to make sure this couldn't happen.

PV

Please rate your acceptability of the installation of PV panels on the area of derelict land?
5, I think solar power is a good thing. I think it could help with cheaper energy.

The financial side of electricity is your main motivator?
Yes

Is this area of derelict land used for anything else?
Yes, but I would still put the solar panels in. I think the solar panels are a good idea and there are enough places for people to go to dog walk etc.

Do you think it would be a good idea to incorporate both the recreational uses and the PV?
I think that would be a good idea as long as it was safe. I would be concerned about the safety.

Would you be concerned about people getting into the PV panels, causing vandalisms and risking hurting themselves?
Well depending on how close people could get to them. I would definitely want the safety of people to be a main consideration

You seem very positive about the development. Do you think there is anything more beneficial to the community that the land could be used for?
No, I think we have enough things like community centers and sports areas, so I think we should have solar panels.

Do you think this could be used as an opportunity for community engagement such as education?

Yes, I think showing people how it works, and the technology would be good

With developments there can sometimes be the idea of not in my back yard, would you be concerned about this?
No that wouldn't bother me

If some money from the generation was fed back into the community, how would you feel?
I think that would be a great idea. And if along with that there was cheaper electricity then it would help a lot.

You mentioned that cheaper electricity is a big reason for why you accept this development, in some areas there is a lot of fuel poverty. Do you think that people in fuel poverty would be encouraged by seeing these developments?
Yes, I think people in fuel poverty would be very glad to see these developments. It would show that some progress was being made to help them. I think people would see this and think if it helps them then I'm happy for the development to go ahead.

Interview 4

Occupation: Laborer
Age: 20-30
Postcode: G22

Charging Points

Would you ever consider buying a vehicle which required charging?
Yes, I'm aware of the environmental aspect but really if I knew it would save me money then I would buy one.

How would you feel about the installation of public charging points in your street? Please rate (rating explained)?

4, I would be okay with them installed

Do you have a place to privately park your car?
No

Do you think this affects your acceptability of this development?
Yes, I would have to rely on these public charging points, so I would need to be more accepting as they would be the way I would charge my car the majority of the time.

Do you think that having these charging points could cause any conflict on your street due to people not using them fairly?
Yes definitely. There is already a problem with finding parking spaces in my street so adding another thing to this could cause problems. I also don't like the idea of relying on other people to move their car on not use the space to long so that I can charge mine. I like to be able to refuel my car when I need to and not rely on others. I think to make sure each person was able to charge there would need to be a sort of management system in place.

PV

Please rate your acceptability of the installation of PV panels on the area of derelict land you are thinking of?
4, I think it would be a good idea

Is this area of land used for anything else such a dog-walking or sports?
No

If there was a way to incorporate the PV panels in the area, and include some recreational uses, do you think this would be a good idea?
Yes, I think it would be a good idea but it's not something I'm overly bothered about. There are enough places to go dog-walking and play sports, there are four parks near this piece

of land so although I think having these uses incorporated would be an advantage, and it would be a major motivator in my acceptance.

If some of the money made from this development was fed back into the community, do you think this would aid with acceptability in the community?

Yes, I think it would help people to accept it more as they would see a direct benefit. However as with the previous question, it is not a major motivator to me personally to accept it.

Appendix 3- Questionnaire Results Tables

Charging Points

	Personal Details			Question Number and Description					
				plug in vehicle	Acceptability of Development	Domestic Charge Ability		Conflict	
Questionnaire No.	Age	Occupation	Postcode	1	2	3	4	5	6
1	20-30	Physiotherapist	G21	would consider	3	Y	N	Y	3
2	20-30	Student	KA21	would consider	5	Y	N	N	5
3	20-30	Civil Engineer	G22	not consider	2	N	Y	Y	2
4	20-30	English Teacher	G21	would consider	5	Y	N	N	5
5	20-30	Student	G4	would consider	5	N	N	Y	5
6	30-40	Student	PA14	would consider	5	Y	N	Y	5
7	20-30	Student	G1	would consider	5	N	N	Y	5
8	20-30	International Coordinator	G33	not consider	4	Y	Y	Y	3
9	20-30	Student	G20	not consider	5	Y	N	Y	4
10	20-30	Student	G4	would consider	5	Y	N	Y	5
11	20-30	Student	G43	would consider	5	N	Y	Y	1
12	30-40	Student	G40	would consider	5	Y	N	Y	5
13	20-30	Student	G31	would consider	3	Y	N	Y	4
14	20-30	Student	G4	would consider	4	Y	N	N	4
15	20-30	Carer	KA16	would consider	5	Y	N	Y	5
16	20-30	Waiter	KA16	would consider	5	Y	N	Y	5
17	20-30	Student	G1	would consider	4	N	N	Y	2
18	50-60	Admin Assistant	G22	would consider	4	N	N	Y	2
19	40-50	Hospitality Hostess	G21	not consider	2	Y	N	Y	2
20	<20	Sales Assistant	G21	would consider	5	Y	Y	Y	5
I1	50-60	Delivery Driver	G21	not consider	3	Y	Y	Y	1
I2	<20	Student	G12	would consider	5	N	Y	Y	5
I3	>60	Retired	G21	not consider	1	Y	Y	Y	1
I4	20-30	Labourer	G22	would consider	4	N	Y	Y	4

PV

	Personal Details			Question Number					
				Acceptability of Development	Used for Recreation	Change opinion	Incorporate Recreational Activity	More Beneficial Land Use	Profit feedback
Questionnaire No.	Age Range	Occupation	Postcode	1	2		3	4	5
1	20-30	Physiotherapist	G21	3	N	.	4	Y	4
2	20-30	Student	KA21	4	N	.	4	Y	4
3	20-30	Civil Engineer	G22	3	Y	Y	4	N	4
4	20-30	English Teacher	G21	5	Y	N	5	Y	5
5	20-30	Student	G4	4	N	.	4	Y	4
6	30-40	Student	PA14	5	N	.	4	Y	5
7	20-30	Student	G1	5	Y	N	2	Y	2
8	20-30	International Coordinator	G33	5	N	.	5	N	5
9	20-30	Student	G20	5	Y	Y	5	Y	5
10	20-30	Student	G4	5	Y	Y	5	N	5
11	20-30	Student	G43	5	Y	N	5	N	5
12	30-40	Student	G40	4	Y	N	5	N	5
13	20-30	Student	G4	3	N	.	3	Y	3
14	20-30	Carer	KA16	4	Y	Y	4	N	4
15	20-30	Waiter	KA16	5	N	.	5	N	5
16	20-30	Student	G1	5	N	.	5	N	5
17	50-60	Admin Assistant	G22	4	N	.	4	N	5
18	40-50	Hospitality Hostess	G21	5	Y	N	5	N	5
19	<20	Sales Assistant	G21	4	N	.	4	N	4
I1	50-60	Delivery Driver	G21	5	Y	N	5	N	5
I2	<20	Student	G12	5	Y	N	5	N	5
I3	>60	Retired	G21	5	Y	N	5	N	5
I4	20-30	Labourer	G22	4	N	.	4	N	4