## Introduction



The Sustainable Glasgow initiative aims to make Glasgow one of Europe's most sustainable cities within 10 years.

Sustainable Glasgow is a collaboration between University of Strathclyde; Glasgow City Council; Scottish and Southerm Energy; Source One Veolia; Blitzer Clancy and Company, and Scottish Enterprise. Additional partners, including Scottish Power; are now coming on board to help make the sustainable city a reality.

Most scientists in the world agree that emissions of gases such as carbon dioxide and methane are a major cause of climate change – and that the effects of climate change are likely to have dramatic but as yet unresolved impacts for all parts of world, including Glasgow. Countries are therefore working together through global and European treaties to set binding targets to reduce carbon emissions. The use of energy has brought huge benefits to human populations across the world, but also comes with significant environmental impacts. Carbon dioxide emissions by human populations are strongly linked with energy production and consumption.

Cities have an important role to play. Cities are massive concentrators of the world's people and resources. Over half the world's population lives and works in cities, where up to 75% of energy is consumed – and the proportion of the world's population living in cities is projected to increase.

Around 80% of the world's greenhouse gas emissions are created in and by cities – and most of these emissions are related to the generation and use of energy from fossil fuels. Scotland's cities will therefore need to play a vital part in tackling climate change – and as Scotland's largest city Glasgow has a key role to play.





#### **Public Policy Context**

The Scottish Government's Climate Change Act has set a target to reduce Scotland's carbon emissions by 42% by 2020 – with an 80% reduction by 2050 (both these targets are measured against a benchmark of Scotland's emissions in 1990. The 42% target equates to a 30% reduction from 2006 CO2 emission levels). The Act also requires the Scottish Government to set annual targets, after seeking advice from the Committee on Climate Change. It requires that emissions reduce each year from 2010, and that the rate of reductions from 2020 onwards is at least 3% per annum. These are ambitious targets that will require active participation from all parts of Scotland's society and economy. Glasgow recently joined the EU Covenant of Mayors and is committed to achieving a 20% reduction in carbon emissions by 2020 – and Sustainable Glasgow aims to go beyond this.

The UK government is committed to achieving an 80% reduction by 2050, and to an EU target for 15% of all energy consumed in the UK to come from renewable sources by 2020.

The Scottish and UK Governments, and the EU, are putting in place a wide range of policy measures designed to achieve the above targets for carbon emission reduction, through improving energy efficiency and growing renewable energy generation. A number of major incentive mechanisms are already in place – such as the renewable obligation (or RO) and EU Emissions Trading Scheme. These mechanisms have acted mainly on large scale energy producers and consumers. Other mechanisms are being brought into effect over the next few years that will have an impact on a wider proportion of economy, right down to the household level. These measures involve both regulatory enforcement and financial incentives designed to give a significant and growing stimulus to the development of the UK's low carbon economy. The Scottish Climate Change Delivery Plan aims at four major transformational outcomes:

- a largely decarbonised electricity generation sector by 2030
- a largely decarbonised heat sector by 2050 (with significant progress by 2030)
- an almost complete decarbonisation of road transport by 2050 (also with significant progress by 2030)
- a comprehensive approach to ensure that carbon (including the cost of it) is fully factored into strategic and local decisions about rural land use.

A few examples of key new policy measures are given in the diagram opposite.

#### New Public Policy Measures 2010 - 2015

Domestic Sector measures								
<b>January 2009</b> Energy Performance Certificates required	Decen CESP so	nber 2009 cheme active		April 2011 CERT scheme end possible extension	s —	Dec CES (CEI	<b>Eember 2012</b> P scheme ends RT extension ends)	
2009		2010		2011	2012		2013	2014
Duringen								
Business measures								
April 2010 Carbon Reduction Commitm Energy measurement red Businesses face penalties	<b>nent</b> quired	April 2011 First sale of C allowances £12 per tonn	CRC CO2		April First a allowa	12013 CRC auction of ances		<b>January 2015 CRC</b> Penalties/bonuses applied
2009		2010		2011	2012		2013	2014
April 2009 Renewable Obliga Banding introduce	ation d	April 2010 Electricity Feed cariffs introduc	d-in ed	April 2011 Renewable Heat Incentive introduced		Jan Em Sch intr	uary 2013 EU issions Trading terme Phase III roduced	
2009		2010		2011	2012		2013	2014
April 2010 Climat Change Act (Scot Sets carbon targets 50% reduction by 20 80% reduction by 20	<b>te :land)</b> 30 50	<b>June 2010</b> Scottish Minist climate change	Janu New to de	<b>tary 2011</b> 7 duty on public bodi elivering climate chan 2 annual ts	es to contribute ge targets	Januar City F	ry 2014 Ilan 3 adopted	
November 2009 Scottish Government Renewable Heat action plan published		Spring 2010 Scottish Governr efficiency action	ment E plan pu	nergy Iblished				

#### **Strategic Approach**

Delivering major carbon emission reductions is not an insurmountable goal. By breaking delivery of carbon reductions into a series of smaller evidence based opportunities and projects, and situating those projects within an overarching framework created so that projects support each other, the steps to delivering that goal become clear and achievable.

Through analysing Glasgow's current carbon emissions; the city's renewable energy resources; its infrastructure; and proposed new developments the Sustainable Glasgow Initiative has identified technically and financially feasible opportunities that could reduce Glasgow's carbon emissions by 30% within the next 10 years. 2006/07 will be taken as a baseline for this target. This is equivalent to the Scottish Government's target of achieving a 42% carbon reduction by 2020.

Glasgow will therefore make a major contribution to achieving Scottish and UK carbon emission targets and, where possible, Sustainable Glasgow will seek opportunities to go beyond its 30% reduction target.

There is an inherent tension in reducing carbon emissions whilst simultaneously seeking economic and population growth. Balancing these goals means Glasgow must seek to reduce the carbon intensity of its energy supplies, as well as improving the efficiency with which energy is utilised within its economy and homes. Sustainable Glasgow's focus is on identifying technologies and approaches that are feasible for Glasgow now. The proposals given here do not rely on some unproven technological magic bullet to deliver a major reduction in the city's carbon emissions at some indefinite point in the future. The proposed technologies are proven and financially viable.

Tackling climate change is not just an obligation – it is also an opportunity and Sustainable Glasgow goes significantly beyond achieving carbon emission reductions. Sustainable Glasgow will deliver major investment; create long-term jobs; help tackle fuel poverty; support the development of new clean energy sector in the city; create new revenue streams for the Council; improve air quality; and help regenerate communities. This will help transform Glasgow's image – making it a better place to live, work, and invest.

Sustainable Glasgow aims to maximise the potential for partnerships with other public and private investment programmes, and will work to maximise the positive outcomes from this strategy for Glasgow and its people.

Glasgow City Council has a key role to play in delivering Sustainable Glasgow – providing leadership and implementing supportive public policy measures. But vital to Sustainable Glasgow's success will be the active support and involvement of its citizens; businesses; universities; housing providers; developers; utility companies; and the wider public sector. Sustainable Glasgow proposes a framework for the future development of energy infrastructure in Glasgow – and takes a long term view that will allow the even larger carbon emission reductions necessary for Scotland and the UK to achieve an 80% reduction by 2050 target.

The initiative so far has identified the significant opportunities available in Glasgow, and makes proposals that will make Glasgow one of Europe's most sustainable cities. The next phase of activity for Sustainable Glasgow will be focussed on making the proposals in this strategy real – bringing in a wider range of potential partners; drawing in the investment required; and consulting Glasgow's citizens and businesses on how they want to take Sustainable Glasgow forward.

The primary focus of Sustainable Glasgow has been on the city's carbon emissions; the energy systems and energy consumption related to those emissions; and closely related issues – such as the attitudes and behaviour of citizens and organisations – and opportunities related to these issues. The main themes for the Sustainable Glasgow strategy are:

- Improve energy management
- Identify and use the main renewable energy resources;
- Implement efficient energy systems
- Engage the enthusiasm and talent of Glasgow's people and businesses
- Create a supportive public policy environment
- Deliver this in a way that helps tackle fuel poverty; delivers jobs; and improves the city as a place to live, work and locate.

This report summarises the main findings of the initiative so far – however certain details are omitted due to commercial sensitivities.



## Glasgow's vision

Sustainable Glasgow Initiative has developed a vision statement in order to:

- ensure that Sustainable Glasgow's partners, the people and businesses of Glasgow, and other stakeholders, share a common understanding of Sustainable Glasgow's objectives;
- show clearly the direction of travel of the Sustainable Glasgow initiative;
- enthuse and assist in gaining the support of people, businesses and other stakeholders

The vision statement balances different policy goals that to some extent exist in tension and balances ambition with realistic opportunities for delivery.

#### **Vision Statement**

Sustainable Glasgow will act in partnership to make Glasgow one of Europe's most sustainable cities within 10 years. Our aim is to improve the lifestyles and opportunities for Glasgow's people and businesses, enhance Glasgow's image as a leader in sustainable urban living, and to deliver this in a way that is compatible with the development of a vibrant and growing city.

We will make a tangible contribution to tackling climate change through reducing Glasgow's carbon emissions by 30% within 10 years, maximise use of sustainable energy resources, and minimise Glasgow's adverse impacts on the environment.

Sustainable Glasgow will go significantly beyond achieving carbon emission reductions. Sustainable Glasgow will deliver major investment; create long-term jobs; help tackle fuel poverty; support the development of new clean energy sector in the city; create new revenue streams for the public sector and communities; improve air quality; and help regenerate communities. We will help transform Glasgow's image – making it a better place to live, work, and invest.

Our vision is broad – covering energy systems, energy management, waste, transportation, and behavioural change. We aim to deliver Sustainable Glasgow in a way that is both technically and financially achievable with a 10 year time frame.

# Glasgow's Carbon Footprint



#### **Glasgow's Carbon Footprint**

The first step to delivering large scale carbon emission reductions for the city is understanding its existing pattern of carbon emissions.

Energy use in Glasgow city is responsible for emissions of around 4 million tonnes of carbon dioxide every year. This is around 8% of Scotland's total carbon dioxide emissions linked to energy production and use. The breakdown by sector is Transport - 20%; Industrial/Commercial/Public sector – 42%; Domestic – 34%.

#### Glasgow's Carbon Footprint - 2006/07

Annual Carbon Dioxide Emissions for Glasgow City

Domestic Electricity	17%
Domestic Gas	17%
Industrial/Commercial Electrici	ty 28%
Industrial/Commercial Gas	14%
Personal Transport	12%
Road Freight	7%
Buses	1%
Coal, Oil	4%

(Thousands of Tonnes)	
Domestic Electricity	694.5
Domestic Gas	673.4
Ind/ Com electricity	34.0
Ind/Com Gas	539.3
Personal Transport	494.3
Road Freight	261.0
Buses	41.0
coal, oil	149.7
Total	3987.3

Annual CO2 emissions for Glasgow

Source: BERR: Regional and Local Authority Energy Consumption Statistics 2006/07

Glasgow's energy comes almost entirely from national energy distribution and transmission systems. Glasgow currently generates very little energy from within its own boundaries.

These emissions figures do not include emissions from the Greater Glasgow conurbation (so emissions related to Glasgow Airport are excluded for example).

The carbon emission figure given above also does not include additional methane emissions related to waste treatment and disposal (estimated as the equivalent of an additional 200,000 tonnes CO2 per annum – or an additional 5% carbon emissions from Glasgow), or carbon emissions incurred elsewhere linked to goods and services consumed in Glasgow (eg food consumed, the steel used in cars, the concrete used in buildings etc). A further phase of research could examine Glasgow's wider carbon footprint and impact on the world.



Comparing Glasgow to other parts of the UK suggests that its carbon dioxide emissions per capita at 7.1 tonnes are lower than the Scottish average of 8.5 tonnes – and lower than other Scottish cities. However it is important to see this comparison in a wider context. Carbon emissions reflect factors such as the composition of local economic activity, household income, car ownership, access to the gas grid, building quality and density, and the relative sizes of homes. Glasgow has a higher dependency on commercial and public sector activity (rather than manufacturing – which is a higher energy consumer), lower car ownership, a significant number of low income homes, and smaller than average dwelling sizes. The Scottish Index of Multiple Deprivation (SIMD) 2006 indicates that, on measures relating to income, health and education, 52% of the most deprived areas (worst 5%) SIMD zones in Scotland are in Glasgow. Lower incomes and other factors all tend to lead to a lower than average carbon footprint. Per capita carbon emissions (and similar indicators) are therefore probably better used by Glasgow as a way of measuring its ongoing progress rather than as a way of comparing its performance to other regions.

However, parts of the city show a different picture. The map below shows that the city centre of Glasgow has the highest density of energy consumption in Scotland (once power stations and oil refineries are excluded) and this is mainly due to high levels of commercial and retail activity. Glasgow also has a number of significant industrial energy consumers – such as food and drink companies.

This geographic analysis allows Glasgow's sustainability strategy to be designed so that it targets low carbon energy measures in the areas where they will have the most impact on Glasgow's carbon emissions.



#### Glasgow's Carbon Emissions 2006/07– Geographic analysis

There is little data available on long-term trends of energy consumption in Glasgow. However by analysing changes in the composition of Glasgow's industrial and commercial sector; and population trends, we can make deductions about Glasgow's energy use. This suggests the following: industrial energy consumption will have dropped over the last 20 years and commercial and public energy consumption will have risen (and can be expected to continue to rise). It is too early to evaluate the energy impact of the current economic recession on Glasgow but this will have reduced energy consumption in some sectors – reduced occupancy of office space in Glasgow suggests that the business sector will have seen a reduction in activity (and therefore energy consumption). Assuming a resumption of economic growth this reduction in activity is expected to be temporary.



Change in Glasgow Company Stock by Sector - 2001 to 2008

The picture in the domestic sector is more complex –but the long term trend for the domestic sector is expected to reflect the projected trend for Scotland – a rise in energy consumption by the domestic sector of around 1% per annum. This is due in part to the increase in energy consumption by consumer electronics and computers; use of dishwashers and washing machines; increased use of freezers and larger refrigerators; and increased numbers of single person householders. Rates of car ownership in Glasgow are the lowest in Scotland (at 0.25 vehicles per head of population), and the second lowest in the UK – but vehicle ownership rates are increasing quickly and this will act to increase transport energy consumption, as well as having an adverse impact on air quality.

Demographic factors are also important A growing population and the UK-wide trend towards an increasing proportion of single person households (due to increased longevity) will also tend to increase energy demand.



The graph below shows a dramatic decline in Glasgow's population since the 1950s. This was due to range of factors – including the decline of Glasgow as one of the world's major ports, changes in trade patterns that meant the loss of markets for manufactured goods, and projects aimed at improving living conditions for people in the city centre that moved them to new out of town housing developments. However, more recently the city's population has started to increase to its current level of 584,000 - with the wider urban conurbation having a population of 1.2 million.



**Glasgow Population** 



Overall the report estimates that Glasgow's energy consumption and carbon footprint will have risen over the last 10 years. Assuming a stable (or growing) population and economic growth the upward trend can be expected to continue unless significant action is taken. The next section summarises the new low carbon energy systems proposed for Glasgow.

The report recommends:

- ongoing tracking and more detailed analysis of Glasgow's carbon emissions;
- consideration is given to conducting an analysis of Glasgow's wider carbon footprint.

# A new energy framework for Glasgow

### Sustainable Glasgow proposes reducing the city's carbon emissions through improved energy management and the development of new integrated low carbon energy systems for the city.

Typically new developments in cities – such as offices, hotels, housing estates, and hospitals - are seen by both developers and energy utility companies as a series of islands – at least in energy terms - with no relationship with each other, their neighbours, or other infrastructure. This means that many opportunities to implement green energy solutions across the city are not currently grasped - and opportunities for these developments to work together are lost.

By looking at the city in a new way this report takes a holistic view of the city and its opportunities – and proposed energy systems are designed so that they support each other, as part of a wider framework, rather than as a series of opportunistic small-scale changes to existing systems.

The proposals are based on analysis of the following key elements:

- Mapping and analysing the city's energy demand by sector and geographically;
- Mapping the low carbon energy resources in and around the city – including their size and availability;
- Identifying approaches that could improve energy management and energy efficiency in the city;

- Identifying the low carbon energy systems that are technically, environmentally and financially viable for deployment in the city – including an assessment of the overall impact they would have on reducing the city's carbon emissions, the estimated costs, and other impacts;
- A review of the approaches that are working well in other cities across the world;
- The positive role that such systems could have in tackling problems in the city – such as fuel poverty; poor air quality; unemployment; and traffic congestion;
- The contribution that the proposals would make to the city's other strategic objectives;
- The potential contribution to meeting environmental regulations – such as the need to reduce landfill, and obligations under the Carbon Reduction Commitment;
- The public policies that could be put in place to support the development of Glasgow as a low carbon city, and to maximise the wider positive impacts of that development – such as job creation, community regeneration, and improving the city's image;

Delivering city-wide large scale carbon emission reductions requires major change – and this step change will need to be delivered by large scale projects and large scale investment that will create a new integrated clean energy infrastructure for the city. Significant changes to create a supportive public policy environment are also necessary. Small scale and emerging renewable technologies also have the potential to make a contribution to carbon emission reductions as well as generating community engagement and direct benefit. The main themes for reducing the city's carbon emissions related to its energy use are summarised in the table below I. The list below is not a hierarchy, all of these opportunities need to be pursued in an integrated fashion in order to maximise carbon emission reductions. No one technology or approach can deliver the levels of carbon emission reduction required.

Theme	Example measures
Reducing wasteful or unnecessary energy use by end users	<ul> <li>Improved energy efficiency – eg household devices; vehicles; buildings</li> <li>Behavioural Change</li> <li>Energy management</li> </ul>
Improving the efficiency of energy systems	<ul><li>District Heating</li><li>Smart grids</li><li>Demand Management</li></ul>
Reducing use of high carbon fuels	Phasing out of coal, oil and electrical resistance heating
Exploiting local renewable energy resources	• Biomass, solar, wind
Reusing the city's waste for low carbon energy	<ul> <li>Capturing waste heat from industry</li> <li>Waste to energy</li> <li>Production of biogas from sewage and organic waste</li> </ul>

<sup>1</sup>The study's focus is primarily on energy use – and it has therefore not examined measures that could reduce Glasgow's indirect carbon impact from the goods and services it consumes – such as reducing consumption of goods and services and increasing recycling.



#### Proposed integrated low carbon energy systems for Glasgow

The systems proposed are in use individually elsewhere in the world already – so their technical feasibility is proven. What is unique is the way these systems have been integrated and designed for sympathetic retro-fitting on a large scale into an existing city. The proposed new systems are shown in the diagram above. It shows how the city will harness cleaner energy sources and use more efficient systems to deliver carbon emission reductions.

- New low carbon energy systems will process the city's sewage and municipal waste using microbes (anaerobic digestion) to produce biogas which can fuel buses and generate heat and power for the city.
- Compost and digestate produced from anaerobic digestion can make the city's vacant land more fertile to help grow urban woodlands.
- Timber from the new urban woodlands and from forests around Glasgow will be used to generate heat and power for the city in biomass energy centres.
- District heating systems will use underground insulated hot water pipes to take the heat from these low

carbon energy sources to businesses and communities for heating buildings and providing hot water.

- Highly efficient local energy centres will use natural gas and biogas in Combined Heat and Power systems to generate low carbon heat and electricity.
- The above systems will also allow waste heat and other waste materials from industrial and commercial premises to be captured and used to provide low carbon energy for the city.
- Wind and microgeneration technologies such as solar power will also make a contribution to providing low carbon energy.
- Smart grids offer the opportunity to integrate low carbon technologies and manage energy demand through enhanced energy distribution and transmission in ways that offer greater carbon emission reductions.
- New energy efficiency measures and energy management systems are implemented in homes, public buildings, and businesses to improve the efficiency of energy use.

The main opportunities lie in capturing low carbon energy and utilising energy more efficiently through the following approaches. The estimated contribution each approach would make within 10 years to Glasgow's 30% carbon emissions reduction is given below:

Combined Heat and Power/District Heating	9%
• Biomass	2%

- Biogas and Waste to Energy systems
   6%
- Other renewable energy systems
   3%
- Sustainable Transport systems
   3%
- Phasing out high carbon fuels 3%
- Energy management and energy efficiency 6%

The opportunities already identified come to slightly more than the 30% target proposed.

The total cost of implementing these systems is estimated as around  $\pounds$ 1.5 billion. Much of this investment is expected to come from the private sector.

Implementation of these systems will require co-operation from a wide range of commercial and public sector entities – and there is already strong interest from investors, developers and utility companies in taking these projects forward.

The stakeholder map at Annex A identifies some of the main potential stakeholders in the Sustainable Glasgow initiative. These include a wide range of public, commercial, and voluntary organisations - though the list is not exhaustive. The analysis provides a view of their probable main interests in relation to the initiative.



## Energy Management

### Delivering a sustainable city depends on citizens and organisations using energy more efficiently and effectively – as well as the delivery and integration of new clean energy systems.

Energy efficiency measures can often offer the easiest and most cost effective approach to achieving carbon emission reductions. Many homes and businesses have already taken some steps to improve the energy efficiency of their homes and premises. However there are a number of barriers that act to restrict the adoption of additional measures. These barriers relate to provision and understanding of information; consumer behaviour, understanding and priorities; access to finance; and current energy supply business models and regulation. Most energy consumers do not undertake energy efficiency measures with the direct aim of reducing carbon emissions. They are more normally motivated by a range of more direct and immediate benefits – such as achieving cost savings; improving building comfort levels; improving the value of buildings; improving process performance; and improving organisational reputation.

#### Summary of key barriers to greater adoption of energy efficiency measures by people and businesses:

- Many consumers do not see energy efficiency as a priority
- · Consumers tend to focus on the up-front costs of efficiency measures rather the whole life benefits
- · Consumers have difficulty in estimating the financial savings that will be achieved by a given energy efficiency measure
- · Consumers often have inadequate information on the effectiveness of individual energy efficiency measures
- · Poor customer information/understanding on which activities/devices consume the most energy
- Customer distrust of certain sources of information (eg government and energy companies)
- Difficulties in achieving long-term and sustained behavioural change
- Frequency of moving home acts as a disincentive to installing measures requiring a long-term financial payback
- Energy efficiency tends to get a low ranking on consumer reasons for buying/renting a property
- A lack of incentives for making improvements in rented properties for both tenant and landlord
- Energy sector business models which link revenues to sales of energy
- The consumer's right to change energy supplier frequently acts as a barrier to alternative business models (eg Energy Services Companies or ESCOs)
- Difficulty in obtaining low cost finance for significant energy efficiency measures
- Businesses often focussed on short term profitability.

A significant number of initiatives are in place that support the implementation of energy efficiency measures in the domestic, commercial and public sectors. These are detailed below. It is not the intention of Sustainable Glasgow to replace these measures – but the initiative will seek to identify gaps; areas where existing measures could be targeted more effectively;

and seek to identify and implement additional energy management measures and initiatives that lead to significant reductions in the city's carbon emissions. This report does not provide details of individual technical energy efficiency measures as high quality information is available, along with advisory services, from several other sources and agencies.

#### **Existing energy efficiency initiatives**

There are a number of existing and proposed government programmes which make a substantial contribution to improving energy efficiency in Glasgow. The Scottish Government is currently consulting on its Energy Efficiency Action Plan for Scotland. Some of the proposals below would require legislative changes and will therefore need to be raised with the Scottish Government as a part of its current consultation.

#### Domestic Energy Efficiency

The housing type mix, age profile and tenure mix of the housing stock in Glasgow is markedly different from the rest of Scotland. Housing Associations currently provide around 43% of Glasgow's housing – much higher than the rest of Scotland – and the privately owned sector is correspondingly smaller. Glasgow currently has 294,000 homes – and estimates suggest that this will increase by between 25,000 and 30,000 homes over the next decade. 51% of properties in Glasgow are tenements and a further 23% are flats – making up 74% of properties (compared to 33% for Scotland as a whole).

Glasgow's housing stock is also older than average for Scotland with nearly half of the stock constructed before 1945, and only 12% constructed in the last 25 years.

Due to a progressive tightening of building regulations new houses are generally far more energy efficient than older properties - however the slow rate of replacement of buildings (I to 2% per annum) means that older less energy efficient properties will provide the majority of housing for many years to come. This means that measures that can be retro-fitted at reasonable cost to older properties are particularly valuable in reducing carbon emissions. Existing properties also contain large amounts of embedded energy – that is, the energy used to produce and transport materials such as brick, concrete, cement, and stone – and energy used in the construction process. So demolishing existing buildings to replace them with more efficient structures can take some years to actually produce a net overall carbon emission reduction.

Tenure	Glasgow	Glasgow	Scotland
Owner Occupier	149,483	48%	64%
Glasgow Housing Association/Local Authority	72,260	29%	23%
Private Rented	27,945	8%	8%
Housing Association	44,462	14%	5%
Total	294,150	100%	100%

An assessment by Glasgow City Council for the Home Energy Conservation Act (HECA) concluded that the city could achieve a 35.5% reduction in carbon emissions (from 1997) from housing within 10 years. This figure includes savings from both physical measures and behavioural change. Glasgow reported in 2007 that it had achieved a 32.1% reduction in its carbon emissions from housing. The greatest improvement was achieved in ex-council housing stock which was transferred to the new Glasgow Housing Association in 2003 - and are benefitting from a £1.5 billion investment programme that has fitted new heating systems, replaced windows, improved heating controls, and fitted both internal and external insulation. Emissions from local authority/GHA stock are estimated as having been reduced by 55% in the period 1997 to 2007. This very significant reduction is due in part to the relatively poor energy efficiency of much of this stock when HECA started monitoring in 1997.



The reduction achieved so far is significant – but it does not mean that further improvements cannot be delivered through improved energy efficiency and energy management. There are likely to be greater opportunities for simple energy efficiency measures in the owner occupied and private rented sector – as these have shown the smallest improvement in the last 10 years – but these sectors are more difficult to target.

Details of UK wide energy efficiency schemes that also operate in Glasgow are given below. These schemes are useful – but are significantly smaller than the ongoing investment in improving Glasgow's social housing.

#### The Carbon Emissions Reduction Target (CERT) -

is the largest individual programme contributing to energy efficiency in housing - estimated as spending around £100 million per annum to 2012 across the whole of Scotland. CERT is an obligation on large electricity and gas suppliers to achieve a specified amount of carbon savings in homes across Great Britain between 2008 and 2011. Energy suppliers are free to meet their target in homes irrespective of location, ownership, eligible measures used, or energy supplier. A pro-rata share of this funding would suggest that around 8,000 homes in Glasgow would benefit from loft insulation or cavity wall insulation. Other measures commonly supported by CERT in the past include the provision of free low energy light bulbs.

#### The Community Energy Saving Programme (CESP)

will run over three years, beginning in January 2010. It requires energy suppliers and generators to achieve carbon savings in areas of low average income – and as such a number of areas in Glasgow could benefit. However it is a much smaller programme than CERT – though there is expected to be a larger successor programme in 2013. CESP could lead to  $\pounds$ 3 I million of spend over three years by energy suppliers and generators in Scotland. Glasgow City Council estimate that if Glasgow's share of this funding is proportionate to levels of deprivation the city would receive around  $\pounds$ 9 million – which would benefit around 3,000 homes.

Advice on energy efficiency measures for householders is available from a number of sources – including social landlords, Glasgow City Council, and the Energy Saving Trust (www.energysavingtrust.org.uk). Measures such as the Energy Assistance Package target low income households for energy efficiency measures.

In taking decisions on energy efficiency many householders are currently strongly motivated by a wish to save money (due to concerns about high energy prices), and a wish to increase comfort levels in their home - rather than a direct wish to reduce carbon emissions and tackle climate change. Engaging householders in improving the energy efficiency of their own properties, household devices, and electronic equipment through the decisions they make in their day to day lives has been a main plank of energy efficiency policy for many years. However the response to such campaigns can be disappointing – with many householders failing to make investments in relatively simple and cheap energy efficiency measures. This is particularly true in the privately rented sector where both tenants and landlords are less likely to be willing to make investments that they see as mainly benefitting the other party (though in fact both parties benefit overall). A further problem is that many householders in the UK move homes relatively frequently and may see it as a poor investment to install energy efficiency measures that take several years to repay the initial capital investment.



A survey conducted for the initiative showed that certain key sources of information (such as government, environmental groups and energy companies) are much less trusted than friends and family as sources of information on climate change. Creating networks of local experts and champions within communities might therefore be a more effective way of delivering accurate information on sustainability and energy efficiency.

Generally current energy tariff structures do not actively encourage households to reduce energy consumption. In fact households with higher energy consumptions pay a lower average price per unit of energy consumed. There are alternative tariff structures that charge a lower price for the initial units of energy consumed, and then progressively increase the cost per unit so that households with the highest consumption pay the highest average rate per unit consumed. Instituting such an alternative tariff structure would require the co-operation of both utility companies and the regulator (Ofgem) – as well as care to ensure that certain types of household (eg those with children or older people) are not unfairly penalised.

One of the problems faced by the initiative is a lack of sufficiently detailed information to allow strategic targeting of additional energy efficiency measures. The initiative recommends improved sharing of energy consumption data by energy companies with local energy planners to help target future investment and activity. This is likely to require changes to energy regulations.

A key further issue is how householders and small businesses can be given improved access to low cost finance for energy efficiency measures. One option is the Energy Services Company (or ESCO) model where the ESCO invests in energy efficiency measures and shares the financial savings with the householder or business. This is likely to require changes to energy regulations that would allow the finance to be linked to the property rather than the customer. It may be possible to set up ESCOs through partnerships with major commercial entities. A similar result could be achieved by creating property linked loans for energy efficiency from the Council that are recovered via the Council tax.

The initiative proposes a number of additional measures for the domestic sector:

- Conduct an accurate building by building survey of Glasgow, and create a geographic information system, that will allow identification of the properties that will benefit most from energy efficiency and energy management measures. These buildings then to be targeted for advice and other measures. This might also enable implementation of a targeted street by street approach to improving energy efficiency – this approach has been found to be effective in other schemes.
- Propose to Scottish and UK governments a regulatory change that would allow energy consumption data from individual domestic customers to be shared with certain organisations (eg local authorities) for the purposes of energy planning and improving energy efficiency.
- Open discussions with utility companies and the regulator on the potential to implement additional alternative tariff structures that reward lower energy consumption – perhaps on a pilot basis to allow evaluation of their impact in the city.



- Recommend the Sustainable Glasgow Initiative works closely with the social housing sector to identify additional technically and financial feasible energy efficiency measures. For example, potential opportunities may lie in energy monitoring and management.
- Sustainable Glasgow Initiative to consider working with EST, housing associations, and other providers of energy efficiency advice to deliver joint awareness raising campaigns, and to consider how to improve the effectiveness of such campaigns. This might include creating and training local community champions and working through schools – the initiative's survey results are clear that more people trust their friends and family than other sources for information on climate change.
- Work with other organisations to identify effective measures for retrofitting in the types of building that make up much of Glasgow's housing stock – ie tenements, flats, and older buildings.
- Work with potential commercial partners to explore options for the creation of Energy Services Companies (ESCOs) in Glasgow.

- The Council to consider creating energy efficiency home loans that are linked to homes (rather than people) and recovered via the council tax linked to that property over a number of years. Such loans would only be applied to an agreed list of eligible energy efficiency measures and technologies. This would require legislative change in order to be delivered – and the suggestion could therefore be fed to the Scottish Government as a part of their current consultation on its Energy Efficiency Action Plan;
- Glasgow City Council to set a minimum standard for energy efficiency for Houses in Multiple Occupation (HMOs) as a part of the licensing procedure. Local authorities are allowed to set any conditions they deem appropriate for HMO licenses – however there are only around 2,500 licensed HMOs in Glasgow (less than 1% of the housing stock). Nevertheless such a move could still be a useful signal to the wider rental market. New legislation is expected that would allow a minimum energy efficiency standard to be set for all privately rented properties.

#### Commercial and Public Sector Energy Efficiency

A breakdown of jobs in Glasgow gives an indication of the make up of Glasgow's economy. A significant proportion of Glasgow's non-domestic carbon emissions are related to retail, finance, commercial and public sector activity – with the service sector making up 80% of Gross Value Added in the city – however there are sectors where a small number of organisations can have high energy consumption and high emissions due to the type of activity – particularly relevant in Glasgow are the food and drink sector; the leisure sector; data processing and storage; distribution warehouses; and certain types of public sector facilities (such as hospitals). There are also a few large manufacturing facilities with high energy profiles. The carbon density map below shows the very high density of emissions in the centre of Glasgow – predominantly due to commercial, retail, and public sector activity.

These organisations, the economic activity and jobs they bring, are very welcome in Glasgow. They play an essential role in making Glasgow a vibrant and successful city. Sustainable Glasgow's objective is assist these organisations to reduce their carbon emissions in ways that make financial and operational sense for them – and help them to achieve their objectives through reducing costs, identifying new potential revenue streams, and improving the city environment in which they work and do business.

Employee Jobs by Sector	2007	2002
Energy/Water	4.0	4.1
Manufacturing	23.1	26.7
Construction	16.1	16.8
Distribution	79.4	80.7
Transport	21.7	23.5
Finance	103.0	88.5
Public Services	125.3	7.7
Other Services	18.1	21.3
Total	390.7	379.3

(Thousands)

Source: Office for National Statistics

NB: The Distribution sector includes hotels and catering the Finance sector includes all other commercial activities (such as retail); and the public sector includes health and education.





#### UK Prices Of Fuels Purchased By Industrial Consumers (Excluding Tax)

In many of these sectors energy has historically been a low proportion of operating costs, and regulatory pressures on these sectors to reduce energy consumption have not been high. But major increases in energy prices over the last 5 to 6 years are proving a significant spur to commercial interest in reducing energy consumption. In addition the Carbon Reduction Commitment will act to incentivise carbon emission reductions in many medium sized organisations.

Both the Energy Saving Trust and Carbon Trust (www. energysavingtrust.org.uk and www.carbontrust.co.uk) provide targeted advice to businesses to help them improve their energy efficiency. Energy efficiency and energy management measures in the commercial, public, industrial sectors frequently need to be assessed on a case by case basis in order to demonstrate the cost and energy savings available. As well as the Carbon Trust and the Energy Saving Trust there are many commercial consultancies able to provide advice in this area. The nature of business (where short term profitability is a significant concern – particularly in a recession) means that many organisations will only implement energy efficiency measures with very fast payback times (ie less than 2 or 3 years).

A range of regulatory measures are already in place to incentivise improved energy efficiency by commercial organisations. These include the Climate Change Levy which is a tax on energy delivered to non-domestic consumers. Under the Climate Change Agreement energy intensive industries can receive an 80% reduction on the levy in return for meeting challenging emission reduction targets. The EU Emissions Trading Scheme (EU ETS) places a cap on carbon emissions from certain industrial sectors – and requires companies to buy permits to cover any additional emissions. The EU ETS is unlikely apply directly to most industrial activity in Glasgow – it has however led to an increase in electricity prices for all consumers. From April 2010 the Carbon Reduction Commitment (CRC) will apply to organisations whose electricity usage is more than 6,000 MWh a year - and that are not already covered by a Climate Change Agreement or the EU ETS. The CRC will (for example) cover Glasgow City Council, government departments, universities, hotel and supermarket chains, and commercial and retail activity. The scheme will operate like the EU ETS – as a cap and trade scheme – so that organisations emitting more than their cap will need to pay for additional allowances. The revenue from the scheme will recycled to participants in proportion to the emission savings they achieve.

The Sustainable Glasgow initiative has obtained significant amounts of energy consumption data from individual organisations – however in a city the size of Glasgow this is highly resource intensive task. The initiative makes proposals below aimed at improving the available of energy consumption data to energy planners.

Many commercial building in the centre of Glasgow are leased or rented from commercial landlords – and this can create a barrier to investment by commercial organisations to improving the energy efficiency of the buildings they lease. A significant proportion of commercial buildings in the centre of Glasgow are owned and operated by a relatively small number of major commercial landlords.

Additional mechanisms exist to promote energy efficiency in the public sector – including mandated government targets, and access to novel financial support mechanisms (such as revolving loan funds, Salix and the £20 million Central Energy Efficiency Fund). Under such schemes the financial savings achieved from energy efficiency measures are reinvested in the loan fund to deliver additional energy efficiency measures in the future. Independent evaluations have shown these revolving loan funds are successful, and the initiative recommends consideration is given to creating or expanding such funds on a city-wide basis.

#### Recommendations:

- Conduct an accurate building by building survey of the commercial centre of Glasgow, and create a geographic information system, that will allow identification of the properties that will benefit most from energy efficiency and energy management measures. These buildings then to be targeted for advice and other measures.
- Propose to Scottish and UK governments regulatory changes that would require detailed consumption data from individual commercial and public sector customers to be shared with certain organisations (eg local authorities) for the purposes of energy planning, energy management, and improving energy efficiency.
- Engage with the major commercial property landlords in Glasgow to discuss measures they can take to reduce the carbon emissions of the buildings they own;
- Conduct a more detailed mapping of carbon emissions in key sectors – such as food and drink manufacture, data storage and processing, leisure, large retail, large offices and the public sector;
- Work with organisations in these key sectors to help them reduce carbon emissions in ways linked to Sustainable Glasgow projects;
- Examine options for creating/expanding revolving loan funds for energy efficiency measures.



#### Infrastructure

The initiative has also examined whether there are opportunities for improved energy management linked to the city's underlying infrastructure – for example its street lighting and water supply systems.

Street lighting accounts for around 29,000 tonnes (0.75%) of Glasgow's total carbon emissions – and is necessary for road and building safety, security, and improving the appearance of the city. There are a number of techniques available to improve the energy efficiency of lighting systems – including improved control systems, lighting policies that reduce the hours that streets are lit, voltage regulation, and modern lighting systems such as Light Emitting Diodes (LEDs). Trials of intelligent lighting systems in Oslo, Fife, and the US have delivered reductions in energy consumption of between 50% and 70% - and have payback times of around 5 years. A more detailed assessment is required of the opportunities in Glasgow so that carbon emission reductions are balanced with security and safety - but it appears a programme of more efficient lighting could deliver a reduction of up 0.5% in Glasgow's carbon emissions.



#### Water

A strong link exits between energy and water consumption. Achieving efficiency in the water sector involves addressing water the whole of the water supply and consumption cycle - the supply of water; end use of water; and the treatment of waste water.

Inefficiencies in water supply systems means that more water is filtered, purified and pumped to meet customer needs. In Glasgow as much as 35-40% of distributed water is lost through leaks, primarily due to aging infrastructure. Scottish Water is undertaking a leak reduction programme agreed with its regulator. Unnecessary use of water in homes and businesses also increases the volume of water heated, as well as increasing the volume of waste water that requires treatment. Water supply and treatment is estimated to add around 1 to 1.5% to Glasgow's carbon emissions. Heating water is estimated to be responsible for at least 13% of Glasgow's energy use. Reducing unnecessary water consumption therefore directly reduces carbon emissions.

A wide range of effective measures are available to improve the efficiency of water supply, consumption, and treatment.

#### Opportunities to Improve Water System Efficiency

Supply-Side Efficiency Measures	Demand-Side Efficiency Measures	Comprehensive Demand - /Supply-Side Approach Synergies
Water supply systems offer opportunities to reduce water and energy waste directly, while better serving customer needs	Reducing demand by helping the consumer use water more efficiently decreases the required water supply, saving both energy and water:	Looking at a water system comprehensively and ensuring efficiency projects are designed in tandem creates even greater efficiency opportunities.
Leak and loss reduction	Water-efficient household     appliances	Right-sizing pump systems after reducing consumer demand
Improved operations and maintenance	Low-flow toilets	<ul> <li>Avoiding wastewater treatment by promoting reuse and reducing demand</li> </ul>
Higher efficiency pumping systems	Low-flow showerheads	Network optimisation
Wastewater treatment	• Industrial water reuse	System monitoring and measurement
	Leak and water waste reduction	
	Behavioural change	
	• Water metering	



The initiative proposes the following measures should be considered by the Council, Scottish Water, the regulator and its partners as potential parts of an overall water consumption reduction strategy. Some of the proposed elements serve to expand or enhance initiatives already underway through Scottish Water and the City Council. Clearly all of these potential policies – particularly those relating to pricing and metering - would need to be assessed in order to minimise any adverse impact on socially deprived homes and communities. Initiatives targeting high water use would also need to take into account the circumstances of individual homes that might lead to higher water use – for example homes with children.

#### • Implement and Track Demand Side Management Programs (DSM)

- Develop realistic and achievable water consumption reduction targets that are compatible with wider social and health policy objectives.
- Monitor customer consumption data to ensure consumption patterns are in keeping with targets.
- Encourage and promote community and citizen participation to help guide the planning and implementation of DSM programs
- Work with corporate customers to develop DSM reduction plans that reflect the overall corporate reduction objectives.
- Monitor and adapt DSM programs over the long term.

### • Enhance Customer awareness and education through social marketing programs

- Continue to implement permanent water conservation programs and resource these with staff that possess technical skills and understanding in the fields of economics and customer education.
- Develop relationships with high water users in all customer groups and work with these users to develop reduction strategies.
- Develop incentive-based social marketing programs designed to reduce consumption.
- Offer advice and assistance to all customers who wish to reduce water use.

#### • Link Water Conservation to Development Approvals

- Make project planning approval contingent upon demand management planning that provides measurable outcomes.
- Require that all new developments and retrofits of existing facilities and homes to make use of the best available water conservation technologies.
- Encourage major infrastructure developments to incorporate water conservation planning.

### • Examine potential revisions to pricing structures

- Review opportunities for metering technologies as part of infrastructure improvement/replacement programs.
- Volume based pricing structures.
- Sending strong pricing signals during peak demand periods.
- Incentives that penalise wasteful users and reward low users.

#### Reduce Water System Leakage

- Quantify water system losses. Identify costs associated with delivery and lost revenue.
- Enhance the current leak detection program by identifying priority areas and completing leak detection surveys.

#### Promote the Use of Water Efficient Fixtures

- Review existing fixture replacement programs to ensure they reflect the latest effective technology available and confirm that all new development continue to be installed using water efficient fixtures.
- Work to identify water use reduction opportunities within all city owned facilities.

#### • Explore and Develop Water Reuse Opportunities

- Identify water re-use opportunities within city council operations.
- Explore retrofits or new installation potential where water reuse makes sense.

#### **Recommendations:**

- The Council should work with partners to assess opportunities for the installation of more efficient street lighting systems – and consider piloting systems to examine their effectiveness and suitability.
- The initiative to work with Scottish Water, housing providers, major employers and other potential suppliers to develop a water supply and consumption reduction strategy.

#### Smart Grids and Demand Management

Electricity demand varies significantly throughout every day – with the peak occurring around 6pm in the evening. Demand also varies from season to season. Electricity currently cannot be stored in large quantities so power stations are switched on and off, and their output controlled, to meet this variation in demand. This means that fossil fuelled power stations are kept "hot" (sometimes for hours on end) and ready to run to meet peak demand. Keeping power stations available in reserve to meet peak power requirements increases UK carbon emissions. A more even demand profile would also mean better utilisation of the existing infrastructure and may postpone the need for new investment in additional power stations. This could help reduce the need for future increases in energy prices.

The existing electricity transmission and distribution system was designed to support a centralised electricity generation system – where the great majority of electricity is generated in a small number of large power plants and then distributed over (normally) long distances to meet customer electricity requirements. However the nature of electricity generation is changing. For example, the generation of renewable electricity from sources such as wind cannot be controlled in the same way as conventional power plants, and the windiest locations are often in remote locations with less availability of transmission capacity. In addition the development of local distributed generation facilities means that system operators have less visibility of what generation is available, and less control over when it is made available. These new developments can make the grid more difficult to control - and infrastructure issues can act to restrict the development of low carbon electricity generation.



#### Summer and Winter GB Daily Demand Profiles in 2005/06

An alternative approach is to seek to reduce peak demand by switching use of household appliances, industrial processes and commercial activity to other times of day. This produces a more even demand profile and reduces the need for power stations to be kept on stand-by.

Techniques for achieving this is include the use of tariff and market structures that incentivise energy consumers to shift demand. In New England medium and large energy consumers are paid to reduce their energy demand at certain times of the day - in just the same way as power stations are paid to increase their energy production at those times of day. For example, a supermarket or other facility with a large cooling load can choose to switch off its refrigeration for an hour, or an office to switch off its air conditioning, or a warehouse to switch off its heating for a similar period - and be paid to do this. This model is only used to a limited extent in the UK – and it is difficult for medium sized organisations to enter the power market. It also true that some groups of consumers may have limited ability to shift demand due to the nature of their business (eg hospitals). Initial discussions with regulator and distribution companies suggest that demand management could have additional potential to reduce carbon emissions.

Smart grids offer the opportunity to integrate renewable technologies and manage demand through enhanced electricity distribution and transmission in ways that offer greater carbon emission reductions.

There is no single agreed definition of "smart grids", but broadly speaking smart grids are a group of sophisticated technologies that offer the opportunity to:

- increase levels of renewable energy generation using existing electricity transmission and distribution infrastructure by enhancing the system's ability to accommodate higher levels of intermittent generation;
- improve the reliability and security of electricity supplies with high levels of intermittent generation;
- increase local distributed generation;
- manage demand so that it more closely follows the availability of low carbon generation;
- give consumers better information and feedback about their energy consumption – with the aim of reducing overall consumption, and reducing energy bills.

Smart grids include a number of technologies and operating practices such as:

- sophisticated grid control and monitoring technologies;
- smart meter systems in homes and businesses that improve consumer information on energy consumption and energy prices (allowing creation of more sophisticated tariff structures that incentivise demand shifting)
   and can be read remotely by energy suppliers;
- systems that can monitor and control remotely the energy demand from individual devices in the home (such as refrigerators, or electric cars on charge) – allowing demand to shifted to match generation;
- measurement and credit for electricity generated by microgeneration.

Smart grids therefore offer a range of benefits that assist the delivery of a lower carbon electricity system within the city – including local renewable energy generation, and local combined heat and power systems – as well as improving the security of electricity supplies. The University of Strathclyde is conducting leading research in this field.

Ofgem has agreed that smart meters will be installed in every home by 2020 – however the measures proposed below may help to accelerate their deployment in Glasgow.

#### Recommendations:

- The Sustainable Glasgow initiative to develop proposals with the regulator (Ofgem), the Independent System Operator (National Grid), the distribution company (Scottish Power), and consumers to develop tariffs and market structures that support demand management on a pilot basis in Glasgow. Given the density of energy consumption and constraints on electricity supplies in the centre of Glasgow this area might be designated as a pilot demand management zone.
- The initiative to work with utility companies, the distribution operator, the University of Strathclyde, and consumers to develop a strategy for the assessment and deployment of smart grid technologies in the city

   with the objective of making Glasgow the leading UK city in smart technologies.

#### The overall impact of energy efficiency

Sustainable Glasgow supports energy efficiency measures - however many economists believe that energy efficiency measures do not ultimately deliver as large a reduction in overall energy consumption as might be expected. This is partly due (for example) to people responding to having a more efficient heating system by increasing the average temperature of their home (known as "comfort taking"). It is also because organisations and individuals spend money saved on their energy bills on other goods, services, and activities. These goods and services also require energy to be produced - and this counteracts to some extent the initial reduction in energy consumption achieved. This is known as the rebound effect. Estimates on the degree of overall energy consumption reduction achieved vary widely between different studies. However despite the rebound effect almost all economists believe that the net overall impact of energy efficiency measures is to reduce energy consumption.

The initiative has made a conservative estimate of overall potential carbon savings from improved energy efficiency and management giving a 6% reduction in Glasgow's carbon emissions in the next 10 years. Given increased regulatory pressures, and that it is normally easier to trigger change in a small number of large organisations rather than thousands of individual households, carbon savings are likely to be greater within the commercial, industrial, and public sectors than the domestic sector:



# Reducing use of high carbon energy sources

Long term UK and EU energy policy is aimed at shifting energy consumption to lower carbon energy sources. By identifying facilities that make unnecessary use of high carbon energy sources Glasgow has the opportunity to accelerate this process.

The use of carbon intensive fuels for heating (such as coal and oil) in a number of buildings makes up around 4% of Glasgow's carbon footprint. By switching away from these fuels to less carbon intensive alternatives – such as gas, district heating, and renewable energy – a relatively simple reduction in carbon emissions can be achieved. Clearly switching to gas can only be seen as an interim step given the need to achieve even larger carbon emission reductions in the longer term.

An estimated 9% of homes in Glasgow are electrically heated (mainly in the social housing sector) by electrical resistance heating devices such electric bar heaters, fan heaters, and storage heaters. This is a far more expensive and carbon intensive option than alternatives. Electrical heating is estimated to make up a further 3% of Glasgow's carbon emissions. Providing these homes with lower cost heating will also reduce Glasgow's carbon emissions.

Some may argue that phasing out electrical resistance heating is an unnecessary step as ultimately the electricity supply may be very largely decarbonised. However a number of analyses suggest it will be many years before the carbon intensity of UK electricity (currently 0.52 kg CO2/KWh) is the same as natural gas (0.19 kg CO2/KWh) – and probably much longer before the carbon intensity of electricity is equivalent to CHP/District Heating. DECC estimate that by 2020 the carbon intensity of electricity the UK grid will drop to 0.42 kg CO2/KWh. Beyond 2020 forecasting of carbon intensity becomes more uncertain and different studies give a range of predictions of the likely profile of future grid decarbonisation. For example, a 2007 Redpoint report for UK Government predicts that by 2030 the carbon intensity of the UK grid will lie between 0.35 and 0.3 kg CO2/KWh. Other studies predict significantly higher and lower values than this. It is therefore important that policies in relation to heating technologies such as electrical resistance heating are kept under review and take account of wider movements in the composition of UK generation.

Ofgem projects both gas and electricity prices will increase over the longer term. However the price differential between electricity and gas is expected to remain – meaning that electrically heated homes will still be more expensive to heat in a decarbonised future. The advantage of a district heating system is that once electricity shows a carbon advantage over other fuels it can be easily integrated into the district heating system to deliver heat to the community alongside other fuels – with decisions on fuel supply being taken that balance carbon emissions, price, and security of supply.

The initiative proposes that Glasgow City Council seek to reduce electrical resistance heating in the city through two measures – requiring all Houses in Multiple Occupation (HMOs) over a 3 year period to replace electrical heating systems as a condition of licensing; and seek agreement from all Social Housing providers to phase out electrical heating systems as a part of their capital investment plans over a 10 to 15 year period, and to not implement any new electrical heating systems.

There are also schools in Glasgow that are heated using coal fired boilers. Coal is the most carbon intensive form of fuel – and its use for heating cannot be condoned in a sustainable city. Through a planned and phased replacement of such systems, as an integral part of existing ongoing capital investment programmes, these high carbon systems could be phased out. Over the next 10 years fuel switching could deliver an estimated 3% reduction in Glasgow's total carbon emissions.

The initiative recommends:

- Identification of all significant facilities consuming high carbon fossil fuels (ie coal and oil) for heating and power within the city boundaries and development of agreed strategies for the phasing out of coal and oil use in these facilities.
- Progressive phasing out of electrical resistance heating in the city through agreement with social landlords, and stronger regulation of the private rented sector.



# Glasgow's low carbon energy resources

The new energy systems proposed by Sustainable Glasgow harness the low carbon energy resources available around Glasgow and apply them to work for the city. The initiative has mapped and quantified the resources that could be realistically captured and utilised given current technology, energy prices, and regulatory support mechanisms - and considered how these can be applied in a way that helps fulfil wider policy objectives.

It is clear that significant growth of renewable energy production is essential to meeting UK and Scottish carbon reduction targets. Both UK and Scottish governments therefore have significant strategies and policy measures in place designed to promote growth of renewable energy.

Penetration of renewable energy production into urban areas in Scotland has so far not been high. In part this reflects the distribution of renewable energy resources in Scotland (which are mainly in more remote and rural areas) – but it also reflects structural and cultural issues. Additional policy measures are planned that will increase incentives for development of smaller and community based renewable energy systems – and this is expected to incentivise development in urban areas.

#### Waste

Waste to energy and biogas from waste represent major low carbon energy opportunities for the city – representing an estimated carbon reduction of around 6%.

Currently Glasgow produces around 400,000 tonnes of domestic and commercial waste every year. The Council operates four civic amenity waste transfer stations in Glasgow, located at Dawsholm, Easter Queenslie, Polmadie and Shieldhall. Most of this waste is subsequently taken to the Cathkin 2 landfill site just to the south of Glasgow. The Polmadie plant also deals with reclamation, and processes annually up to a maximum of 25,000 tonnes of material such as paper, food and drink cans.

The city currently recycles and composts 18%, and landfills 82% of Municipal Solid Waste (MSW). Glasgow City Council

Source	Reduction (Tonnes CO2)	% Reduction in Glasgow's emissions
Wind (77 GWh.annum)	33239	0.8
Biomass	65000	1.6
Waste to Energy	81000	2.0
Biogas (lower limit)	156283	3.9
Biogas (upper limit)	312566	
Solar	50139	1.3
Heat pumps	51196	1.5
Total*	~425,000	11.1

\* Lower biogas limit assumed

is required by new environmental regulations to reduce the amount of waste going to landfill – and faces penalties of £25 million per annum unless it makes significant reductions in its use of landfill. The city will therefore shortly publish a new waste strategy aimed at reducing use of landfill.

A review identified three long term preferred strategies for the management and treatment of waste streams within the city:

- Physical processes (autoclaving to produce segregated waste streams with an organic fibre by product)
- Biological processes (mechanical biological treatment or anaerobic digestion)
- Chemical processes (including gasification and incineration)



Waste to energy facilities can help Glasgow meet its environmental targets – and the viability of some the proposals below will depend on GCC adopting a compatible and supportive waste strategy. However there is a need for care in the design and capacity of waste to energy systems given the objective of reducing waste volumes over the longer term. With the aim of maximising reuse and recycling the Scottish Government has set a limit that no more than 25% of waste should be used in waste to energy systems.

Much of the city's waste (such as sewage and food waste) could be treated using anaerobic digestion to produce biogas which is then used to produce heat and power for homes, businesses and public buildings – or to fuel public transport. Anaerobic digestion treats waste organic matter (e.g. sewage, farm slurry or factory and kitchen food waste) in a sealed container using microbes to produce biogas and a residual compost like material. Certain wastes will produce far more methane than others, and the upper and lower limits for biogas given above depend on the composition of the organic waste available. Biogas is not pure methane and would need a further cleaning ("scrubbing") process if it were to be fed into the gas grid.

Where possible combined facilities should be used to treat sewage and food waste – as well as combined facilities to consume timber and woody municipal waste. This should reduce capital costs, as well as public opposition to the development of such facilities.

The initiative therefore suggests that the sewage treatment plants at Dalmamock and Shieldhall should be considered as locations for anaerobic digestion facilities, and the waste treatment plant at Polmadie as a potential location for a waste to energy plant. These locations all have potential centres of energy demand nearby. Biogas can be used to fuel Combined Heat and Power stations – and also to fuel road freight and public transport vehicles. Biogas from Shieldhall could be linked to the new Southern General Hospital development, and biogas from Dalmarnock could feed energy to the Commonwealth Games Village, or the bus depot at Larkfield (for example).



**Glasgow City: Waste Transfer Stations and Sewerage Treatment Plants** 

The Council has already announced plans for an autoclaving plant at Polmadie. Autoclaving is not ideal as a waste to energy technology (the net energy yield from this process is lower than alternative processes) – but it is an easier process to implement practically, and waste to energy can still be integrated into autoclave systems and deliver useful energy yields. It also produces "recyclates" that count toward Scottish Government targets for recycling. As a result of the autoclave process it is estimated that 44% of the treated waste would be converted into an organic fibre known as Refuse Derived Fuel. This fibre can then be used as fuel in a biomass energy plant (which would need to be Waste Incineration Directive compliant). Alternatively the fibre can be used as feedstock for an anaerobic digestion process to produce biogas. The above estimate of an 81,000 tonne saving in CO2 emissions from waste to energy is based on a single such plant at Polmadie treating 150,000 tonnes of Municipal Solid Waste per annum.



#### **Biomass**

Glasgow has existing parks and woodlands capable of producing 1,800 tonnes of timber per annum in a sustainable manner.

In addition there are around 1300 hectares of vacant and derelict land throughout the city (see map below) – around 7.5% of the city's area. Much of this land has been vacant for over 20 years and this can create a negative impression of the city. There are opportunities for the sustainable redevelopment of these areas. Glasgow's production of biomass could be increased through the planting of this vacant ground with trees to create urban woodland for short rotation coppicing that would start producing timber for energy after 5 or 6 years. The estimated average yield is around 10 tonnes of timber per hectare per annum (so perhaps 13,000 tonnes of timber could be sustainably produced if all the vacant land is available for urban woodland). Further investigation of underused land, is recommended to supplement this land supply. The Council's emerging Open Space Strategy includes quality and quantity assessment for open space that will provide data for this exercise. The study recommends development of an urban woodland strategy, building on the partnership of the City Woodland Initiative that would balance the creation of biomass for energy in the city with improving the city's appearance, and providing areas of woodland for recreation and relaxation by local communities. The benefits of urban woodland, beyond its aesthetic appeal, include the following:

- Improved Air Quality. Trees absorb air pollutants.
- Reduction of Greenhouse Gas Emissions. As a tree grows, it sequesters carbon dioxide and converts it to woody biomass.
- Improved Wildlife Habitat. Urban woodlands can provide food and shelter to birds and animals.
- Water Run-off Management. Street trees and other vegetation intercept and absorb rain, reducing and slowing the amount of runoff that makes its way to the sewer system.
- Noise Abatement Trees can form a barrier that partially deadens urban noise, while providing the background sound of rustling leaves and branches that muffles other street sounds.
- Increased Psychological Well Being. Exposure to trees can reduce stress, with increased feelings of well-being and belonging.
- Improved Energy Conservation. Trees can cut heating and air conditioning use by providing shade and cutting the wind, reducing energy costs.
- Increased Property Values. The value of homes in neighbourhoods with trees tends to be higher than those of comparable neighbourhoods without trees.

The fertility of vacant land could be improved by adding compost from waste and the digestate from the anaerobic digestion process. These forests can improve soil quality through extracting pollutants – as well as improving the city's landscape.

Significant additional timber resources are available from the 121,000 hectares of forest within a 30 mile radius of the city boundary; an estimated total of up to 723,000 tonnes per annum could be theoretically available – however it is not clear how much of this resource would be available in practice as it may be contractually committed to other purposes. It may be possible to grow other biomass crops both within the city and the surrounding metropolitan area in addition to woodland, giving a mosaic of landscapes.

This biomass can then be used to produce heat and power. Where possible treatment facilities will be co-located with existing sewage and waste-handling facilities. Advanced high temperature combustion technologies (such as pyrolysis or gasification) could be used to produce energy from biomass in order to minimise the emission of particulates and other pollutants. These technologies also have the option of capturing more carbon from the timber grown – in the form of charcoal (known as biochar) – which can also be used to treat waste land. By locking in carbon for hundreds of years biochar significantly increases the carbon reductions achieved from the use of biomass in energy systems. Biochar can also be used to improve soil conditions – improving fertility, and capturing pollutants in the soil.

There are few examples of pyrolysis being deployed on a large scale anywhere in the world – so this is a technology which would need careful assessment before full-scale implementation. A small scale pyrolysis plant might be a useful step in evaluating this technology for larger scale deployment in the city.

The carbon footprint of transportation of biomass will be minimised through keeping biomass production close to the point of consumption – and where possible rail, river and canal transportation will be used rather than road. Where road vehicles must be used preference will be given to vehicles fuelled by bio-fuels or electrically powered vehicles.

The total carbon reduction available from biomass is estimated as 1.6% of Glasgow's total carbon emissions.
# Woodland and Vacant Land in Glasgow





### Wind

Wind energy is one of the most mature and widely used renewable energy technologies currently available. There are existing major wind developments just outside Glasgow (including Europe's largest windfarm at Whitelee) – however attributing the carbon savings from Whitelee to Glasgow would result in double-counting of the carbon emission reductions (as the renewable electricity is already taken into account in calculating the carbon intensity of grid electricity), and would therefore be inconsistent with generally accepted carbon accounting practice.

Large wind turbines (60m to 130m in height) normally perform far more effectively than smaller turbines. Within what is a densely populated city wind power represents a relatively small opportunity. Nevertheless a small number of large wind turbines (around 17) could be placed in suitable locations around the city and could reduce Glasgow's carbon footprint by just under 1%. A previous study by Glasgow City Council identified 10 potential sites.



Three sites were favoured:

- Cathkin Braes
- Netherton Braes
- Robroyston

And the following sites were identified as having potential for future development:

- Queenslie
- Springhill
- Easterhouse
- Cuningar Loop
- Clydebridge
- Dalmarnock
- Polmadie Depot

These sites are shown on the map in the diagram below. The Cathkin Braes site is already under development and the Netherton Braes site appears to offer similar potential for 2 to 3 large turbines if airport issues can be resolved. There may be additional opportunities in relation to industrial and brownfield sites – and these need to be assessed.

The Cathkin Braes site originally received an objection from Glasgow Airport due to potential impact on radar systems. The site is expected to be used as a test site for a radar absorbent blade material (RAM) which may alleviate the radar issues. If trials are successful then the opportunities for wind development in Glasgow may be expanded.

The predicted energy yield from these 17 large wind turbines would be around 76 GWh per annum.

Smaller scale wind devices (defined as being 10m to 30m in height) could also make a contribution. As these devices are closer to the ground their performance can vary significantly



between different sites. Assuming 50 suitable sites can be found across the city this would deliver 1.3 GWh per annum. Although the energy yield is lower smaller scale wind could play a useful role in community based projects.

Micro wind devices are small generating units designed to be installed on small masts or buildings. While some sites in Glasgow may be suitable for these devices, their effectiveness in producing energy and displacing carbon will be highly site dependant. Micro wind generation is not expected to make a significant impact on the city's carbon emissions – even in good situations the energy yield can be relatively small – for example, an estimated 80,000 micro wind turbines in good locations could be required to reduce the city's emissions by around 1%. However micro-generation may have a useful role to play in raising awareness, involving communities, and generating revenue.



### Hydro-power

Despite Glasgow having the Clyde, and other rivers and canals, the energy available from these for hydro-electric power is not large - as neither the height drop or speed of flow is high in most of these rivers, making them unsuitable for most turbine systems. However some of the Clyde tributaries and canals may offer potential for some small hydro-electric systems. Although this is unlikely to make a large contribution to Glasgow's overall energy needs there may be locations suitable for community based energy schemes. Water bodies can also provide a good source of heat for heat pump based systems (see opposite).

The initiative recommends an assessment is undertaken of the hydro-electric potential of Glasgow's water courses.

### Geothermal Energy and Ground Source Heat

In the right circumstances certain types of geological structures can deliver large amounts of low carbon thermal energy at relatively high temperatures for heating and power. This energy comes from high temperature rocks deep below the surface of the earth. This is known as geothermal energy, and is widely used in countries such as Iceland. There is currently no evidence for the easy availability of high temperature heat sources in the geology beneath Glasgow.

However Glasgow has a number of geological structures beneath it that appear suited for extracting ground source heat – such as old mine workings and aquifers – and there are some small existing developments in Glasgow that receive heat from ground source heat. Ground source heat relies on large amounts of low temperature heat held in sub-surface structures. This heat mainly comes from solar energy. This energy is then raised to higher temperatures using heat pumps (explained below). Scottish and Southern Energy has supplied the map below that predicts those areas of the city where ground source heat pumps are likely to deliver better performance (as the ground in certain areas has greater thermal conductivity than other areas).

The British Geological Survey is undertaking a study (the Clyde Urban Super Project or CUSP) that will help evaluate the geothermal resource beneath Glasgow. The CUSP project will deliver detailed 3D subsurface models of the geological structures beneath Glasgow. The data from over



## Glasgow City: Areas with predicted potential for Ground source Heat

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30,000 boreholes has been used. This will allow modelling of the ground source heat potential of minewaters beneath the Glasgow conurbation, and of superficial deposits in the vicinity of Glasgow – allowing a more accurate assessment of the realistic carbon reduction potential available from ground source heat in Glasgow.

Heat pumps are often explained as operating like a "fridge in reverse". They move heat from a lower temperature thermal reservoir (such as a body of water; the ground, or the air) to a higher temperature. Ground and bodies of water tend to be better heat sources for heat pumps than air. Just like in a refrigerator an electrically powered pump is used to achieve this effect. Generation of a unit of electricity produces more carbon dioxide (currently around 0.52 kg CO2/KWh for the UK grid) than natural gas (around 0.19 kg CO2/KWh). The amount of heat produced for each unit of electricity is therefore a critical factor in assessing the effectiveness of heat pumps in reducing carbon emissions. UK government sources tend to assume lower performance from heat pumps – and the Energy Saving Trust's current advice is therefore not to replace efficient gas-fired heating systems with heat pumps (arguing that there is little or no overall carbon saving). Other commentators argue that UK government figures are out of date and that higher performances are being achieved in practice – with some installers stating that their systems deliver 3.8 units of heat for each unit of electricity (and therefore deliver carbon savings). Performance of heat pumps varies between different situations – depending on the profile of energy demand and the heat source being used. It is also true that not all buildings have access to mains gas – and for off gas-grid buildings heat pumps offer much larger carbon savings when compared to electrical heating. This variation in circumstances means that heat pumps need careful assessment on a case by case basis before a decision to install can be taken.

Heat pumps have a better performance when used in systems that combine heating with cooling – for example, when the heat rejected from one system (eg air conditioning) is used for another purpose (such as heating water for washing, or for heating other buildings through a district heating system). So in combination with cooling systems heat pumps could have a role in reducing Glasgow's carbon emissions – for example, heat rejected by data centres could be reused to heat adjacent buildings.

Heat pumps can be expected to offer much larger carbon savings in the future as UK grid electricity becomes less carbon intensive. This should lead to significant improvements in the carbon reduction performance of heat pumps over the longer term. There is therefore a need to keep the carbon reduction performance of this technology under review.

The calculated carbon saving for heat pumps given above has been provided by SSE and assumes installed heat pump systems deliver an overall performance of 3.8 units of heat for each unit of electricity (and assumes current grid electricity carbon intensity levels).

### Solar

Glasgow has a large theoretical amount of solar energy available, and photovoltaic (PV) devices are relatively easy to install. However the low efficiency of photovoltaic devices means that thousands of homes and offices would need to fit PV to have a significant impact on Glasgow's carbon emissions, and low efficiency means that capital costs are currently high in relation to the amount of energy produced. Depending on the support measures brought forward by the UK and Scottish governments (see below) this difference in capital cost may prove less critical in the future – and PV could potentially deliver income in the future.

Solar thermal systems are primarily used to produce hot water. Consequently, solar thermal technology is more suitable for domestic properties, hospitals and swimming pools and is less suited to commercial buildings due to their comparatively low hot water requirement.

Taking both solar availability and housing profile in Glasgow into account, Scottish and Southern Energy estimate that solar thermal could provide up to 33,000 m3 of domestic hot water each day from around 27,000 potential systems of various capacities. This would include around:

- 15,800 small systems of approximately 2m<sup>2</sup>, for households of up to 2 occupants
- 11,100 medium sized systems of approximately 3m<sup>2</sup> serving households of 3 or more occupants
- 29 swimming pools.

It is estimated 33 GWh of thermal energy would be available from these solar thermal systems. The map below shows the areas in Glasgow with higher proportions of building roofs suitable for solar energy devices.

These maps indicate that areas outside the city centre, not ideally suited to district heating due to their lower density of heat demand, may offer opportunities for the complementary deployment of other low carbon energy technologies.



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### Government support measures for renewable energy

The Renewable Obligation (known as the RO or ROCs) is the UK's main method of supporting development of renewable electricity generation. This system requires generators to obtain a quota of their electricity supplied from renewable sources, or to pay penalties. The overall effect of the system is to pay generators of renewable electricity a premium for electricity generated – currently around £40 per MWh. This currently effectively doubles the price for each unit of renewable electricity received by a generator. The costs of this system are passed on to consumers as a part of their energy bills.

The UK and Scottish governments are currently implementing a system of banded support that will give an increased amount of funding to renewable technologies that need additional support in order to be profitable. This will deliver increased support to technologies such as off-shore wind for example. In the right circumstances these support measures can allow even technologies that deliver relatively modest reductions in carbon emissions – such as PV and micro-wind – to deliver significant revenue streams. These revenues can help support wider community development, reduce the costs of delivering public services, or could help grow the low carbon communities fund for Glasgow (proposed below) – and even small schemes can help improve understanding and awareness of energy systems and wider opportunities to reduce carbon emissions, as well as involving local communities. The reinvestment of such funds in measures that deliver larger carbon reductions, help regenerate communities, or reduce fuel poverty is consistent with the aims of Sustainable Glasgow.

		Proposed Initial tariff (p/kWh)	Approx ROC equivalent
AD	Electricity only	9	2
AD	CHP	.5	3
Biomass	<50kW	9	2
Biomass	50kW - 5MW	45	I
Biomass	CHP	9	2
Hydro	<10kW	17	4
Hydro	10-100kW	12	3
Hydro	100kW - 1 MW	8.5	2
Hydro	I – 5MW	4.5	1
PV	<4kW (new build)	31	7
PV	<4km (retro fit)	36.5	8
PV	4-40kW	31	7
PV	10-100kW	28	6
PV	100kW 5MW	26	6
PV	Stand alone system	26	6
Wind	<1.5kW	30.5	7
Wind	1.5 145kW	23	5
Wind	15 – 50kW	20.5	5
Wind	50 – 250kW	18	4
Wind	250 – 500kW	16	4
Wind	500kW - 5MW	45	1
Existing microgenerators transferred from RO		9	2

The UK government is also consulting on the potential implementation of a feed-in tariff (or FIT) that is expected to provide additional revenues for small to medium sized low carbon electricity generation facilities (up to 5 MW, or 50 KW for fossil fuelled CHP). The government has stated that it intends to start the operation of the FIT system by April 2010, and the levels of support proposed in the consultation are set out below. For some technologies incentive levels are expected to be higher in the earlier years of the scheme. These incentives are designed to give a significant incentive for early investment in small scale renewable technologies. However the final levels of support and rules of the scheme have yet to be finalised. A number of projects require this information before their financial viability can be determined. Powers in the Energy Act 2008 will also allow the creation of a Renewable Heat Incentive. This measure is designed to provide financial support development of renewable heat, biogas and biomethane - as other forms of heating are currently often cheaper to install and run. Payments are also believed necessary to trigger early action by households and communities. The diagram below sets out DECC's analysis of the relative costs per tonne of carbon saved of different renewable heat technology – the most cost effective (in terms of carbon saved) being replacing electrical heating with biomass. The diagram also shows DECC's estimate of the carbon saving potential of different heat sources on a UK basis, clearly the relative potential of these technologies in Glasgow will differ from the overall UK picture.



### Marginal Abatement Cost curve for heat

\*Society costs estimated on the grounds of commercial costs net of ROCs, Landfill Allowance Trading Scheme Credits and the value

of the Landfill Tax component of gate fees for CHP and waste technologies resepectively.

\*\* Office of Climate Change assumption used for industrial/commercial biomass level of support of  $\pm$ 10/MWh

Under the proposed RHI scheme from April 2011 producers of renewable heat of any scale (household, community, and large scale industrial) will receive additional payments for renewable heat produced. The level of financial support will vary according the size of the facility (as larger facilities tend to need less support) and by technology. The RHI will be funded by a levy on suppliers of fossil fuel heat (eg gas) – and can therefore be expected to increase the price of fossil fuels for heating. The levels of RHI support for individual technologies will be announced by the UK Government during 2010.

In the pre-budget report December 2009 the Chancellor announced that income generated by individuals from selling small scale renewable electricity from their homes will be exempt from income tax.

The Scottish Government's Community and Renewable Energy Scheme (CARES) is the successor to the SCHRI scheme. It started operating in April 2009 and provides grants of up to  $\pounds$ I 50,000 for community based renewable energy schemes.

The proportion of community based renewable energy schemes in urban areas is low. Reasons for this include the greater opportunity and ease of implementation of mature renewable energy technologies in rural areas. The initiative recommends that additional measures to assist urban communities to plan, finance and organise local renewable energy projects are considered. For example, this could involve the creation of a small team and information resources to assist communities – as well as access to funding.

#### Summary of proposed actions:

- Development of a waste strategy that supports and integrates principles aimed at achieving greenhouse gas emission reductions
- Urgent development of a biogas strategy aimed at starting implementation of a large scale anaerobic digestion facility within 3 to 5 years
- Development of an urban woodland strategy with community involvement – aimed at starting planting of more new woodlands within 2 years
- Development of a wind strategy aimed at wind turbine construction on the sites already identified

   with involvement of local communities – and assessment of potential brownfield sites for wind turbines.
- Development of a strategy aimed at maximising revenue generation from microgeneration for public bodies and communities.
- Commission a study to analyse the hydro-electric energy potential of the rivers and canals in the Glasgow area.
- Keep the carbon reduction performance of heat pumps under review.
- Consider additional measures to assist urban communities to plan, finance and organise local renewable energy projects.
- Development of a pilot pyrolysis plant within 3 to 5 years – with evaluation to assess suitability for large scale implementationt

# Low Carbon Heating Systems: District Heating and CHP

Heating buildings makes up 40% of energy consumption and heating water a further 13% - accounting for 47% of UK carbon emissions. Heat in Glasgow is delivered largely from fossil fuels - either directly (eg gas heating) or indirectly (electrical heating). Low carbon heating systems therefore represent a significant opportunity to reduce the city's emissions – and district heating is one of main approaches able to deliver low carbon heating on a large scale.

The UK and Scottish Governments, and the EU Commission support the development of district heating and Combined Heat and Power (CHP) systems – as set out in the UK Energy White Paper "Meeting the Energy Challenge"; the UK Low Carbon Transition Plan; the Heat and Energy Saving Strategy Consultation; and the Scottish Government's Renewable Heat Action Plan.

# **District Heating**

District heating uses large insulated underground hot water pipes to provide heat to communities for heating buildings and hot water. District heating is commonly used in other countries (for example 60% of Denmark's buildings use district heating) but currently it supplies less than 1% of buildings in the UK.

The Sustainable Development Commission's report "Renewable Heat in Scotland" states "We believe that district heating – whether using heat from a CHP or thermal only plant – is the most efficient way to heat closely grouped buildings using fuel. It certainly makes the conversion from fossil heating to renewable heating much simpler. Considerable moves towards district heating are probably necessary to achieve Scotland's interim and long term heat targets."

The main obstacles to the implementation of district heating systems in the UK are:

• Large initial capital investment (to install the heat pipe network)

- Lack of information available to assess opportunities
- Lack of knowledge of district heating in the UK
- Lack of a regulatory regime for heating in the UK
- Customer demand risk (ie customers could theoretically choose to leave the district heating system at short notice)
- Competition from natural gas (which has provided a clean and, until recently, relatively low cost fuel in the UK since the 1970s)
- Inertia caused by the existence of other energy delivery networks, existing market structures, and the commercial interests of large energy companies
- Local and central government apparently unwilling or unable to co-ordinate investment and operation of local energy systems.

Sustainable Glasgow's approach is designed to overcome these barriers by:

- Identifying the areas with highest density of heat demand;
- Facilitating engagement with key potential customers and energy providers;
- Linking with major investment projects;
- Implementing a business and regulatory regime that:
  - reduces risk for customers and suppliers
  - raises the necessary finance
  - delivers long term demand and price stability
- Facilitating delivery of shared underlying infrastructure.

Under the proposed system heat will be distributed using a new district heating (DH) system in five key areas of the city (see diagram below). The five proposed district heating areas have been identified based on 3 main criteria:

- a high density of carbon emissions linked to heating I.
- the presence of large commercial and public sector organisations that can act as anchor customers
- and/or the presence of major new investment or regeneration initiatives.

These areas therefore offer financial stability for investors, the opportunity to embed DH at lower cost, as well as targeting the areas where DH could achieve the largest carbon emission reductions. By selecting areas with high densities of carbon emissions the initiative is also focussing on areas which have high levels of economic activity – and therefore funding available for investment. Detailed assessments have been conducted for each of these areas – identifying the major energy consumers, quantifying the amounts of energy consumed, identifying potential sources of waste heat, and examining infrastructural issues.

<sup>1</sup> For this analysis density of gas consumption is used as a proxy. Gas consumption in the city is very largely used for heating buildings and water: However there is also significant use of electricity for heating in some areas.



### Proposed District Heating Zones for Glasgow



### Density of CO2 Emissions linked to Gas Consumption

The identified areas are large by UK district heating standards and the initiative proposes that ultimately these are linked together to form the core of a city-wide district heating network. A larger district heating system is technically more resilient (as different parts of the system back each other up); performs more efficiently (as having a wider range of customers creates a more even demand profile); operates at lower financial risk (as the system is not overly reliant on any individual customer), and offers greater opportunities for system expansion.

Residential customers are not proposed as the initial primary target for district heating in Glasgow – and this is because a DH system focussed solely on residential customers would be more expensive to implement and operate in relation to the revenue generated. A purely residential system might therefore struggle to draw in significant capital investment - and may struggle to expand quickly due to financial constraints. Therefore in order to create an energy system that is an attractive investment proposition large commercial, industrial, and public sector consumers form the core of the initial DH target. This increased financial viability will allow the system to expand over time into residential areas. Where appropriate such expansion would be phased to fit with social housing investment and maintenance plans – thus allowing fuel poverty to be targeted. The initiative is already in discussion with GHA (as Glasgow's largest social landlord) about how some of their properties might benefit from district heating in the future. In the future additional areas of the city will also be identified as DH zones. One of the additional factors that will be taken into consideration in designating such zones are areas of the city where development is constrained due to a lack of capacity in existing energy distribution systems to meet increased energy demand. Current information suggests this is a problem in some parts of the centre of the city.

Communities may also wish to work together to put together propositions to expand district heating into their area. Sustainable Glasgow will work with the Council, social landlords, and community groups to examine how community involvement in district heating systems can be facilitated. The study recommends a consultation exercise is undertaken to identify additional areas as candidates for designation as district heating zones.

There is infrastructure in place that could help reduce the costs and speed the roll-out of district heating. Over 2000 dwellings in the city are already connected to district heating systems, some parts of the city have defunct district heating systems in place that potentially could be revived, and there are several miles of disused rail tunnels beneath the city that have potential to be used to take district heating ducts. Care will need to be taken in the roll-out of the district heating system to ensure that construction disruption is minimised.

Glasgow has a major programme of investment planned to improve Glasgow's urban drainage. This will require major construction works to lay new drainage pipes. Where appropriate the roll-out of district heating pipes should be integrated into this project in order to reduce construction costs and disruption for both projects.

Once in place district heating can be largely invisible (as it is buried beneath the streets). However the initiative proposes that in order raise awareness of the city's transformation that specially marked trees are planted in parallel with the line of the district heating pipes – so that citizens will see lines of trees spreading through the city as it becomes greener in both senses of the word. The trees will become a symbol of the city's new greener energy system.

In addition the initiative also recommends the installation of specially marked cycle lanes in parallel with the roll-out of district heating. These cycle lanes will also act as a permanent reminder of the green energy systems running beneath citizens' feet.

# Combined Heat and Power

Combined Heat and Power systems will (at least initially) supply most of the energy to the district heating system. CHP systems tend to be deployed as small local energy centres.

Combined Heat and Power (CHP) systems deliver an overall efficiency (around 85%) far greater than conventional power stations (typically 35% to 50% efficient) by capturing waste heat from electricity generation and using it for other purposes (such as heating buildings). Both CHP and conventional power stations incur additional energy losses in the delivery of energy to the customer through energy distribution systems. In efficient district heating systems in Scandinavia the energy losses from district heating networks lie between 6 and 9%.

The sizing of CHP systems in the city would need to take into account potential future heating demand reductions due to improvements in the energy efficiency of buildings, however this tendency would need to be balanced against forecast future economic and population growth for the city – both of which will tend to increase demand for energy.

CHP can be powered by a range of fuels, including fossil fuels, biomass, biogas or waste. In Glasgow the CHP energy centres are expected to be fuelled using natural gas (at least initially) fed into gas turbine or reciprocating engines. In the longer term, in order to deliver even greater carbon emissions, it would necessary for these energy centres to switch to renewable fuels such as biogas or biomass.

Around 10 of these small energy centres would be located across the city. Precise locations have yet to be selected – and would be subject to normal planning procedures. These energy centres can be made largely invisible through integrating them with new or existing buildings (such as office blocks, hotels, sports facilities and multi-story car parks) – or made features of the city. For example, a glass-fronted CHP station could be used as an educational and awareness raising tool.

Due to its greater efficiency CHP systems could deliver heat at prices below that of gas – and still be financially viable. CHP therefore offers an opportunity to help tackle fuel poverty. The financial and carbon savings would be much greater for the estimated 10% of households in Glasgow heated by electricity. Typically these properties are two to three times as expensive to heat, and have twice the carbon emissions of gas heated properties. Ironically many electrically heated properties are occupied by those on the lowest incomes.

## Other Heat Sources

The district heating network is a key element of enabling infrastructure that will allow a broader range of low carbon heat sources to be harnessed. For example, waste heat from industrial processes (such as distilleries and breweries) can be used to heat homes and businesses (as well creating additional income for the businesses supplying heat). The study has identified a number of major businesses in Glasgow that could feasibly sell waste heat into a district heating system. Heat pumps used to cool offices and data centres can also supply significant amounts of heat to district heating systems. The district heating network will also allow small scale facilities (which could potentially be community owned) to sell heat into the system.

### Business Models for District Heating

The analysis in this report suggests that a public/private partnership should be created to plan, co-ordinate, own and regulate the city's district heating network. A public/private partnership will reduce risk, find it easier to raise capital, ensure that the network is developed within an agreed strategic plan, and provide regulatory assurance to customers. A more detailed analysis comparing different business models is set out later in the report.

The initiative believes that the implementation of CHP/district heating systems in the five district heating zones identified so far is also likely to be through public/private partnerships. Discussions with key potential customers in each of the zones has shown there is considerable interest in purchasing energy from district heating systems, in participating in partnerships in these zones, as well as interest in building the CHP/district heating systems from developers and investors.

Any entity that complies with the technical and operating standards set for the city's district heating network will be able to link to it. So public, private, and community owned bodies will also be able to sell heat into the network.

In order to develop district heating networks in each of the five identified zones the initiative proposes that a stakeholder group for each zone is immediately created – to include key customers, developers, potential heat suppliers, and the city council.

### Regulation and pricing

There is currently no regulatory system in the UK for heat. This is because there is no effective heat market in the UK. The markets are instead in the fuels used to produce heat – gas, electricity, oil, and coal. The gas and electricity markets are regulated to ensure fair and open competition between suppliers; allow customers choice; and ensure that customers do not face undue charges for the development and operation of shared underlying infrastructure (such as transmission and distribution systems).

Connecting to a district heating system requires installation of a heat exchange system in place of a gas boiler (for example), but existing wet radiator systems would remain in place. Customers will need reassurance to persuade them to make a long term commitment to district heating. In order to reassure customers that Glasgow's heat systems will deliver a fair pricing and billing structure; will deliver heat supplies reliably and to consistent quality; and remain financially viable over the longer term, the initiative proposes that the district heat network should be regulated by a joint public/private board that would include the city council.

The initiative's analysis finds that although district heating has a high initial capital cost the heat produced can be sold slightly below the equivalent price of gas – and still offer investors a good rate of return on capital. This is due to the high efficiency of CHP and regulatory incentives for CHP/ district heating systems. The initiative proposes that heat prices are indexed to the price of gas – so that heat prices to consumers are set with the aim of ensuring that they are below the equivalent price of gas.

### Technical and operating standards

The public/private district heating heating board will agree common technical and operating standards to be used by CHP/district heating systems in Glasgow. These standards will be designed to ensure:

that different district heating zones and projects can be connected together as part of a city-wide district heating network;

the system has a whole can be monitored, controlled and administered;

the system as a whole operates safely and reliably; the system achieves measurable carbon emission reductions; that metering of heat is standardised; that financial systems are clear and transparent.

All new CHP/district heating systems within a designated district heating zone will be required under planning rules to comply with these standards; and all systems that may wish at some point in the future to join the wider district heating network would also need to comply.

# Public policy measures to support district heating

The nature of district heating (which involves laying underground insulated hot water pipes to distribute energy) means it is easier and cheaper to integrate the technology as a part of a new development. Sustainable Glasgow proposes the development of CHP/ DH in Glasgow is assisted by the adoption of a supportive planning and public policy regime that will require new developments to connect to an available CHP/DH system, or prepare for connection to a planned district heating system – unless a lower carbon energy system is available. The study also proposes that all new developments and major energy consumers are required to publish the projected energy consumption and profiles, and carbon emissions, of their development.

# Government Support Measures for low carbon heat

High efficiency CHP and district heating systems can benefit from a number of government incentives.

• Favourable treatment under the EU Emissions Trading Scheme

CHP, as a low carbon technology, does not have to buy as many allowances to emit CO2 as conventional power stations.

- Carbon Reduction Commitment Heat exported from CHP plants will be treated as if it were zero carbon, even if it comes from fossil fuels.
- Exemptions from the Climate Change Levy The Climate Change Levy is a tax on certain forms of energy supplied to the non-domestic sector. Fuel inputs and electricity outputs from high efficiency CHP plants are exempt from this tax.

### Enhanced Capital Allowances

Enhanced Capital Allowances enable a business to claim 100% first-year capital allowances on their spending on qualifying plant and machinery, including Combined Heat and Power plant. The whole of the capital cost of investment in CHP can be written off against their taxable profits, helping cash flow and providing a shorter pay back period.

In addition, electricity from renewable CHP qualifies for financial support under the Renewables Obligation, and heat from renewable CHP will qualify for support under the Renewable Heat Incentive.

### Summary of heating proposals

The five initial CHP/DH zones offer a 9% reduction in Glasgow's emissions using natural gas as the main fuel source – and will create the UK's largest district heating network. Delivering this level of carbon emission reduction will depend on achieving a high degree of take-up of district heating in the designated zones – particularly by large energy consumers. Initial discussions with key consumers in the proposed district heating zones have shown a strong degree of interest in joining district heating systems. Greater emission reductions will be achieved as the system expands across the city – and lower carbon heat sources (such as biogas and waste industrial heat) are substituted for natural gas. This ability for the district heating system to move to even lower carbon fuels in the future is likely to be essential if Scotland and the UK are to achieve an 80% reduction in carbon emissions by 2050.



Summary of proposed actions for heating in Glasgow:

- consultation and designation by the Council of the 5 identified areas as district heating zones
- creation of stakeholder groups for each of the designated district heating zones
- consultation on creation of additional district heating zones
- consultation and adoption of planning and public procurement policy measures to support the development of district heating in the city including:
  - a requirement for new developments in a designated district heating zone to join the district heating system when it is available
  - a requirement for buildings owned or leased by public sector bodies (in particular the council) to join a district heating network when it becomes available
  - liaison with planned development of waste water infrastructure so that the district heating network is implemented at the same time where possible – reducing costs and disruption
  - a requirement for new developments to publish their forecast energy demand and profile. The council to co-ordinate publication of this information.
  - Requirements to reduce electrical heating in the residential sector in particular.
- a proposal to UK and Scottish Government that legal powers in relation to district heating zones are strengthened to include the following measures:
  - a power for local authorities to compel connection to a district heating system in a designated zone (this law has operated in Denmark for many years);
  - a power for local authorities to compel large commercial or industrial concerns to sell waste heat to district heating systems.

- creation of an entity (potentially a public private partnership) to raise capital, develop, own, and regulate the district heating network.
- Proposal to UK and Scottish governments that legal restrictions on local authorities acting as energy companies be removed.
- development of an agreed implementation plan for district heating in the city
- development of technical and operating standards for the district heating network
- development of a regulatory system for the network including:
  - a commitment that the prices for heat to residential customers will permanently be below the equivalent price of gas
  - a commitment that prices for heat to businesses and public sector customers will be set no higher than the equivalent price of gas
- measures to increase awareness of the district heating network as it is implemented:
  - planting of trees and cycle lanes alongside district heating pipes
  - development of at least one Combined Heat and Power facility as an educational and awareness raising facility
  - active promotion of the district heating zones to businesses as a low cost, low carbon energy location opportunity



# Combined Map of Low Carbon Opportunities in Glasgow



# Transport

Cities rely on effective transport systems for their existence. These systems must transport people, goods, and supplies quickly and effectively in order to maintain the city's economy and social structures. Transport also has a major impact on the quality of life in a city, its environment and the economy.

With over 390,000 people working in Glasgow this creates heavy demand for transport at peak periods – with 50% of people working in the city commuting from outside its boundaries. Forecast increases in population and continuing regeneration of the city – including special events such as the Commonwealth Games in 2014 – will tend to continue to increase demand for transport.

The city has an extensive road network consisting of some 40 km of motorway and 1700 km of other public roads .The backbone of the road system is the M8 motorway that runs through the city and continues to Edinburgh. On the eastern outskirts of the city the M8 joins with the M73 which links with the M74 route to Carlisle and the south, and with the M18 route to Stirling and the north.The M77 runs from the south west of the city to Ayrshire. The M74 link is currently being constructed to the south of the city and will complete a ring of motorway around the city.

Several other major road routes radiate from the city centre. A large proportion of journeys along these routes are by commuters in private cars travelling into the city. As a result there is frequent congestion on routes leading to the city – including the motorways - during peak periods. Cars account for around 40% of journeys in the city. Glasgow also has around 1,400 licensed taxis, and a further 2800 licensed hire cars.

As well as the road system, an underground railway system and the largest suburban commuter rail network in the United Kingdom outside London also operate in Glasgow. Each day the rail network is used to make 100,000 daily passenger trips in or out of the six central area stations, with almost 20% of this figure accounted for by morning peak hour movements alone.Two major railway stations (Queen Street and Glasgow Central) are sited within Glasgow city centre and link to a



further 60 railway stations throughout the city, five of which have park and ride facilities. The SPT Subway (Glasgow Underground) operates on 10.4 km of double track and handles more than 40,000 passengers a day and is estimated to be used by about 10% of city centre travellers. Together the rail and underground network account for 30% of peak trips to the city centre. It was recently announced that the proposal for a rail link to Glasgow airport would be cancelled as it did not attract sufficient funding.

SPT and Glasgow City Council are developing proposals for Clyde Fastlink, a dedicated bus route serving key locations on the Clyde Waterfront which is designed to be capable of being adapted to light rail. Space along the waterfront between Central Station and the SECC, and on the Clyde Arc bridge, has been reserved for Fastlink and/or light rail. The objective is to support regeneration on the waterfront. The Southerm General Hospital expansion is also planned for connection to the Fastlink system.

In addition, a main bus station (Buchanan Bus Station) is also situated within the city centre. This is Scotland's busiest bus station with an estimated annual footfall of 14 million people. Around 1,000 buses are operational in Glasgow – with First



Group being the dominant bus operator, and a number of other operators also providing services. SPT reported an 18% increase in patronage of local bus services since 1999/2000 – with buses accounting for around 22% of journeys in the city. Buchanan Bus Station is used by an estimated 35,000 passengers per day. Glasgow International Airport lies some 10 km west of the city centre, outside the city boundary.

Glasgow is believed to have one of lowest rates of bicycle usage within the UK. In the past few years the number of cycle lanes in Glasgow has been increased by 212km and over 500 bicycle parking racks have been placed across the city for public use. The use of cycles has also been supported by such schemes as the bikes for schools scheme which has seen a hundred bikes issued to pupils in 4 schools in the city, and cycle to work schemes.

Transport systems in Glasgow are responsible for 18% of the city's carbon emissions – as well as 80% of a range of other pollutants such as Nitrogen Oxides and particulates. These pollutants have a damaging effect on health and have resulted in the Council declaring three Air Quality Management Areas in the city – covering the city centre, Byres Road/Dumbarton Road, and Parkhead.

The city has both a Local Transport Strategy and an Air Quality Management Strategy that have been developed after extensive research and consultation. Some of the measures in these strategies will contribute to improving air quality and reducing carbon emissions. These reports and their recommendations are not repeated in detail here. The city's Local Transport Strategy is based on enhancing public transport, measures to promote Sustainable Transport, with targeted road investment to relieve congestion in key locations.

The Sustainable Glasgow Initiative has sought to identify additional technically and financially feasible opportunities that would assist in reducing transport related carbon emissions – in a way that is consistent with the continuing development of an economically successful, attractive and growing city.

The initiative's proposals for transport have 3 main themes:

- Reducing private road transport and road freight
- Decarbonising road transport and public transport
- Improving public transport



# Reducing private road transport and road freight

In the city centre there are significant problems with traffic congestion and poor air quality linked to both private and commercial road vehicle use. The city's motorways facilitate road transport and make it easy to drive directly into the city centre. Combined with an abundance of cheap car parking in the city centre these factors act to encourage cars to come into the city centre. The numbers of road vehicles act to reduce the quality of experience for those living, working and visiting the city centre.

Glasgow currently has one of the lowest rates of car ownership in the UK (at around 57 vehicles per 100 households) – this is linked mainly to deprivation in parts of the city, but also to good public transport within the city. But car ownership is now increasing at a faster rate than the rest of Scotland – and increased by 92% between 1984 and 2004. A significant number of car journeys in the city start from outside the city for the purposes of shopping or commuting to work.

Glasgow City Council's monitoring of traffic suggests that overall road traffic decreased at 0.46% per annum between 1996 and 2005 – but on trunk routes (including the M8) traffic increased at 2.97% per annum. This suggests the Council's traffic control measures on local roads have met with some success. The Council has set a target to reduce traffic in the city by between 0 and 0.5% per annum – but although the Council recognises the importance of reducing traffic in the city centre, and is putting city centre traffic monitoring measures in place, it has not as yet set a target for reducing traffic in the city centre. It also appears that Glasgow will fail to meet targets related to air quality in several locations unless additional action is taken. In response Glasgow is considering measures that would set standards for reduced emissions from both buses and taxis – as these are significant contributors to pollutants in the city centre. The Council has also expressed a wish for legal powers that would allow it to regulate buses in the city.

Given that Glasgow is a major commercial and retail centre it is also subject to a large number of lorry and van movements to deliver goods and supplies to shops and offices. In Amsterdam a scheme to move goods in the city centre through the use of trams for freight was forecast to halve the city centre's 5000 daily lorry movements. However the scheme failed financially in mid-2009 – possibly due to an insufficiently supportive public policy environment (ie that it was still too easy to run lorries into the city centre).

The initiative suggests the potential for a mixed use passenger and freight tram system in the centre of Glasgow should be explored. This would initially operate primarily in the pedestrianised areas of the city - thus reducing traffic disruption during the installation of the system, and providing a transport link between Queen Street and Central Station (something that has been proposed by numerous projects over the years). By operating in these areas freight deliveries to a large number of retail and commercial premises would be enabled. Freight transfers from road to rail could be facilitated by using rolling stock that can share existing rail tracks – thus allowing lorries to transfer freight to the rail/tram system outside the city centre. Systems exist that can allow track to be laid relatively cheaply in pedestrianised areas (such as that deployed in Portland, Oregon), and trams and pedestrians happily share streets in many European cities. This proposal would clearly require detailed further study before it could proceed - and would require a supportive public policy environment in order to proceed (eg measures that would seek to restrict lorry movements in the city centre).

Given Glasgow's role as a commercial centre many journeys – particularly at peak hours - are related to people commuting to work. The initiative suggests that the Council should work with major employers in the city to encourage them to develop employee travel strategies that encourage use of public transport – including (for example) the creation of car pooling schemes, and ensuring provision of salary sacrifice schemes for bicycles.



### Residents regularly using public transport

Survey of 600 residents conducted by Infosurv for the University of Strathclyde. Survey conducted September/October 2009.

Rapidly increasing car ownership and economic expansion in Glasgow could undermine efforts to reduce transport related carbon emissions. Once a household has invested in a car it often works out cheaper to use that car rather than use public transport. The survey above suggests that 40% of residents do not use public transport – with the most common reason (42%) given for not using public transport being "I just enjoy driving my car'. Maintaining Glasgow's current low rate of car ownership is likely to depend on the following things delivering a high quality public transport system, implementing public policies that actively discourage individual car ownership and use (eg through restricting car parking and introducing additional charges for car ownership and use), and perhaps in the longer term changing people's attitudes so that they no longer see owning a car as necessary or as a status symbol. The current recession may assist in persuading people not to own a car - providing there are viable alternatives.

The Council has previously considered the possibility of congestion charging – and the initiative recommends the Council looks again at this issue. Following introduction congestion charging in London in 2003 there was an immediate 30% reduction in cars and lorries traffic in the central charging zone (as well as a 20% increase in buses) - however this reduction in traffic levels has been eroded significantly over time - so that current traffic levels are now perhaps only 8% lower than 2002 levels. Transport for London argues that this may be due to a long term trend in increasing traffic levels rather than any failure of congestion charging. However a more relevant factor may be that the cost of the congestion charge has not risen as fast as public transport fares - causing the impact of the congestion charge on travel decisions to be eroded. Recent announcements on increases in congestion charging by the Mayor of London may counteract this effect. Stockholm estimates a 19% reduction in traffic entering the inner city as a result of its congestion charging scheme. Any new consideration of congestion charging would need to consider design of the scheme carefully to seek to achieve ongoing reductions in traffic levels - and should only be implemented as a part of a wider transport strategy that ensures the public and commercial organisations have viable alternatives.

A survey conducted for the initiative suggests that two-thirds of residents would support some type of congestion charging - though these results might change once residents are asked about a specific scheme. The experience in Edinburgh was that a referendum on congestion charging in 2005 was rejected by residents by a margin of 3 to 1. Car ownership in Edinburgh is at much higher levels than Glasgow and this is likely to affect people's attitudes – though perhaps not in the ways expected. Support for congestion charging is significantly higher amongst car owners than non-car owners (both in the Glasgow survey, and the Edinburgh referendum). This could be due to the fact that car owners are more aware of the size of the congestion problem - and want action to tackle this. The interesting contrast between Glasgow and Edinburgh is that public transport users in Glasgow also support congestion charging. A key additional factor in Glasgow may be the large proportion of cars and commercial vehicles in the city centre which are from outside the city.

There may be concerns that congestion charging is inequitable and unfairly penalises low income households – however given the low ownership of cars in lower income households in Glasgow this may not be a significant factor in practice.

An additional issue is the need to keep the city centre as a vibrant and growing economic area – and there may be concerns that congestion charging could act as a disincentive to business by discouraging shopping and business trips in cars. However businesses would also benefit from having a more attractive city centre where more people would be attracted to live, work and shop. Clearly there would be a need to consult businesses on their views, and to ensure that businesses, their customers and employees, have viable alternative transport options available.



# Proportion of residents supporting "charging car owners for driving in the city centre"1

Survey of 600 Glasgow residents - conducted by Infosurv for the University of Strathclyde, September and October 2009.

Proposals for congestion charging schemes in the city centre would also need to consider travel patterns on the M8 – and how these would interact with a city centre congestion charging scheme. The city council has no powers to control traffic on the M8, and therefore this issue would need to be raised with Scottish Government.

Car clubs exist in a number of cities in the UK – with the largest being in Edinburgh. Car clubs operate by allowing members to share a pool of cars. Members pay according to their usage of the pooled cars – and are allowed to book cars for periods as short as half-an-hour. Cars are located at designated parking bays in the local area and accessed using a smart card and PIN. A number of evaluations have shown a strong correlation between car clubs and reduced car ownership, and car mileage. Edinburgh has a successful car club with nearly 3,000 members – where an evaluation suggests that each car club vehicle takes 22.5 cars off the road. However attempts to expand car clubs into other parts of Scotland have not taken off. The Transform Scotland Trust recently announced a project which will examine how car clubs could be expanded across Scotland – and the role they could play in reducing carbon emissions. Car clubs can also be used by businesses as an alternative to using pool cars – and depending on the type of business, can reduce business costs.

A number of studies have examined the attractiveness of car clubs to different types of household. People join car clubs to avoid replacing or buying a car. Studies indicate that households with a higher degree of education, with lower car mileage, and restricted street parking, are more likely to join car clubs initially. This suggests that certain parts of the city might be targeted for city car clubs first – however there may be social benefits in also ensuring the availability of car clubs in lower income parts of the city.

An additional incentive to joining a car club would be to make these vehicles exempt from congestion charging and/ or to provide discounted parking for car club vehicles in key locations. City car clubs could increase access to cars in low income areas, as well as reducing vehicle numbers in higher income. Car clubs in other cities have required an initial subsidy from the Council to get of the ground – but these subsidies have typically been small.

Where possible low emission vehicles should be used for car clubs – however an option to promote wider use of the car club would be to include a small proportion of "high status" vehicles in the car club pool. This might increase the attractiveness of the car club to a wider range of individuals, families, and businesses.

Car pooling is where people make an arrangement to share cars rather than each driving individually. These schemes can be particularly effective when facilitated by employers – as individuals tend to have similar journey patterns, and there are fewer concerns about personal safety. The initiative proposes working with employers in Glasgow to encourage them to facilitate and promote car sharing schemes.

The Council already has measures in place aimed at expanding support for walking and cycling in the city as alternative to powered transport. The cities where cycling is most popular (Amsterdam for example) have a supportive infrastructure in place that makes cycling an integral part of the city's culture – cycle paths, cycle traffic lights, secure cycle parking, and good links with public transport. The initiative suggests that the Council consider increasing provision of cycle paths in two ways – in conjunction with the installation of other infrastructure (such as district heating networks, and drainage systems), and the allocation of cycle paths in pedestrianised areas – so that walkers and cyclists can share the same streets. In addition an expansion of secure cycle parking in key locations would help encourage people to use cycling as a part of their commuting and shopping experience.

The UK government allows employers to offer cycles at a discount through salary sacrifice schemes (effectively allowing employees to buy cycles at a discount of between 20% and 40%). However it is unclear what proportion of employees in Glasgow have the salary sacrifice scheme available to them. The initiative suggests working with all major employers in Glasgow to ensure that salary sacrifice bicycle schemes are available, and promoted, to as many employees as possible. Employers should also provide secure cycle parking.

The measures set out below are primarily aimed at reducing the number of vehicles on Glasgow's roads – particularly in the city centre – and working to keep Glasgow as a city with low car ownership.

#### **Recommendations:**

- The initiative recommends the Council sets a traffic reduction target for the city centre – and in particular a reduction target for the most polluting vehicles.
- The initiative to conduct a study to assess introduction of a mixed passenger/freight tram or electric vehicle freight delivery scheme in the city centre.
- The Council to consider introducing charges for lorry and van movements in the city centre. This could be phased to coincide with the introduction of a freight tram system and/or an electric vehicle delivery system
- The initiative to consider the potential impact of varying council tax as an incentive to reduce car ownership. If appropriate propose to the Scottish Government that new powers should be provided to local authorities to vary council tax rates in line with car ownership. Set at appropriate levels this might act to maintain low rates of car ownership one possibility would be to reduce council tax rates for homes that have no car, to increase council tax for homes with I car, and increase council tax significantly for homes with two or more cars. Such charges might be phased in over a number of years to allow householders to take informed purchasing decisions.

- The Council to develop cycle paths in conjunction with district heating and in pedestrianised areas.
- The initiative to work with major employers in the city to encourage them to develop employee travel strategies that encourage use of public transport, the creation of car pooling schemes, and ensures provision of salary sacrifice schemes for bicycles.
- The Council to review existing parking provision and regulation in the city with the objective of reducing availability/attractiveness of city centre parking. This could include measures to ensure that the disabled parking permit scheme is not abused by drivers not entitled to such permits.
- The Council to seek additional powers to regulate the provision of all types of car parking in the city.
- The Council to re-examine congestion charging as an option for reducing traffic in the city centre – with exemptions for low carbon vehicles, and potentially car club vehicles.
- The initiative to work with transport providers to examine how the costs of certain journeys by public transport can be made comparable with the cost of driving (for example, the cost of commuting by rail between Edinburgh and Glasgow).
- The initiative to work with the Transform Scotland Trust and others to examine options for expanding use of car clubs in Glasgow.
- The Council to consider requiring new housing and commercial developments to introduce strategies that actively promote use of public transport and reduce use of road freight.



# CO<sub>2</sub> emissions from electricity and hydrogen under different grid mix scenarios (gCO<sub>2</sub>/km)

Source: Etech (2007) A review of the UK Innovation System for Low Carbon Road Transport Technologies

Grid mix scenario C - 176gCo.,/kWh - increased renewables/nuclear and use of CCS with coal

### Decarbonising road vehicles

In addition to seeking to reduce the number of vehicles on Glasgow's roads, and the number of miles they travel, measures can also be taken to reduce carbon emissions from vehicles. Smaller vehicles with more efficient engines produce less carbon per km travelled. Average CO2 emissions from new cars have dropped by around 12% since 1995 - and the average for new cars in the UK is 160g CO2/km. The EU's New Car CO2 Regulation has set targets for average emissions of 130gCO2/km from 2012, with full compliance by 2015, and 95gCO2/ km by 2020. As cars on the road are replaced over time, these regulations will act to gradually to reduce emissions from private transport.

Hybrid road vehicles, and electric vehicles, offer lower carbon emissions than conventional petrol or diesel fuelled vehicles but these vehicles are significantly more expensive, and electric vehicles in particular have different performance characteristics that can make them more appropriate in urban settings rather than for longer journeys. When lower running costs are taken into account they can be cost-effective for some types of users. Battery-electric vans such as the Modec are already available, and are suited to environments where daily mileages are 100-150 miles or less, such as urban deliveries.

The adoption of low carbon vehicles could be incentivised in the public transport sector through a self-financing subsidy system. This is analogous to the way that renewable electricity generation is subsidised in the power industry. Under the system all operators of conventional public transport vehicles in the city would pay a levy into a central pool (say 5% of the revenue generated by each vehicle). Separate funds would potentially be operated for taxis and buses. These central funds would then divided between the operators of low carbon public transport vehicles in proportion to the chargeable mileage for each low carbon vehicle. Early adoption of low carbon vehicles would be incentivised – as early entrants to the scheme would be likely to receive much greater rewards than later entrants (as the initial number of low carbon vehicles would be smaller). It is possible that public transport fares would need to be increased by a small amount in order to make this scheme viable. New legislation would also be required in the Scottish Parliament – and any proposal to increase fares may prove controversial with the public. It would however be likely to have a significant effect on the composition of public transport vehicles in the city.

Grant schemes funded from the public purse are another option for promoting adoption of low carbon vehicles. However the costs would be significant and sufficient public funding is unlikely to be available in Glasgow to trigger a major growth of the sector.

Vehicle	Technology readiness	Range	Recharging time	Top speed
G-Wiz	Available today	48 miles	2hrs 30 mins – 8hrs	45 mph
EV Smart for 2	Small fleet	62 miles	3hrs 30 mins – 8hrs	74 mph
Tesla 2 seater sports car	In production	200 miles	3hrs 30 mins – 8hrs	130 mph
Modec commercial vehicle	In production	100+ miles	Overnight	50 mph
Smith electrical van range	In production	up to 150 miles	Overnight	50 mph

## Electrical vehicle performance

Table compiled from manufacturers' information.

The UK currently has a very small number of natural gas powered vehicles (the Department for Transport estimates around 500) – this appears to be largely due to the low availability of gas refuelling points, lack of confidence/experience in gas powered vehicles, and the higher capital cost of gas powered vehicles. This is in comparison to 500,000 gas powered vehicles in Italy, 30,000 in Germany and 10,000 in Ireland (2006 figures). Natural gas powered vehicles can easily be switched to operating on biogas or biomethane.

Studies estimate a 75% to 200% reduction in carbon emissions when biogas is used instead of diesel. Biogas also offers particulate reductions and a significant reduction in vehicle noise levels. A number of cities in Scandinavia and the Baltic region already run their bus fleets on locally generated biogas – and a previous section notes the significant biogas generation potential available in Glasgow.

Given the lack of existing gas refuelling facilities biogas will initially be more suitable as a fuel source for fleets of vehicles making mainly local journeys – such as buses, taxis, and local commercial delivery vehicles. Operating all Glasgow's buses on biogas would deliver at least a 0.75% reduction in Glasgow's carbon emissions; and carbon reductions from a switch to biogas taxis are estimated at around 1.5% - and improvements in Glasgow's air quality would be significant. Achieving a switch to biogas in HGV fleets would deliver even larger carbon savings.

Biogas is estimated as around 40% cheaper to run than diesel (2006 figures). However capital costs are significantly higher for biogas vehicles – studies estimate biogas fuelled heavy duty vehicles are up to  $\pounds$ 25,000 more expensive, and light duty

vehicles up to  $\pm$ 5,000 more expensive, with potentially higher maintenance costs. When these costs are taken into account only intensively operated biogas vehicles are competitive with a diesel vehicle over an operating life of four years. This supports the case for measures that would act to make biogas more economically competitive.

The proximity and redevelopment of the First Bus depot close to Polmadie and Dalmarnock Sewage Treatment Works suggests it would be possible implement biogas network links to these facilities – should anaerobic digestion facilities be located at these points in the future. Thus creating a major biogas refuelling facility for many Glasgow buses.

A Low Emission Zone (LEZ) is a declared area where operators of vehicles not meeting an agreed emission standard can be required to pay a daily charge to enter the LEZ or are fined. The aim of the LEZ is for fleet operators to replace or improve some of the heaviest polluting vehicles operating within the LEZ area. The Council is currently considering introduction of this measure.

One of the quickest ways the composition of vehicles on the road could be improved is by public and commercial organisations changing their fleets to lower carbon options.



The initiative recommends the following potential measures are considered to promote use of lower carbon vehicles in Glasgow:

- Creation of Low Emission Zones in the city centre (already proposed by the Council's draft Air Quality Action Plan)
- The adoption of public procurement policies that favour the procurement and use of low carbon vehicles (a variation on a proposal already made by the Council's draft Air Quality Action Plan)
- The adoption of lower congestion charges for lower carbon vehicles (eg electrically powered and biogas)
- Low cost/reserved parking for electric and biogas vehicles (already proposed by the Council's draft Air Quality Action Plan)
- Variation in business rates to penalise companies not adopting lower carbon transport strategies, and to reward companies that do. This proposal would require additional legislation – and would need to be phased in over a number of years in order to give businesses time to respond.
- Incentives for car clubs to adopt low carbon vehicles (eg a grant system).
- Free licensing for electric/biogas taxis.
- Licensing conditions that require taxi emissions to be below a certain carbon benchmark (a variation to the proposal already made by the Council's draft Air Quality Action Plan)

- Promoting the creation of charging points for electrically powered vehicles in public authority, company car parks, and multi-story car parks (through planning policy);
- Consider a planning requirement for the creation of electrical vehicle charging points as an integral part of the development of any CHP facility;
- Open discussions with major bus, taxi and fleet operators on the creation of a strategy for the adoption of electric and biogas vehicles;
- Seek additional powers from the Scottish Government that would allow creation of a subsidy system for low carbon public transport vehicles.

Glasgow's underground system is electrically powered – and is responsible for over 4,000 tonnes of CO2 emissions per annum (0.1% of Glasgow's carbon emissions). The initiative is examining development of a CHP facility that would provide lower carbon electricity to the underground system – as well as additional revenues to SPT. The additional revenues could be used to improve services – for example, upgrading the system and enabling extended running hours for the Glasgow underground system.

### The initiative recommends:

 Opportunities for decarbonising power used by Glasgow's underground system and electrified rail systems are assessed.

### Improving public transport

Integrated fare systems – where passengers can change between different modes of transport (eg bus to underground train) in a single journey without penalty (usually within a set time period) – have been shown in many cities to increase take-up of public transport. Estimates of the increase in public transport demand due to integrated fare systems range between 4% and 30%. There are a number of barriers to the introduction of such systems – including the need for transport operators to co-operate with each other, and the capital costs of introducing new ticketing systems. However many cities have overcome these barriers and report significant benefits.

Strathclyde has an existing integrated fare system (known as the zonecard), but it is complex – involving 77 travel zones across the region (compared to 8 travel zones in London). It also requires users to carry a photocard, and zonecards must be purchased in durations of I week or more. It appears these complexities may create barriers to the use of zonecards (despite the offer of significant discounts with the zonecard).

The initiative recommends:

 Glasgow City Council, other local authorities around Glasgow City, SPT and other transport providers work together to develop and assess options for introduction of a revised and simplified integrated fare system for the Glasgow area.  Consideration is also given to the development of integrated fare options for common longer distance commuter journeys outside the Strathclyde area (eg Edinburgh to Glasgow).

Integrated passenger and freight trams/light rail system for the city centre are recommended for consideration. By focussing initially on the pedestrianised area of the city centre such a system could be introduced with less disruption; provide a link between Glasgow's two main railway stations; and improve transportation options in an area that is the objective for many journeys into and across the city. This tram system could be integrated to run along the routes currently reserved for the Fastlink system to provide a more extensive integrated light rail system.

### The initiative recommends

• Consideration of future integration of a city centre tram/LRT system with routes reserved for Fastlink.



# Attitudes and Behaviours



The effectiveness of the Sustainable Glasgow initiative in the medium and longer term will depend on achieving changes in behaviour and attitudes amongst Glasgow's organisations and individuals – in homes, in communities, in businesses, and within the public sector. In some cases, this will involve the widespread adoption of sustainable systems (such as district heating and public transport) over alternatives; in others it will be the result of cumulative small-scale actions (eg waste reduction, energy efficiency, and community renewable energy projects).

Understanding how to change Glasgow's behaviour towards more pro-environmental actions is thus a critical part of the initiative. Measuring and delivering change in environmental behaviour is complex. The focus of the recommendations here is on identifying those behaviours and attitudes where change would create the most significant positive impacts for the Sustainable Glasgow initiative.

It is clear that people and organisations are not all the same in their environmental attitudes and behaviours. Understanding these differences is critical in designing effective behavioural change policies. In particular, a 'segmented approach' can assist in making interventions more effective, and be targeted towards supporting groups already adopting some sustainable behaviour and encouraging more effectively those who so far have limited adoption of pro-environmental behaviours. This approach is based on appreciating the differences in people's attitudes, barriers, motivations and current behaviours. This study has analysed existing evidence, and conducted a new survey of environmental attitudes in Glasgow, in order to better understand the segmentation of attitudes and behaviours in Glasgow.

A key issue is that although many people in the UK (and Glasgow) express pro-environmental attitudes this has not brought about significant behavioural shifts. Physical, social, cultural and institutional contexts shape and constrain people's choices and options. Moreover, sometimes significant shifts in behaviour can be achieved without any influence on attitudes; for example, through regulation or through economic instruments such as pricing, taxation and other incentives. However; attempts to change behaviour without changing attitudes contain political risks. This helps to explain the emphasis in government-led campaigns on raising the level of awareness and education on environmental issues. DEFRA has used the following classification to map citizen's expressed willingness to act against their ability to act.

This study suggests the motivational and behavioural characteristics of these groups can be split into the following three categories:

- · those who are pro-environmentally aware
- those who are willing but remain cautious in their behaviour
- those who are largely disengaged from pro-environmental behaviour.

The DEFRA segmented approach can be positioned within what has been termed the '4Es' approach to changing behaviour; motivating change through a mixture of 'enabling', 'engaging', 'encouraging', and 'exemplifying'. This strategy recognises that each group is different in its potential to do more and different in its willingness to act to do more.

The 4Es approach was developed as part of the UK Sustainable Development Strategy in 2005. It outlines four key areas of interventions, largely led by government but including business and community as well.



Enable:	Engage:
<ul> <li>remove barriers to motivation &amp; action</li> <li>give information &amp; best practice</li> <li>provide facilities for action</li> <li>provide viable alternatives</li> <li>educate/train/provide skills</li> <li>provide capacity</li> </ul>	<ul> <li>create community action</li> <li>develop co-production</li> <li>deliberative fora</li> <li>Support personal contact &amp; enthusiasts</li> <li>media campaigns/opinion formers</li> <li>use networks</li> </ul>
Encourage:	Exemplify:
<ul> <li>adjust tax system</li> <li>offer grants &amp; expenditure</li> <li>provide reward schemes</li> <li>create recognition &amp; social pressures (eg league tables)</li> <li>impose penalties, fines and enforcement action</li> </ul>	<ul> <li>leading by example</li> <li>achieving consistency in policy</li> </ul>

The figure below illustrates one way in which different motivational approaches are likely to have most impact on each segment



A strategy based on the 4 E's argues that government needs to invest to make solutions available, to change behaviour through promoting examples of adoption, provide more information on products, and undertake campaigns to show collective action and support – however evidence for its effectiveness is currently limited. This model assumes that through time all people will see the interventions as desirable and will therefore feel a desire to change their own behaviour:

An alternative (perhaps complementary) approach is to seek to compel changes in behaviour through regulatory and infrastructural changes.

### Engaging and motivating individuals

A survey I was conducted across Glasgow to examine individual attitudes and behaviours – the results in many ways replicated the national pattern. Survey responses show:

most respondents stated that they were engaging with some pro-environmental actions

a strong link between household income and age and environmental attitudes and behaviours;

different incentives and barriers exist for these different groups; the greenest income group in terms of waste watching are those in middle income households

the greenest age groups in terms of recycling are the youngest and middle aged group (15 to 30) and older group (50 to 59) that a clear majority support certain compulsory measures – such as congestion charging, charging 10p for a carrier bag, and introduction of water meters

friends and family are the most trusted source of information on environmental issues.

## Causes of environmental inaction

The most common reasons given for environmental inaction were insignificant money saving, high price of environmental alternatives, the amount of time they take, and lifestyle restrictions that might follow.

Amongst the lowest income group, 'too much time and hassle' was identified as the most frequent response, by 46.8%, and then 'costs too much' by 43%. In contrast, the highest income group 47% explained their inaction by 'sometimes you just forget' and 'there's no recycling facility nearby'. The middle income group identified as being the most positively green, also offered a wider range of explanatory factors for non-action: including 'just forget' (47%), 'too much time and hassle' (45%), 'money you save is insignificant' (42%) and 'don't' know what else or what more you can do' (41%).

Analysing the sample by age groups also offers clear patterns. The 'money you save is insignificant' was mentioned by 67% and importantly 3 in 5 of the youngest group (15 - 19) indicated that they ''don't see why you should because hardly anyone else is doing it''. This contrasts with around 10% of older groups mentioning this factor. It is evident that peer examples matter to younger groups. For the 20s age group, the most frequently mentioned factor was ''energy saving products are unattractive'' – outweighing financial dimensions. In no other age group did more than 40% mention this factor:

The importance of financial issues for environmentally friendly behaviour decreases with age. Only 30 to 40 percent of those between 40 and 60 years old mentioned 'insignificant money saving' and 'it costs too much' among the reasons for their environmental inaction. Around 40% of respondents aged between 30 and 60 explained their inaction by 'sometimes you just forget' and around 30-35% - by 'there's no recycling facility nearby'. The greenest age groups appear to be people between 40 and 60 years old. The majority of respondents explain their inactions with financial reasons. And around 50% of respondents mentioned 'takes too much time and hassle' among the factors that impact their environmental behaviour:

### Policy implications

### Caring about sustainability

Respondents assigned highest importance to economic issues; crime and violence; employment; education; health, family and relationship issues. Sustainability, climate change, and environment gained much lower importance. The results broadly correspond to the results of the Scottish Government Attitudes and Behaviours Survey (SEABS).

The survey indicates that across the income groups, there are different levels of importance attached to sustainability. Sustainability (61%), the environment (63%) and climate change (57%) were all rated very important by more people in the middle income group than other groups. Sustainability was of greatest concern to those in 20-29 age group, climate change and the environment to the youngest cohort, with older groups more concerned by the environment.

#### Target Action:

I. 'Positive greens' – the middle income group and those in the younger age cohorts represent the groups with most concern for sustainability and pro-environmental behaviour. This is illustrated by their wider range of current actions. This represents a key target group to act as leading adopters of new initiatives, and champions of sustainable behaviours in their local communities.

2.'Reluctant participants' - the lower income groups, and those in middle age groups (30-49 years) have least concern for environmental concerns. This is illustrated by limited pro-environmental behaviour and by them identifying a wider range of barriers to changing their behaviour. This group could be targeted as having currently least awareness and involvement and thus offering the largest potential gains.

Income group	% use	
A – under £10k pa	72.2	
B – £10-20k pa	54.0	
C – £20-30k pa	52.3	
D - £30-40k pa	55.0	
E – above £40k pa	57.8	

### Transport attitudes and behaviours

More than 50% of respondents indicated that they walked or cycled instead of using the car for some of their journeys. The lowest income group used public transport most – with 72% using public transport. Around 45% of respondents in higher income groups do not use public transport.

### Target Action

Across all the groups, amongst the most cited reasons for not using public transport were related to safety. Except for the lowest income groups, more than 40% in each of the other groups rated 'anti-social behaviour' as off-putting to use, and similar proportions in the middle and upper income cited concerns about personal safety. Such concerns need to be addressed to increase use of public transport. Action may also be possible for lower and middle income earners. This group included in their list 'it's too expensive', 'services are too infrequent', 'routes not convenient' and 'vehicles are too crowded' - suggesting that service improvements could increase public transport usage.

### Policy summary

Previous research has shown income is closely related to pro-environmental behaviour. Drawing on evidence from the survey, the table below illustrates some key conclusions.

The table summarises the following 4 aspects for each income group:

- areas where each group is already contributing at levels well above the average for the city;
- areas that merit specific attention for intervention or action;
- the barriers which inhibit pro-environmental action for that group;
- factors which they suggest motivate them to engage positively with sustainable behaviour.
|                      | Current strong actions   | Key areas to target  | Barriers  | Motivators   |
|----------------------|--|--|---|--|
| Lowest income group  | Switch off/unplug electrical<br>appliances<br>Use public transport<br>Buy environmentally<br>friendly goods          | More use of energy<br>efficient appliances   | Costs too much<br>Too much time & hassle  | Save money<br>Good for health<br>Environment concerns<br>Friends   |
| Lower middle earners | Turn out lights<br>Use of shower over bath   | Raise use of public<br>transport *<br>Recycling of electrical<br>products<br>Use of council rubbish bags<br>Decrease purchases with<br>packaging<br>More use of energy<br>efficient appliances | Costs too much<br>Money saved insignificant<br>Too much time & hassle<br>Don't have a garden<br>No recycling facilities<br>nearby<br>Cost of public transport | Save money<br>Friends  |
| Middle income group  | Use energy saving light<br>bulbs<br>Reuse water<br>Grow own produce<br>Purchase organic food<br>Compost garden waste | Increase bottle & glass<br>recycle<br>Greater use of public<br>transport *   | Insignificant money saving<br>Don't know what else<br>to do<br>Mainly up to businesses  | Purchase organic food<br>Reduced packaging in<br>purchases<br>Safer and more frequent<br>public transport<br>Concerns for sustainability |
| Higher earners       | Turn out lights<br>Use of shower over bath<br>Efficient use of dishwater   | Greater use of nearby recycling facilities   | Don't have a garden   | Good for environment<br>Good for health Save<br>money  |
| Highest earners      | Fuel efficient car use<br>Purchase UK produce and<br>organic food<br>Water garden less<br>frequently in summer       | Greater use of public<br>transport *<br>Compost garden waste   | Too much time & hassle<br>Don't know what else<br>to do   | Good for environment<br>Ease and convenience   |

\* Address concerns of all groups on safety is use of public transport

Each group can be targeted more effectively with specific approaches aligned to their particular attitudes and barriers. The actions proposed for each group are:

	Suggested targeted actions
Lowest income group	Offer information on energy efficient appliances which are available at little or no additional cost over less efficient appliances
Lower middle earners	Key target group – but difficult to motivate Aim: greater use of existing services, including i) public transport via allaying safety concerns ii) recycling facilities and waste/rubbish separation iii) information about purchasing of reduced packaging in conjunction with key retail outlets
Middle income group	Most motivated group – ambassadors of current actions through friends and social networks; exemplars for other groups Aim: greater use of public transport, via allaying safety fear
Higher earners	Least engaged group in current action: Aim: information about low levels of engagement to appeal to their concerns for environment
Highest earners	Offer more information on the range of pro-environmental actions possible and encourage greater use of facilities available to provide convenient action (eg cheap compost bins, local produce)

Policy initiatives can also be identified for different age groups that reinforce existing behaviour and assist to address those with less engagement.

	Suggested targeted actions
Youngest age groups	Exemplify peers who are engaging, showing actions by examples especially in waste reduction, recycling, water saving Reinforce their concerns about sustainability and illustrate range of possible actions Emphasise continuation of pro-environmental behaviour into later years
20s age group	Key target group – Make energy saving devices 'attractive' Focus on family benefits as well as financial savings
30s and 40s group	Least concerned and active group, and least able to identify constraints – key target group Improve access to facilities and pro-environment alternatives Indicate cost savings
50s group	Offer more information on the range of pro-environmental actions possible and encourage greater use of facilities available to provide convenient action (eg cheap compost bins, local produce)
60s group	Reinforce concern for wider environment through use of public transport, purchase local produce, and greater reuse of water:



Delivering significant and meaningful behavioural change often requires long-term action – and adoption of a group of policy measures that work together to reinforce and support behaviour change. One off publicity campaigns are unlikely to be effective, as people tend to need to be reminded to continue with new behaviours, and may need help that enables them to adopt the new behaviours in the first place. The City of Vancouver's "One Day" is a 10 week programme that provides participants with practical information and resources, and reminders, on how to change their behaviour in ways that reduces their energy consumption in all aspects of their lives.

#### The report recommends:

- that the initiative examines options for creating and training networks of "sustainability champions" in local communities, employers, schools, and colleges – working where possible with existing initiatives such as eco-schools;
- the initiative works with the Council, schools, employers, retailers, communities, social landlords, transport providers to develop and implement a targeted strategy designed to change individual attitudes and behaviours in ways that will deliver the greatest long term impact on the city's sustainability;
- that all Sustainable Glasgow projects are designed to take account of behavioural change issues, and support behavioural change programmes as an integral part of their design;
- the Council examines the availability and awareness of recycling facilities;
- Transport providers work to improve safety and perceptions of safety on public transport.

#### Motivating communities

The focus here has largely been on individuals - especially how individuals can be grouped by shared motivations, attitudes, and socio-economic background. This model has dominated research on sustainable behaviour, recognising that ultimately it will be decisions and choices made by individuals and households which matter:

However, for technologies to be efficient as well as effective in changing behaviour, there has to be large scale adoption. District heating systems or more sustainable transport require more collective behavioural change. They cannot be economic or indeed have the desired sustainability impact unless they are used by groups of people.

The study has recommended elsewhere a number of measures designed to bring about community support for Sustainable Glasgow initiatives. These are designed to engage community support through delivering direct benefits and involvement to communities:

- training and jobs linked to Sustainable Glasgow projects;
- funding from Sustainable Glasgow project revenues for community based educational, sports and recreational facilities;
- funding from Sustainable Glasgow project revenues for actions that directly benefit local individuals – such as the creation of educational trusts for local young people in communities near to CHP facilities;
- giving communities direct involvement in local Sustainable Glasgow projects – such as the creation of urban woodlands;
- creation of a Low Carbon Communities Fund to facilitate local smaller scale community based projects;
- improving the local environment as an integral part of implementing Sustainable Glasgow projects.

Community and organisational attitudes and behaviours have been significantly under-researched and thus how to motivate communities to change behaviour together is poorly understood.

Sustainable Glasgow has the opportunity to lead in this area; both in terms of understanding what policies and interventions can bring about community level behavioural change, and in showing how such change can be put in practice.

The study therefore recommends that as a part of the next phase Sustainable Glasgow undertake a further study into delivering community level behavioural change.

# Creating a Supportive Public Policy Environment

The creation of a supportive regime of public policy measures is a vital step in ensuring that Sustainable Glasgow is successfully delivered over the long term – maximising positive impacts for the city and minimising any negative impacts. The public policy regime will also ensure that Sustainable Glasgow makes a full contribution to delivering a wider range of policy objectives – such as tackling fuel poverty; delivering jobs; regenerating communities; and building a positive image for the city. All the other sections include public policy measures – notably transport and energy management –for the sake of brevity these measures are not also repeated in this section.

#### Job Creation

At 8.5% of the adult population unemployment in Glasgow (as at October 2009) is significantly higher than the Scottish average of 4.7%. The proportion of employed adults (66%) is also significantly lower than the Scottish average of 76%. Parts of Glasgow are the most deprived in the UK.

Sustainable Glasgow aims to draw in around  $\pounds$ 1.5 billion in new investment into the city – and as an integral part of the development of these programmes the initiative will seek to ensure that companies and people in Glasgow derive a significant economic benefit from that investment. This could be achieved through:

- Identifying the areas and technologies where new jobs are expected to be generated – both in the long and short term;
- Identifying skills gaps in the potential local workforce;
- Working with partners to deliver training to meet those gaps;
- Development of the supply chain by identifying the products and services that will be required to deliver Sustainable Glasgow;
- Ensuring that local companies are aware of the future opportunities that will be available;
- Designating a number of green technology economic development zones in the city to attract low-carbon businesses, technologies, products, and services – potentially in partnership with the city's universities;
- Giving financial support and guidance to green entrepreneurs – making Glasgow a desirable location to set up innovative green businesses.

Significant numbers of jobs would be created by Sustainable Glasgow during the construction and implementation phase – with a smaller number of permanent jobs being created in the long term. Scottish Enterprise is committed to working with Sustainable Glasgow to maximise the economic and jobs impact for the city and Scotland as a whole.

The growth in urban clean energy technologies is expected to continue. It will be an essential element of delivering Scottish and UK climate change targets. By taking a lead Sustainable Glasgow will help create and develop companies that will be able to benefit from an ongoing growth of sustainable urban energy technologies across the UK and Europe.

#### **Fuel Poverty**

Fuel poverty is a major problem in Glasgow. At the end of 2008 105,000 homes in Glasgow were estimated to suffer from fuel poverty (defined as a household that has to spend over 10% of its income to maintain a reasonable heating regime) – with 35,000 of these in extreme fuel poverty (a household that has to spend over 20% of its income on energy). Energy prices are currently the main driver of levels of fuel poverty. Both Glasgow and the Scottish Government have strategies in place aimed at tackling fuel poverty – and investment in improving Glasgow's housing stock has acted to moderate the impacts of higher energy prices to some extent.

Homes that do not have central heating, or are heated using electricity, or solid fuels, are significantly more likely to suffer from fuel poverty. Electrical resistance heating has a lower capital cost, has a lower maintenance burden, and is therefore favoured by some social landlords. However electrically heated homes are two to three times as expensive to heat and are responsible for emitting twice as much carbon per unit of heat delivered. Ofgem forecasts that over the next 10 years consumer energy bills will rise by a further 40% to 60%. So the impact of energy bills in electrically heated homes is expected to be worse in the near future.

The complete phasing out of electrical resistance heating systems in Glasgow's homes would therefore make a useful contribution to tackling fuel poverty in the city (now and in the future) – as well as reducing its carbon emissions. Sustainable Glasgow therefore proposes that the city adopt a planning ban on new or replacement electrical resistance heating systems; phases in a ban over 3 years in the private rented sector by making electrical resistance heating ineligible for HMO licensing; and reaches agreement with all major social housing providers that they will phase out electrical resistance heating as an integral part of their ongoing investment programmes.

The initiative suggests social landlords replace electrical resistance heating with district heating where possible (unless a lower carbon alternative is available) as this has the advantage of a low maintenance burden.

#### Planning Policy

Sustainable Glasgow is proposing new measures aimed at creating a supportive planning regime for the development and adoption of strategic low carbon energy systems in Glasgow – as well as protecting the environment and the community, and ensuring compatibility with overall city development plans and objectives. Some of these proposals will also have wider impacts, such as the creation of additional costs for developers and businesses operating the city, though these measures will also deliver benefits. These proposals will therefore need careful consideration and consultation by Glasgow City Council should it wish to adopt them. The benefits brought by the development of low carbon energy resources need to be balanced against any potential adverse impacts that such development might have – and the needs of local communities taken into account. Planning and regulatory measures ensure that development proposals receive full and fair scrutiny – and interested parties are given opportunity to have their views considered.

The main themes of the planning proposals are:

- Improving provision of information
- Raising awareness and promoting energy management systems
- Promoting development of low carbon heating
- Promoting development of low carbon buildings
- Promoting community involvement in low carbon energy projects
- Promoting use of public transport and reducing use of private vehicles

#### Improving provision of information

A serious obstacle to the development of strategic low carbon energy infrastructure for the city is the available of energy and carbon emission data for planned and existing developments. This lack of information inhibits the identification of opportunities for joined up low carbon energy solutions.

Energy suppliers and developers often state such data is commercially sensitive and can be reluctant to share it. However there are already cities elsewhere in the world where it is compulsory for such data to be published (eg Boston).

#### Objective I

#### Ensuring availability of energy and carbon emission data

 All proposed new developments over a certain size will provide information giving details of their total projected energy consumption, energy profile, and carbon footprint from energy consumption. This information will be published by the Council. • As a condition of planning consent all developments over a certain size will also undertake to provide actual energy consumption, energy profile, and carbon emission data for publication on an annual basis.

## Raising awareness and promoting energy management systems

Organisations and householders struggle to make rational decisions in relation to their energy consumption without accurate, up to date, and easy to understand information on their patterns of energy consumption. Improved metering, information displays and control systems help householders and organisations to understand where they are using energy and then take steps to reduce that energy consumption either through behavioural change, or through installation of physical energy efficiency measures. In the commercial and public sectors energy management systems often pay back the initial investment within a very short time – as they allow action to be directed where it will be most effective. The case for smart meters at domestic level is currently not as strong but studies appear to show a small reduction in demand from the use of smart meters. Ofgem is requiring utility companies to fit smart meters to all properties by 2020. The proposals below aim to accelerate that process.

Remote meter reading may also allow the introduction of dynamic city-wide demand management systems in the future. Demand management systems allow city wide carbon emission reductions to be delivered through dynamic control of larger energy loads in order to reduce peak energy consumption. Reduction of peak energy loads reduces the need for more polluting power stations to be switched on.

#### Objective 2 Promoting the use of energy management systems

#### • Energy Management Systems

All new public, commercial and industrial developments above a certain size will install smart metering and energy management systems to a minimum specification. Systems must allow remote meter reading by energy suppliers.

Smart Meters

All new residential developments (and public, commercial, or industrial developments below the above size) will install smart meters to a minimum specification. Meters will display real time energy consumption information as well as allowing remote meter reading by energy suppliers.

#### Promoting Development of low carbon heating

Heating buildings makes up 40% of non-transport energy consumption and heating water a further 13% - accounting for 47% of UK carbon emissions. Heat in Glasgow is delivered largely from fossil fuels either directly (eg gas heating) or indirectly (electrical heating).

Some forms of heating produce much more carbon than others. The most carbon intense forms of heating are coal fired heating, oil fired heating, and electrical resistance heating (electrical resistance heating emits over twice the amount of carbon as gas heating). Not only do these forms of heating emit more carbon but they are also far more expensive to operate – and are often found in lower income households, thus playing a significant role in the high rates of fuel poverty in Glasgow.

Under Sustainable Glasgow's proposed new system heat will be distributed using a district heating (DH) system in 5 key areas of the city. This technology uses insulated hot water pipes to provide heat to communities.

#### Objective 3 Promoting development of low carbon heating

#### • Electrical resistance heating

No new buildings, or redevelopments, will use electrical resistance heating as a primary means of heating (unless there is no feasible lower carbon alternative).

#### · Coal and Oil fired heating

No new buildings, or redevelopments, will use coal or oil-fired heating as a primary means of heating (unless there is no feasible lower carbon alternative).

#### District heating

- All proposed new developments in an operational district heating zone must obtain their heat from the district heating system – or propose a lower carbon alternative.
- All proposed new developments in an area designated as a potential district heating zone must have a heating system designed to be capable of easy future connection to the district heating system – and agree to future connection when district heating is available.

#### Renewable heat sources

All proposed new developments not within a designated district heating zone must consider the options available to obtain their heat totally or partially from renewable sources (green energy tariffs are not eligible for consideration under this requirement). The effectiveness of such systems in reducing carbon emissions to be compared to efficient gas heating systems.

#### Objective 4

Promoting development of an integrated low carbon heating system for Glasgow

 All new CHP systems, and heat producing microgeneration systems above a certain size, must meet technical standards set by the Council to allow potential for connection to a wider district heating network.

#### Objective 5

#### Promoting development of low carbon buildings

 All new buildings to achieve a reduction in carbon emissions of 20% over the minimum standard required by existing planning and building regulations – through energy efficiency, low carbon energy generation technologies, and energy management (green energy tariffs are not eligible for consideration under this requirement).

#### Objective 6

Promoting Community involvement in low carbon energy projects

- Promoting community involvement in low carbon energy developments
  - All significant low carbon energy developments will be required to demonstrate that they have consulted communities and will implement measures that directly benefit and involve the local community – eg including shared ownership, long-term revenue generation for community initiatives and infrastructure, and job creation.

#### Objective 7

This measure aims to strengthen existing planning requirements in relation to transport.

- Promoting use of public transport and reducing use of private vehicles
  - All new developments above a certain size will provide transport plans that explain how their development will promote use of public transport and reduce use of private vehicles.
  - Commercial and industrial developments above a certain size to provide transport plans that explain how they will actively seek to reduce use of road freight vehicles – in particular in the city centre.

#### Removing green energy tariffs

Green energy tariffs promise consumers that by paying a small premium on their electricity price their electricity will be carbon free. However a number of studies have shown that green tariffs have no discernible impact on overall levels of UK carbon emissions. There are two main reasons for this:

- if one customer notionally consumes more renewable electricity then other customers notionally consume less renewable electricity – and therefore the tariff makes no net difference to overall carbon emissions;
- green tariffs are not a sufficient incentive to stimulate additional development of renewable energy generation. The main incentives for renewable generation are provided through regulatory market mechanisms (such as the Renewable Obligation).

There is also concern that an organisation or household purchasing a green energy tariff may feel it has less need to use electricity efficiently (as it believes its energy is carbon free).

Green energy tariffs produce no reduction in Glasgow's carbon emissions, and therefore this report does not recommend their use.

This initiative will therefore invite all organisations and households in Glasgow to cease to subscribe to green energy tariffs – and instead to move to the cheapest suitable tariff available.

The initiative will also invite organisations and tariffs moving to a cheaper tariff to invest any cost savings in energy efficiency measures in their own buildings – thus delivering real carbon savings for the city.

In addition this report recommends the Council and it partners set up a fund as an alternative to green energy tariffs – this fund would receive contributions from organisations and households wishing to contribute to projects that deliver measurable carbon emission reductions in the city.

#### Glasgow Low Carbon Communities Fund

The study recommends the creation of a Low Carbon Communities Fund for Glasgow. This fund will promote local low carbon projects that actively involve local communities. A number of options exist for building the fund's capital – including corporate sponsorship; European funding; links to the Scottish Government's Climate Challenge Fund; public fundraising and donations – as well as the link to removing green energy tariffs proposed above. A number of options exist for the fund's governance and operation – including operating it as a revolving loan fund so that its impact continues to grow through the years.

#### Integration with city plan and other initiatives

A range of public policies will have a strong influence on the future success of Sustainable Glasgow. This includes (for example) the city's development plans and policies; major regeneration strategies (such as Clyde Gateway); and public procurement policies. This is not an exhaustive list, there are of course many other relevant public policy areas. From January 2011 public bodies in Scotland will have a new duty under the Climate Change Act (Scotland) to exercise their functions in the way best calculated to contribute to delivery of the Act's emissions reduction targets. The Scottish Government will consult on statutory guidance on this duty during 2010. Glasgow City Council and other public bodies active in Glasgow will need to review their policies in the light of this duty and this report recommends, that the initiative works with public bodies in Glasgow to assist this process. Glasgow's City Plan 2 was adopted in December 2009. It is a development strategy and set of development policies covering the whole of the city. It provides a context for the Scottish Government's broad planning objectives as they relate to the city:

- enabling sustainable development;
- promoting a strong, diverse and competitive economy;
- promoting social justice;
- protecting and enhancing the quality of the environment;
- delivering good design; and
- delivering a more sustainable, effective, integrated transport system.

The wider strategic context for the development strategy is provided by the National Planning Framework 2 (NPF2), Scottish Planning Policies (SPPs), Planning Advice Notes (PANs), the Joint Structure Plan (JSP) and other relevant national frameworks such as the National Waste Plan.

City Plan 2 contains a section on energy in the environment section of the Development Strategy. This refers to a range of policies and guidance aimed at promoting the development of renewable energy and reducing carbon emissions.

The planning system can help to deliver reductions in energy consumption through effective design and construction. City Plan 3 will therefore continue to deal with the energy agenda. The energy section in the Development Strategy will be signposted to a supporting policy and any development guide produced to provide additional detailed guidance, perhaps including guidance for local areas of the city.

During 2010 the Council will start preparing for development of City Plan 3. The main focus of work will be on early engagement with key agencies, developers and the public and the preparation of the Plan's Main Issues Report, Monitoring Statement for City Plan 2 and a Strategic Environmental Assessment of the main issues and options for City Plan 3. The Council aims to publish these documents in early 2011.

There is scope within City Plan 3 to produce a development guide which sets out detail for energy related schemes. However new guidance may be required well in advance of City Plan 3 being adopted (scheduled for 2014). This could be achieved through preparation and adoption of a development guide by the Council. Such a guide would sit alongside City Plan 2 as a material consideration to be taken into account when assessing development applications. There is also the potential to have energy scoped into local development strategies, masterplans, and other local planning frameworks to be produced for local areas in Glasgow.

#### Clyde Gateway

Clyde Gateway is a 25 year programme to regenerate the East End of Glasgow – and as such is one of Scotland's largest regeneration projects. Focused on a former industrial area in the east end of Glasgow and extending into South Lanarkshire, the initiative seeks to capitalise on opportunities to bring substantial amounts of land back into economic use, bringing new jobs, housing, and leisure opportunities to existing communities and the wider area.

The area includes some of the key Commonwealth Games sites, including the Athletes'Village and National Indoor Sports Arena.

The Clyde Gateway will coordinate significant ongoing investment in the East of Glasgow. It is therefore vital that Sustainable Glasgow and Clyde Gateway work closely together to take account of and support each other's objectives.

#### **Public Procurement**

Public procurement policies can be an important lever and signal to the wider market. Scottish Government policy makes clear that public procurement can and should be used in ways that support sustainability. The Scottish Government's Sustainable Procurement Action Plan defines sustainable procurement as "a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis and generates benefits not only to the organisation, but also to society, the economy and the environment." Sustainability can be designed into procurement processes in ways that fully comply with legal obligations on public bodies to ensure open and fair competition, and fair access for suppliers. The initiative therefore recommends the Council and other public bodies in Glasgow review their procurement strategies to ensure they comply with sustainability principles - supporting Sustainable Glasgow objectives where possible.

#### The report recommends:

- Adoption of the planning policy objectives set out above:
  - Objective 1: Ensuring availability of energy and carbon emission data
  - Objective 2: Promoting the use of energy management systems
  - Objective 3: Promoting development of low carbon heating
  - Objective 4: Promoting development of an integrated low carbon heating system for Glasgow
  - Objective 5: Promoting development of low carbon buildings
  - Objective 6: Promoting community involvement in low carbon energy projects
  - Objective 7: Promoting use of public transport and reducing use of private vehicles
- Development of a comprehensive green jobs strategy for the city
- Invite all organisations and households in Glasgow to cease to subscribe to green energy tariffs
- The Council and it partners to set up a fund as an alternative to green energy tariffs that will invest community based carbon reduction projects
- The initiative to work with public bodies in Glasgow to help them take account of Sustainable Glasgow objectives and measures – and to meet their duty under the Climate Change Act (Scotland) to exercise their functions in ways that contribute to the Act's carbon reduction targets
- The Council to take account of the Sustainable Glasgow strategy and objectives in development of City Plan 3
- Sustainable Glasgow to work closely with Clyde Gateway to ensure that the initiatives take account of and mutually support each other's objectives
- The Council to review its public procurement strategy to ensure it supports Sustainable Glasgow objectives – and to encourage other public bodies to adopt similar policies

# Transforming Glasgow's Image

An integral part of Sustainable Glasgow's objectives is to transform the image of the city – both to its own citizens and businesses – and in the wider world. This will play a role in drawing people, businesses and investment to the city, as well as facilitating the successful implementation and operation of major low carbon energy initiatives.

This is not about running a superficial publicity campaign – it is about ensuring that people in the city and across the world understand the very real changes taking place in Glasgow. Low carbon energy solutions can often be designed to be essentially invisible by being integrated into existing buildings and infrastructure – but ironically this may act against people understanding the changes taking place in their city. Another option is to make image change an integral part of the design of Glasgow's low carbon energy projects.

There are clear linkages between transforming Glasgow's image, and the issues dealt with in the earlier section on changing attitudes and behaviour:

#### Greening Glasgow

Sustainable Glasgow's proposals go beyond just achieving carbon emission reductions. The initiative also aims to continue to make the city literally greener and improve the feel of the city as a place to live, work and locate. The benefits of interconnected green infrastructure across the urban environment are now widely recognised. Sustainable Glasgow can create the impetus for separate initiatives and projects to be integrated and develop the step change required.

Increasing the number of trees and green spaces, and reducing city centre traffic levels, will create both a conceptual and a literal breathing space in the city's heart – quieter, and with cleaner air to breathe. This changed reality will change people's understanding of the city.

Measures already mentioned in the report are the creation of urban woodlands. Glasgow has the potential to create

1300 hectares of new woodlands on vacant land in the city. The woodland strategy proposed by this report will need to balance the desire to reduce carbon emissions from increased biomass production (eg through short rotation coppicing), with the opportunity to improve the city's appearance by creating some permanent new woodlands, and the social benefits of creating new green spaces for communities and recreation. The implementation of a district heating system will also create an opportunity for the development of avenues of trees in many of the city's streets. This could deliver a different feel to the city – softening its lines and creating a new interaction between the city's man-made structures and nature.





The benefits of urban woodland, beyond its visual appeal, include the following:

- Improved Air Quality. Trees absorb air pollutants.
- Reduction of Greenhouse Gas Emissions. As a tree grows, it sequesters carbon dioxide and converts it to woody biomass.
- Improved Wildlife Habitat. Urban woodlands can provide food and shelter to birds and animals.
- Water Run-off Management. Street trees and other vegetation intercept and absorb rain, reducing and slowing the amount of runoff that makes its way to the sewer system.
- Noise Abatement. Trees can form a barrier that partially deadens urban noise, while providing a background sound of rustling leaves and branches that muffles other street sounds.
- Increased Psychological Well Being. Exposure to trees can reduce stress, with increased feelings of well-being and belonging.
- Improved Energy Conservation. Trees can cut heating and air conditioning use by providing shade and cutting the wind, reducing energy costs.

 Increased Property Values. The value of homes in neighbourhoods with trees tends to be higher than those of comparable neighbourhoods without trees.

Glasgow has significant air quality problems – particularly in the city centre. Main pollutants are Nitrogen Oxides (NOx) and particulates, mostly from transport. These pollutants have adverse impacts on human health and on Glasgow's image. Recent news reports have likened living and working in parts of the centre of Glasgow to smoking a pack of cigarettes a day. The measures proposed in this report would significantly improve air quality in the city centre – and by raising awareness of the improvements achieve positive impacts for Glasgow's image.

# Designing image change into low carbon energy solutions

Some examples of how image change could be integrated into low carbon energy projects are given below:

- Involve schools and communities in planting and maintaining urban woodlands – ensuring they understand the role of trees in reducing atmospheric CO2 levels
- Create at least one CHP facility that is designed to be architecturally attractive (rather than being concealed) for example, with glass walls so that it can also be used as educational facility to enable people to understand the source of low carbon heat for their homes;
- Ensure that biogas/electric vehicles such as buses, taxis and HGVs are branded consistently and obviously so that the people are aware that low carbon vehicles are operating in their city;
- Lay new cycle paths in a specific colour (consistent with Sustainable Glasgow branding) along the routes of the district heating network;
- Clearly identify any additional underground train services run as a result of additional revenues generated from low carbon energy.

#### Communicating the Vision

Use of a consistent and clear brand across all Sustainable Glasgow initiatives, with agreed brand values, will help raise awareness of the changes happening on the city. This report recommends the development of a brand that can be used in multiple contexts (documents, web, vehicles, and buildings); and used by multiple partners for projects that are consistent with Sustainable Glasgow values, fit with the framework it establishes, and contribute to its objectives. Partners using the brand will gain value through the positive green values associated with Sustainable Glasgow. Awareness and understanding can also be raised through working with schools and employers. For example, the Eco-Schools programme is an international initiative designed to encourage whole-school action for the environment. Eco-schools covers many of the same areas as Sustainable Glasgow - and Sustainable Glasgow projects could offer the opportunity for school involvement.

Direct community involvement in Sustainable Glasgow will also help people understand the initiative's objectives and benefits.

#### The initiative recommends development of:

- guidance and a plan for the incorporation of city image change into low carbon energy projects and initiatives
- a long term "Sustainable Glasgow" brand that can deployed widely – both within the city and for external audiences
- a promotional strategy that explains Glasgow's vision
   and the real and positive changes it is achieving
- integration of education and awareness of Sustainable Glasgow into the curriculum of local schools (for example, through working with the eco-schools initiative)
- a programme designed to engage and involve local employers and employees in Sustainable Glasgow
- a programme designed to involve communities and housing associations in Sustainable Glasgow
- creation of a comprehensive "one-stop" website for Sustainable Glasgow that provides information on the initiative, and tells people, communities and business how they can get involved and what they can do to help.

# Business Models and Financing

The total capital cost of the major projects identified by Sustainable Glasgow is in the region of  $\pm 1.5$  billion. An indicative breakdown is given below.

Measure	Indicative Capital Cost
District heating	£600 million
Renewable energy and energy	£800 million
management	
Urban Woodlands	£30 million
City Centre light rail	up to £90 million
Total	$\sim$ £1.5 billion

Most of these projects will generate significant revenues and offer good rates of return on capital investments. In current economic circumstances it is not realistic to expect this level of funding to be delivered entirely by the public sector. However there are indications that this volume of funding could be available from a number of private sector sources – in particular if the public sector is able to participate in a way that reduces overall project risk.

Potential public sector sources of funding include local authority borrowing, the Clyde Gateway project, European funding, and potentially the Scottish Government's JESSICA fund. The EU is expected to propose a 2 to 3 billion euro allocation of funding for cities that are undertaking innovative and ambitious carbon reduction programmes. This type of infrastructure is also a strong fit to European Investment Bank funding priorities in relation to the environment – improving quality of life in urban areas, and tackling climate change through renewable energy and energy efficiency, and sustainable forestry. Business models to finance renewable electricity projects are well understood – with an existing incentive system and grid infrastructure available for connection. Viable projects should therefore not struggle to raise finance. However in urban areas there may be additional merit in employing business models which include community involvement and or community benefit – as community based projects are likely to experience lower levels of public opposition. However community involvement needs to be considered in line with the need to meet financing requirements. The study recommends that communities are assisted to become involved in smaller scale projects – and that larger scale projects are required to deliver community benefits.

More novel and larger scale infrastructure projects may require different business models. For example, the analysis below suggests that because there is no existing heat distribution system, the heat market is unregulated, and the overall size of investment is large, that the proposed CHP/district heating system would benefit in particular from the creation of a public private partnership to raise capital, implement the infrastructure, and regulate the system's operation.

A further option for raising and holding the required capital would be the creation of a public private investment trust which could invest in a whole range of low carbon projects across the city –such as renewable electricity, waste to energy, biogas, urban forests, district heating, and transport projects. A significant number of variations in equity and operating relationships are possible - but, broadly speaking, these can be summarised under five distinct ownership models:

- Public Sector Direct Ownership A governing body such as the City Council or Scottish Government owns the generating and distribution assets. The public sector entity retains ownership of the generating and distribution assets, facilitates development, obtains financing via public bonds or other instruments, and operates the completed system. There are legal barriers which currently restrict the ability of local government to act as energy utility companies.
- Third Party Ownership A commercial firm owns the generating and distribution assets. The commercial firm retains ownership of the generating and distribution assets, facilitates development, obtains financing via capital markets or other instruments, and operates the completed system.
- Community Ownership Community ownership can be viewed as a form of public ownership, but limited to the direct geographic area of the community. The ownership would be likely to take the form of a not-for-profit limited liability company formed to own and operate the system for the benefit of the local community.
- Co-op / ESCO Partnership Similar to the community ownership model, a Co-op / ESCO Partnership is a form of public ownership, limited to the direct geographic area of the community (but with a potential partnership with the local council), and potentially retaining the services of a commercial firm to develop and operate the system. The ownership would be likely to take the form of a not-for-profit limited liability corporation expressly formed to own and operate the system. A separate ESCO could be retained by the Co-op to operate and maintain the system. The ESCO may also obtain an ownership interest.

 Public Private Partnership – A public body (most likely the city council) teams up with one or more commercial entities to form a limited partnership bounded by the geographic extent of the proposed system. The Partnership retains ownership of the generating and distribution assets, facilitates development, obtains financing via public bonds, equity markets or other instruments, and operates the completed system. Public involvement strengthens the entity's ability to influence regional and national energy policy and the commercial involvement improves the entity's ability to execute commercial relationships with customers, operate the system reliably, and to raise finance.

Ten characteristics have been considered in assessment of different business models in terms of their suitability for large scale low carbon energy systems in the city – in particular in relation to deployment of district heating systems. Below is a description of each of the ten characteristics:

- Appropriate project size In general, large energy requirements in a small geographical footprint improves a proposed district energy system's financial attractiveness and ability to operate in the most sustainable manner. Community organisations may struggle to deliver and operate large scale systems – and may therefore be more appropriate to smaller scale projects.
- Initial public capital requirement District energy systems require a large initial capital investment in order to become operational. This assesses the size of contribution required from the public sector or community in order to finance a project.
- Financial benefit to Council The Council (and therefore the City) can benefit from revenue flows through having an involvement in the business. Public Sector Direct Ownership, and Public/Private Partnerships present the Council with the highest ability to obtain income streams by being directly engaged in the energy delivery business.

- Ability to Raise Capital private firms with strong balance sheets have a high ability to raise capital through securitising debt against assets. Public organisations may also be able raise funds through borrowing. Co-ops, community ownership, and leasing arrangements may have difficulty raising large scale capital due to a low ability to secure debt.
- Enables Wider Investment Across City Each of the five ownership models have attributes that facilitate wider investment within the city. This includes the ability to expand energy systems – and the fact that lower energy costs compared to other areas will enhance Glasgow's relative attractiveness for business investment.
- Overall economic benefit to City the city's economy will tend to be improved by the delivery of large scale investment – improving infrastructure, delivering jobs, and stimulating new commercial activity throughout the supply chain. Models that deliver higher level of investment tend to offer greater benefits to the city. Business models that offer direct revenue flows to the city or communities will also tend to deliver greater economic benefit to the city.
- Ability to tackle Fuel Poverty Energy systems
   operated purely for profit typically have a low incentive
   to provide economic assistance for low income
   communities and households. However, financially
   robust commercial systems have the economic ability
   to subsidise lower tariffs for low income households
   through marginally higher commercial rates but are
   only likely to do this if compelled through regulatory
   mechanisms. Systems with public or community
   involvement may be able to deliver lower nergy prices
   through being able to raise grant funding and are more
   likely to se this as a policy priority.

- Consumer protection Commercially operated energy systems are often backed by strong balance sheets, which give the consumer some assurance of continued long term operation. Publicly operated systems offer consumer protection through policy and regulation – and the backing of a large public entity. Although community owned systems are operated for the benefit of the community they may face financial challenges, and may lack the ability to guarantee continued operation.
- Speed of Delivery Larger, well financed, ownership models typically display better ability to deliver projects quickly. Small, less funded models can encounter funding and technical competence challenges when engaging in the extensive development projects that are typical of large scale energy systems.
- Resultant Risk Level An overall risk level can be assigned based on a weighting of key risks. Council support can act to reduce a number of risks – such as planning risks – or through the introduction of a supportive public policy environment that assists the adoption and expansion of the system. Commercial involvement will tend to reduce technical and operational risks. Community involvement will tend to reduce risk of public opposition to a development.
- Good Governance The Council is in a strong position to influence and contribute to the governance of any district energy system deployed within Glasgow. In particular, any private public partnership deployment will provide opportunity for the Council to influence system design, operation, financial performance, health and safety, environmental performance, and social policies – as well as influencing the direction of the system's future expansion. The Council can also provide guarantees of the system's long term operation.



#### **Potential Business Structure**



Controls wider strategy; Plans, Monitors impacts and opportunities, Revises strategy; develops relationships, ensures projects match public policy objectives; maintains joined up approach; builds support; integrates strategy into public policy and wider plans

Raises funding: develops relationships with potential investors, assesses projects for investment by:

- assessing match to public policy goals and overall framework
- financial viability
- matching projects with investor priorities

Implements and operates new low carbon energy systems and infrastruscture to deliver carbon reductions and economic regeneration. Range of potential business models – public private partnerships, publicly owned; commercial or community ownership

The analysis is summarised in the table above – and this indicates that for large novel energy systems (such as district heating and biogas) a public private partnership is the preferred model. For smaller scale systems a community model may be appropriate, but even small scale projects are likely to benefit from having a commercial partner involved.

For district heating the report recommends the network is controlled and delivered by a public private partnership. The heat suppliers delivering energy to that network could be community owned, commercially owned, or public private partnerships.

Sitting above individual projects the initiative recommends the Council considers creation of an overarching investment trust. This trust would raise funds from public and private sources and distribute these to financially viable projects that are consistent with the Sustainable Glasgow Initiative's framework and objectives. The investment trust could also raise funds from issuing ethical bonds, or through community based funds. The projects could be run and delivered by a range of entities – eg/ community ownership, commercial organisations, or public private partnerships – but must be able to deliver the rate of return required by the Investment Trust's funding sources. The Trust would be controlled by a Board composed of key stakeholders – including the Council and other public bodies; investors (potentially); other strategic bodies (such as Clyde Gateway and the Commonwealth Games) and perhaps commercial partners.

An overarching investment trust structure provides some important potential advantages in the securing of public and private capital and participation. It allows for one or more projects to be combined for financial purposes allowing for investment diversity and decreasing potential investor risk. It also provides for high-level capital structure investments in projects, and if properly structured, could potentially assist in achieving an investment grade rating for private investment offerings. Additionally, this structure also allows for the flexibility in obtaining project level funding (having a different investment criteria) from private parties in addition to the investment trust. The study recommends that:

- The Council works with partners to create appropriate delivery vehicles for the large novel energy systems recommended here;
- The Council considers working with partners to create an overarching investment trust to take forward investment in financially viable Sustainable Glasgow projects;
- The Council examines means to facilitate communities to become involved in, and benefit from, Sustainable Glasgow projects.

Comparing Different Business Models for Large Novel Energy System Development in a City

	Appropriate project size	Initial Public Capital Requirement	Financial Benefit to Council	Ability to raise capital	Enables Wider Investment across City	Overall economic benefit to City	Ability to tackle fuel poverty	Consumer Protection	Speed of Delivery	Governance	Resultant Risk Level
N IN	sizes	High	High	Medium	Medium	Medium	High	H gg	Fast	Strong	Medium
₹	sizes	Low	Low/ Medium	Medium	Low/ Medium	Low/ Medium	Low	No	Fast	Weak	Medium
Sm	all	High	Low/ Medium	Low	Low	Low	High	Medium	Slow	Medium	Medium
Sm	all/ :dium	High	Medium	Medium	Low/ Medium	Low/ Medium	High	High	Slow	Medium	Medium
a Z	edium/ ge	Medium	High	High	High	High	High	High	Medium	Strong	Low

# The Next Steps

The Sustainable Glasgow initiative is providing the city with the evidence it needs to draw significant additional investment – amounting hundreds of millions of pounds and delivering significant numbers of jobs. This investment will allow the major opportunities identified in clean energy systems for Glasgow to take the step to deployment. This will make Glasgow a more sustainable city – greener; more economically successful; and deliver a better quality of life for its citizens.

Delivering on this opportunity requires swift action to draw in investment and to co-ordinate activity.

Typically new developments in the city are seen by both developers and energy utility companies as a series of islands – at least in energy terms - with no relationship with each other, their neighbours, or other infrastructure. This means that many opportunities to implement green energy solutions across the city are not currently grasped - and opportunities for these developments to work together are lost.

There are a number of influential major developments currently taking place in Glasgow. Key decisions over the next few months in relation to the Commonwealth Games Village; Waste treatment systems; the Southern General Hospital; the FE College Campus and transport infrastructure could have a critical impact on the future success of Sustainable Glasgow. The city will live with the decisions taken on these and other projects for many years to come.

There is a window of opportunity that would allow these investment plans to be used in a joined-up strategic fashion that will deliver a wider and lasting legacy for Glasgow. Taking advantage of this window of opportunity requires swift and coordinated action from the Council and other key stakeholders.

Sustainable Glasgow is already having an impact in relation to these projects – with many projects showing an enthusiasm to take on board Sustainable Glasgow's principles and strategic approach. But maintaining this momentum will require a continued co-ordinated push from the Council and its partners. Projects around the world have shown that high level political buy in is vital to building the support of stakeholders and ensuring a lasting positive impact – and the initiative has benefitted significantly from the support provided from the city so far:

Many cities across the world have ambitions to become more sustainable. However such initiatives often perform poorly due to having vague and unrealistic objectives; a poor evidence base; no realistic implementation plan; a scattergun interest in new technologies; an undue focus on small scale pilot projects with no plan for further roll-out; a sole focus on the public sector; lack of continuity in leadership, and no clear business and financing model. By way of contrast, Sustainable Glasgow's approach is to develop a clear realistic strategic framework that applies a strong evidence base to identify the main investment and carbon reduction opportunities in the city; to integrate these so that projects and technologies support each other; and to deliver these in a way that is both technically and financially achievable.

Coordinating delivery of major new clean energy systems is not a trivial task – but Sustainable Glasgow is already changing the way that people and organisations think about and plan energy systems in the city. Ensuring that the opportunities set out in this report are delivered in reality will require a focussed programme of further activity to bring in the right partners; draw in the necessary funding; resolve regulatory issues; and integrate Sustainable Glasgow proposals into Council plans and strategies. A wider range of partners from the public and private sectors will be drawn into the next phase – in particular those bodies whose active support will be critical to the future success of Sustainable Glasgow. This next phase of activity will ensure that Sustainable Glasgow's proposals to reduce carbon emissions, tackle fuel poverty, and deliver jobs, are delivered in reality.

Glasgow is not unique in the issues it faces and the opportunities it has – many other cities in the UK and across the world exist in a similar context. The initiative believes there are significant opportunities to work with other cities, learning from each other; to extend the approaches taken by Sustainable Glasgow both conceptually and geographically.

## The key elements recommended for the proposed second phase are:

- Creation of a high level steering group The report recommends creation of a high level steering group that would take responsibility for delivering Sustainable Glasgow. The steering group could include high level representation from the Council, Scottish Enterprise, University of Strathclyde, wider public sector; business, and the financial sector:
- Appointment of a Sustainable City "tsar"
   The initiative/the Council to consider appointment
   of an individual who will be responsible for the
   ongoing communication and development of the
   city's vision, development of links with key stakehold ers, and ensuring the initiative's direction and drive are
   maintained.

#### • Programme co-ordination

A programme co-ordination/management function will be required to plan and monitor Phase 2 to ensure it remains on track. A small programme office co-located with one of the partners would be one way of achieving this.

- Ensuring the city has access to the skills and expertise it will need to drive forward the next phase of activity
- Development of investment grade project proposals and engagement with potential investors and other funding sources

The amount of funding needed to make Sustainable Glasgow happen in reality is estimated at around  $\pounds$ 1.5 billion. Drawing in this level of funding from major private sector investors requires the preparation of more detailed investment proposals expected to require professional input on both the technical and financial side. In addition, public funding may be available from a number of other sources – such as the EU Smart Cities initiative. The initiative will identify, liaise and seek to involve other potential sources of funding.

• Creation of a wider partnership and delivery business model

A number of business models are available for delivery of Sustainable Glasgow. The report favours a public/ private partnership – though other models are possible. Closer examination of the potential legal structures and putting the agreed structure in place will require professional legal and financial advice.

#### • Creation of an overall energy master plan for Sustainable Glasgow

Sustainable Glasgow has successfully identified major opportunities for reducing the city's carbon emissions, growing the city's green economy, tackling fuel poverty, and changing the city's image. These opportunities need further analysis of costs, risks, impacts, future developments and integration with the city plan, to allow production of an overall energy master plan for Sustainable Glasgow

#### Dissemination, community and stakeholder engagement programme

A significant number of bilateral meetings and other briefings have been undertaken with key stakeholders. However post-launch this work will increase in volume very significantly – and is a necessary part of achieving support from citizens, business, and the wider public sector: With this support Sustainable Glasgow will identify more opportunities, make faster progress, and have a greater positive impact for the city.

## • Ensuring new developments are fully integrated into the Sustainable Glasgow Initiative

Multiple new developments are continuing to come forward in Glasgow. By identifying the opportunities to integrate these developments into the Sustainable Glasgow programme the overall impact and speed of delivery will be significantly increased. Capturing and analysing this information, and meeting with developers and other stakeholders will require a major input of technical and project management resource.

## Consultation and adoption of supportive public policy measures

The adoption of supportive public policy measures in planning and procurement and other areas vital to the success of Sustainable Glasgow.

#### Creation of a plan for developing a clean energy supply chain in Glasgow

Sustainable Glasgow will draw in over  $\pounds$  1.5 billion in new investment into the city. In order to ensure that the city gains the maximum benefit from this investment in terms of jobs and ongoing economic impact action is necessary to analyse the current supply chain in Glasgow; forecast demand for manpower; services and products from Sustainable Glasgow projects; consultation with key industries; and creation of a plan for improving the supply chain in Glasgow

#### • Conduct a Strategic Environmental Assessment of the Sustainable Glasgow strategy

Strategic Environmental Assessments (SEAs) are required under European law when a public authority adopts a programme that will set a framework for projects that are subject to Environmental Impact Assessments. The Council will take forward an SEA, with consultation, for Sustainable Glasgow.

## • Develop an agreed set of indicators for measuring the city's progress

Measuring and comparing progress on sustainability is not straightforward, Indicators need to balance a range of policy outcomes – and need to ensure that behaviour is not distorted in ways that produce undesirable outcomes. There are existing indicators at EU, UK, Scottish level. These would be reviewed, and potential alternative or additional indicators of progress proposed.

## • Creation of a decision support system that can be deployed in other cities

Delivering Scottish and UK climate change targets requires adoption of Sustainable Glasgow principles and analytical techniques across many other cities in the UK. This would therefore create and promote, from the Sustainable Glasgow experience and evidence, a decision support system that could be deployed in other cities.



#### Delivering a long term framework

Finally, the Sustainable Glasgow strategy must be kept under review to ensure that it delivers a consistent and relevant long term framework for the city's sustainable development. This long term activity will ensure that:

- progress is accurately mapped, measured and understood;
- the changing nature of the city (and activities in the city) is taken into account in the strategy;
- opportunities from proposed new developments are identified and assessed in a joined-up fashion;
- potential new partners are brought on board;
- new opportunities to finance the initiative and its associated projects are assessed;
- that new evidence in relation to the performance of technologies and low carbon energy resources is taken into account;
- the implications of changes to the regulatory environment are understood and taken into account;
- the initiative remains on track to deliver even greater carbon reductions in the future.

The initiative recommends publication of an annual report that will review Sustainable Glasgow's progress and the overall strategic direction of the initiative.

Furthermore, the initiative recommends for the wider promotion and development of low carbon energy solutions that Government requires all urban settlements above 100,000 people to map their carbon emissions, energy supply, and energy usage in detail. This would assist in delivering greater carbon emissions reductions across Scotland – as well as helping identify opportunities for Glasgow to work together with other urban settlements.

# Acknowledgements

This report was written by Richard Bellingham, Programme Director for Sustainable Glasgow and Senior Research Fellow, Fraser of Allander Institute, University of Strathclyde, with input and assistance from:

> Sandy Gillon, Glasgow City Council Ciaran Higgins, Glasgow City Council Scottish and Southern Energy Scotia Gas Networks Tom Galvin, Source One Veolia Jack Griffin, Source One Veolia Bill Guarnagia, Source One Veolia Michael Blitzer, Blitzer Clancy and Co

Researchers and colleagues within the University of Strathclyde – including:

Kristina Helmore Craig Menzies Gitanjali Nayar Lindsay Nickerson Yevgenia Shevtsova

Dr Robert Rogerson Peter Booth

As well as many other organisations and individuals too numerous to mention.

# ANNEXA – STAKEHOLDER MAP

Stakeholder	Strategic	Regulatory	Potential	Potential	Potential	Provision of	Promotion	Need to meet	Economic	Reduction in	Concern	Promotion	Promotion
	Direction	/planning/	customer	supplier	funder/	expertise/	of carbon	regulatory	development/	fuel poverty/	at potential	of Glasgow's	of research
		Legislative			partner	information	reduction	requirements	job creation	Fuel prices	disruption	image	and new
		role						(eg building			due to		technology
								standards)			infrastructure		
											development		
Glasgow city council	•	•	•		•	•	•	•	•	•	•	•	•
Strathclyde university	•		•		•	•	•		•			•	•
Scottish government	•	•	•		•	•	•		•	•		•	•
Scottish Enterprise	•		•		•	•			•			•	
Commercial consortium members	•			•	•	•		•	•				•
UK Government	•	•			•	•	•		•	•			•
EU Commission	•	•			•	•	•		•	•			
Citizens			•						•	•	•	•	•
Commercial sector			•	•	•	•		•	•	•	•	•	•
Education Sector			•		•		•	•					
Housing Associations	•		•		•	•		•	•	•	•		
Property developers			•		•	•		•	•		•	•	
Telecoms sector				•	•	•							
Transport sector				•	•	•					•		
Scottish water					•	•		•					
SHN			•		•	•		•			•		
Other public sector			•			•		•			•		•
Energy sector	•			•	•	•		•			•		
Ofgem		•			•	•	•			•	•		
SEPA		•				•	•						
SNH		•					•						•
NGOs	•						•						•
BRE						•	•						•
CarbonTrust						•	•						•
Energy Saving Trust							•						

