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Sustainable Glasgow

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The Sustainable Glasgow Initiative aims to help Glasgow become one of Europe's most sustainable cities. For Glasgow sustainability means achieving a mix of objectives – reducing carbon – but also achieving urban regeneration; delivering jobs and training; helping change the city's image; regenerating communities, and tackling fuel poverty.

The initiative has been led by the University of Strathclyde in an innovative partnership between academia, the city council, major energy companies, the regional development agency, and investment interests.

This paper summarises the key findings and recommendations of the Sustainable Glasgow report – and examines the way forward for the initiative.

The initiative started in Autumn 2008 and over the last year has conducted a set of major feasibility studies into understanding Glasgow's carbon emissions, and identifying the technically and financially viable opportunities that would feasibly reduce the city's carbon emissions by 30% within 10 years1. The full report was published on 27 January and is available at www.sustainableglasgow.org.uk.

The policy context

Ambitious targets are being set to reduce carbon emissions at EU, UK and Scottish levels. EU targets require the UK to obtain 15% of all its energy (covering heat, transport and electricity) from renewable sources by 2020. Both UK and Scottish governments have set targets to achieve an 80% reduction in carbon emissions by 2050 – and the Scottish Government's interim target may require a 42% reduction in emissions by 2020. These targets sit within a wider policy context – with governments also aiming to achieve economic growth, and social policy objectives – such as the Scottish government's aim to eradicate fuel poverty by 2016.

There is an inherent tension in reducing carbon emissions whilst simultaneously seeking economic and population growth, and tackling fuel poverty. Economic growth tends to increase carbon emissions, and the UK regulatory system for supporting the growth of renewable energy directly leads to increases in the price of energy charged to consumers. Achieving these targets means delivering more economic output and more useful work (eg more buildings heated) from each unit of energy consumed – as well as radically increasing the amount of low carbon energy delivered (and that must include heat – not just electricity). Glasgow is not alone in this. This is a worldwide issue.

Cities have a vital role to play in delivering a low carbon future – by their nature they are major concentrations of people and resources. UN figures suggest that cities currently contain over half the world's population – and are responsible for the consumption of 75% of the world's energy, and 80% of the world's greenhouse gas emissions. Projections suggest that the share of the world's population living in cities will grow significantly over the next 20 years – particularly in the developing world. In developed countries most of the cities and most of the buildings that will exist in 2050 are already in place. Retro-fitting low carbon technologies and approaches, and integrating these with the existing infrastructure in cities, and with ongoing city development, is therefore one of the major issues facing governments in reducing carbon emissions.

The way we live and work in cities, and the systems that enable cities to operate, must therefore change dramatically if we are to achieve significant carbon emission reductions.

The municipal level creates real opportunities for achieving decarbonised societies and economies. Cities have the necessary scale to make projects viable, to attract investment and possess the political focus and powers that can applied to assist the implementation of a coherent strategic approach.

The vision and the partnership

The Sustainable Glasgow Initiative is a consortium led by the University of Strathclyde, with Glasgow City Council, Scottish and Southern Energy, Scottish Power, Source One Veolia, and Scottish Enterprise.

Glasgow faces a range of issues – including a need to increase levels of economic activity and to regenerate communities, as well as major opportunities such as the Commonwealth Games in 2014 (which will attract a worldwide audience of over 1 billion people). Sustainability in Glasgow must take account of all these factors – not just aim to meet environmental targets.

The vision of the partnership is to make Glasgow one of Europe's most sustainable cities within 10 years - and to do this in a way that will improve the lifestyles and opportunities for Glasgow's people and businesses. For Glasgow sustainability must be delivered in a way that is consistent with the development of a vibrant and growing city, delivering tangible economic and social benefits, and changing the image of the city.

By successfully developing a shared vision of the city's low carbon future Sustainable Glasgow has succeeded in bringing a number of significantly different interests together around a single agenda. This was achieved by deliberately constructing the initiative's objectives and vision so that it takes account of the objectives and agendas of different

public and private organisations – and setting a timescale (10 years) for the delivery of that vision that is both ambitious, achievable., and builds momentum. For the private sector a 10 year timescale shows a long term commitment which is attractive in terms of its scale, and as a demonstration of public sector commitment to policy change that will act to reduce investment risk. The 10 year timescale also means that initiative is very clearly focussed on approaches that are technically and financially deliverable now – rather than on solutions that may become viable at some indefinite point in the future. This clear focus on delivering real projects has made the initiative credible in the eyes of investors.

By building the initiative to the point of "critical mass"; engaging in dialogue with key stakeholders; and delivering a convincing vision and strategy for Glasgow's low carbon future, the initiative's size, momentum, success and reputation has started to attract other partners – from both within the city and internationally.

As well as major commercial entities the partners and stakeholders now being drawn into the initiative include Glasgow Housing Association (Europe's largest landlord), the National Health Service, and the Clyde Gateway programme. These are all major investors in the city – as well as having important social dimensions to their objectives. This strong social dimension to the Sustainable Glasgow partnership may prove to be a unique differentiator in relation to other sustainable city initiatives.

A new holistic approach

At around 4 million tonnes per annum Glasgow is responsible for around 8% of Scotland's energy related carbon emissions. Glasgow can therefore play a significant role in meeting Scotland's carbon emission reduction targets.

Emissions relating to domestic electricity are higher than would normally be expected – due to a high proportion of electrical heating – particularly in social housing. Commercial and industrial emissions make up a higher proportion reflecting economic activity in the centre of Glasgow. Transport emissions are lower as 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. Unless action is taken Glasgow's carbon emissions can be expected to increase over time.

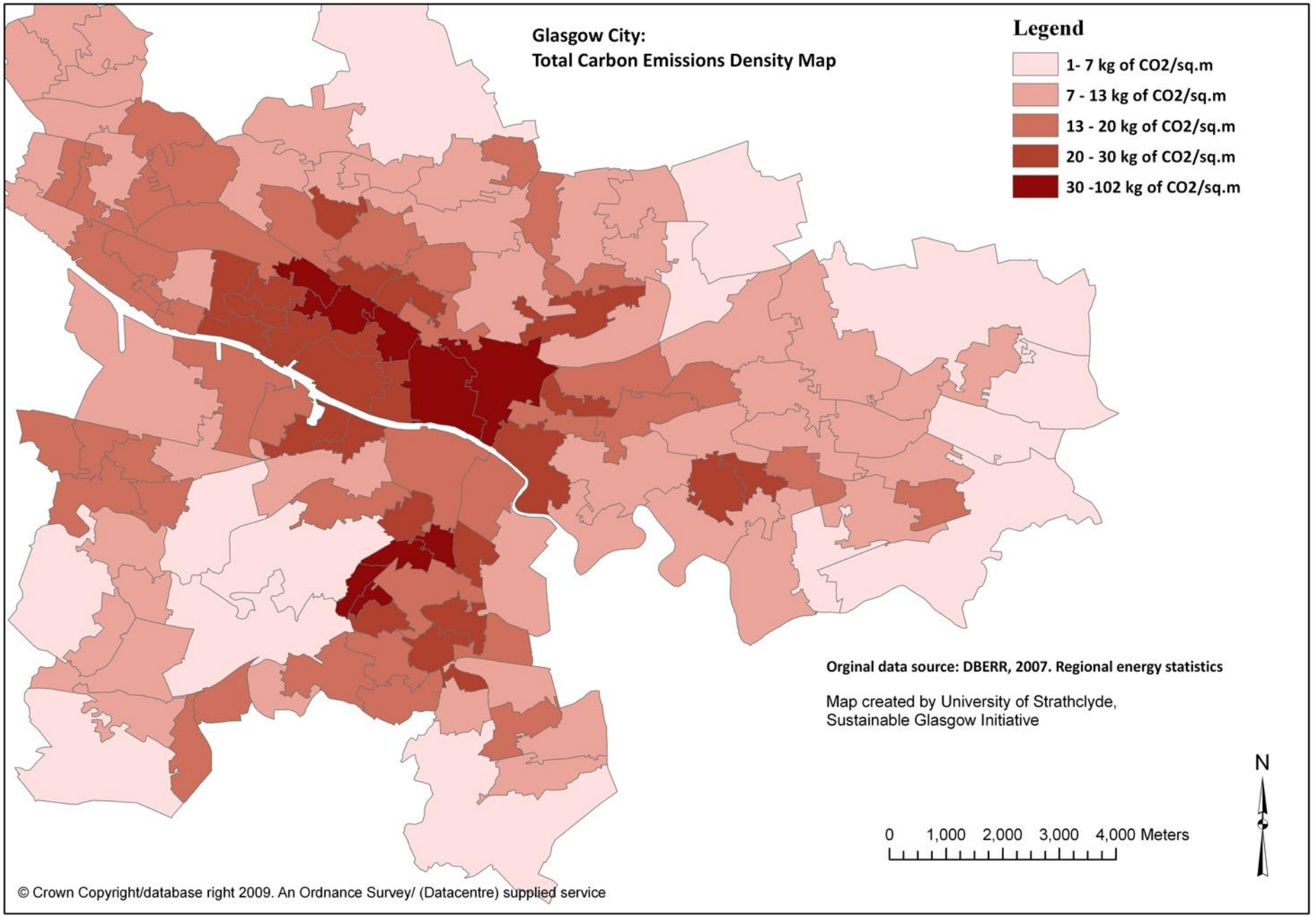
Glasgow's carbon footprint totals around 4 million tonnes – 2006/07

Annual Carbon Dioxide Emissions for Glasgow City

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

The university team used new techniques that allowed the city's carbon emissions and low carbon energy opportunities to be mapped in new ways – allowing the city to be understood holistically, and the spatial relationships between developments, infrastructure, carbon emissions, and low carbon energy resources to be used to identify new opportunities to reduce carbon emissions. This is a radical departure from the conventional approach deployed by planners and utility companies in the UK – which normally considers each development separately, and does not seek to overcome the barriers that often exist between different organisations. A piecemeal approach fails to identify opportunities to link developments together in ways that make new low carbon energy systems viable.

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


Glasgow City:
Total Carbon Emissions Density Map
Legend
1- 7 kg of CO2/sq.m
7 - 13 kg of CO2/sq.m
13 - 20 kg of CO2/sq.m
20 - 30 kg of CO2/sq.m
30 -102 kg of CO2/sq.m
Orginal data source: DBERR, 2007. Regional energy statistics
Map created by University of Strathclyde,
Sustainable Glasgow Initiative
N
0 1,000 2,000 3,000 4,000 Meters
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Sustainable Glasgow main approaches to reducing carbon emissions

Theme	Example measures
Reducing wasteful or unnecessary energy use by end users	• Improved energy efficiency – eg household devices; vehicles; buildings • Behavioural Change • Energy management
Improving the efficiency of energy systems	• District Heating • Smart grids • Demand Management
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	• Capturing waste heat from industry • Waste to energy • Production of biogas from sewage and organic waste

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.

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A new energy framework for the city

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.

By looking at the city in a new way Sustainable Glasgow 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 main opportunities for the city lie in the development of district heating networks; harnessing of waste for energy; biomass energy systems; sustainable transport; energy management; and smart grids. By allowing these different technologies to support each other carbon reductions are maximised and commercial risks reduced.

Delivering city-wide large scale carbon emission reductions requires major change – and this 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.

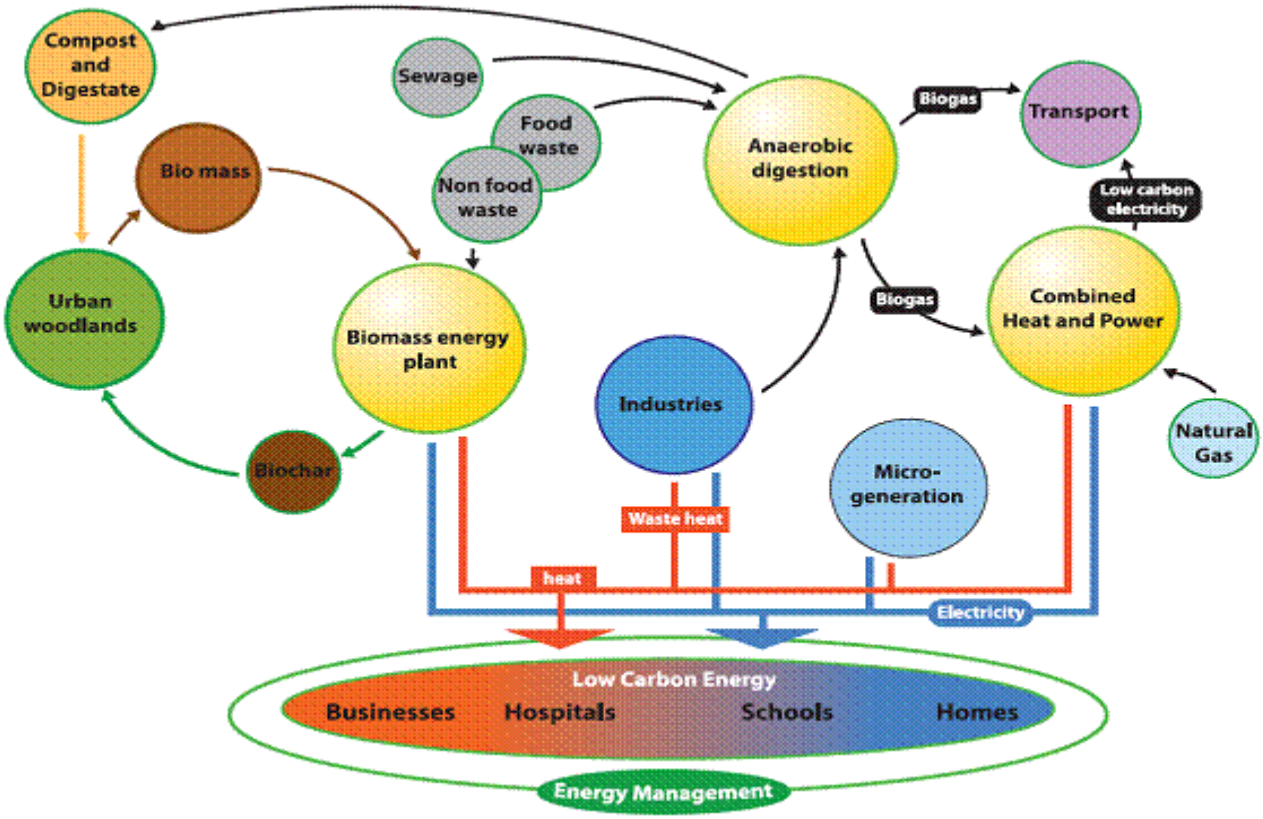
The main themes for reducing the city's carbon emissions related to its energy use are summarised in the table below. The list below is not a hierarchy, all of these opportunities need to be pursued in an integrated fashion in order to maximise carbon emission reductions. No one technology or approach can deliver the levels of carbon emission reduction required.

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 below. 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.



Based on a detailed analysis of the evidence the estimated contribution each approach would make within 10 years to Glasgow's 30% carbon emissions reduction is given below:

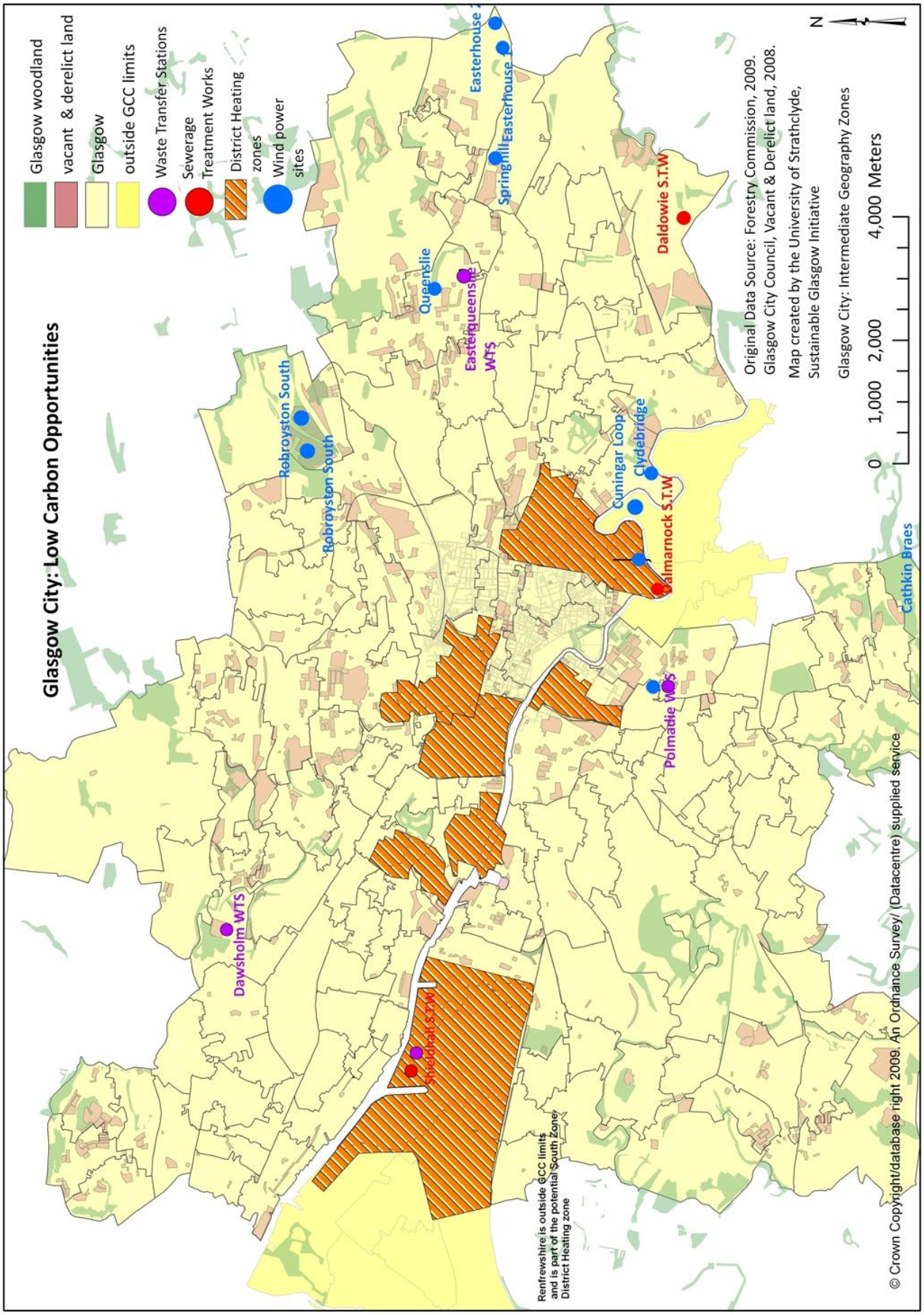
- Combined Heat and Power/District Heating 9%
- Biomass 2%
- Biogas and Waste to Energy systems 6%
- Other renewable energy systems 3%
- Sustainable Transport systems 3%
- Phasing out high carbon fuels 3%
- Energy management and energy efficiency 6%

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

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 map below shows how these opportunities relate to each other. Detailed analysis has allowed projects to be located so that they target areas with the highest carbon emissions; capitalise on the city's low carbon energy



resources; and integrate with major developments in the city.

More than technology

Sustainable Glasgow is not just about technology. 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.

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.

For example, 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

Business models and investment

Implementing these opportunities will require investment of around £1.5 billion. Most of these projects will generate significant revenues and offer good rates of return on capital investments. Much of this investment is expected to come from the private sector – which even in a recession has remained strongly interested in energy investments that can deliver long term and predictable rates of return on capital. Changes in regulatory structures (such as the Feed In Tariffs and the Renewable Heat Incentive) are being introduced that provide additional subsidies for low carbon energy generation. In addition, by working with existing major investments in the city (such as the Southern General Hospital, the New Campus Project, and the Commonwealth Games village) the initiative is succeeding in levering in additional public investment, and should deliver tangible results more quickly. 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.

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 are likely to require different business models. For example, because there is no existing heat distribution system, the heat market is unregulated, the overall size of investment is large, and there is no existing market in heat 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, regulate the system's operation, and act as a "heat broker" between heat suppliers and customers.

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. This trust structure allows for projects to be combined for financial purposes allowing for investment diversity and decreasing potential investor risk – thus allowing more innovative projects to attract funding.

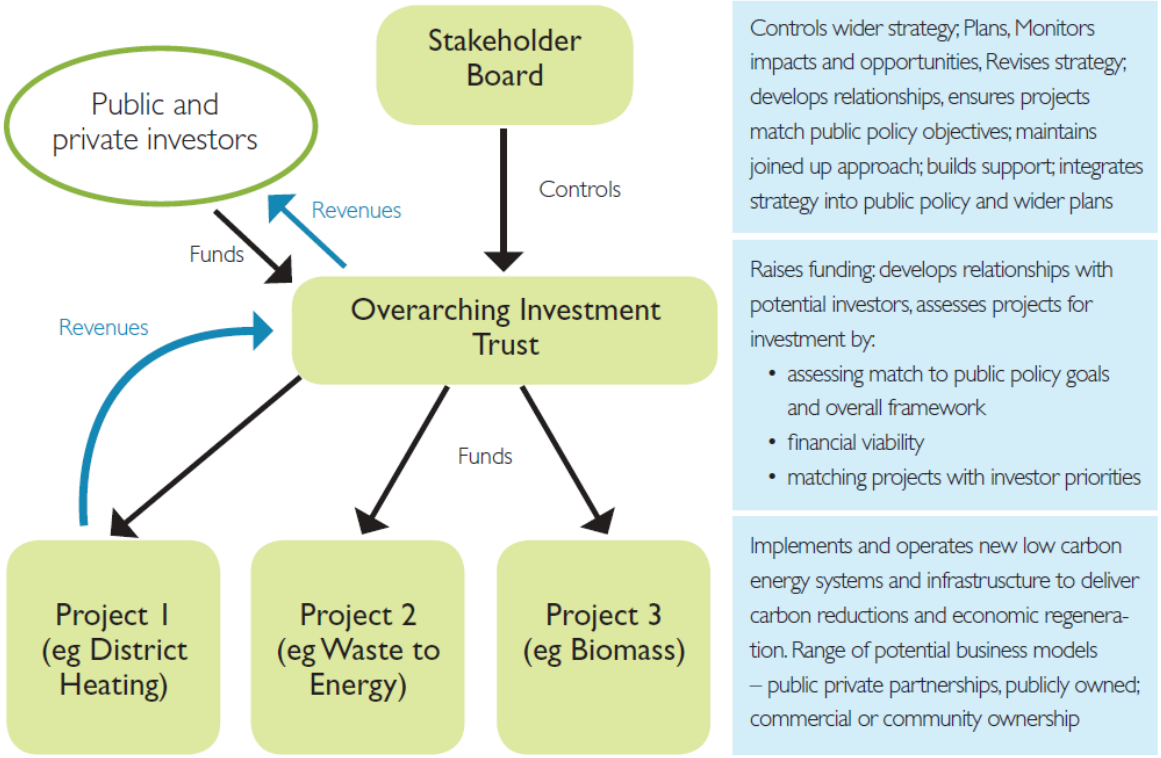
Next steps

The Sustainable Glasgow initiative is strongly focussed on achieving the delivery of real projects and tangible benefits for local people and businesses.

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 identified 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 city plans, policies and strategies.

Maintaining 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

Potential Business Structure



building the support of stakeholders and ensuring a lasting positive impact.

New governance structures are currently being put in place. This includes a high level board which will include the heads of key stakeholder organisations in the city – and will therefore include the Leader of the city council and the Principal of the University of Strathclyde (for example). A steering group supported by a number of sub-groups (composed of the relevant partners) will drive forward activity on finance, public policy, planning, and individual projects.

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 that takes account of how the city will change over coming years.

Finally, Government targets make clear that even greater carbon emissions reductions will be required in the future. These systems have been designed so that they have the inherent flexibility to be expanded and to integrate a wider range of low carbon technologies – thus increasing Glasgow's ability to contribute to Scotland and the UK meeting tighter carbon targets in the future. Sustainable Glasgow's strategy will require ongoing monitoring and revision in response to progress achieved; as new opportunities become available, the regulatory environment changes, and changing external factors.

Sustainable Glasgow is not a one-off exercise, it is an ongoing process summarised by the diagram below.

Summary

Many cities across the world have ambitions to become more sustainable. However such initiatives often perform poorly in practice 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.

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

The Sustainable Glasgow Process

Strategy Development

- Map energy demand and carbon emissions
- Understand the city's resources and infrastructure
- Identify key stakeholders
- Identify major carbon reduction opportunities
- Identify technically and financially viable opportunities
- Join opportunities and projects together so that they support each other

Integrate, Plan and Develop Relationships

- Create high level coordinating entity
- Deepen relationships with key stakeholders
- Consult, raise awareness and develop support
- Ensure projects and initiatives support wider policy objectives
- Integrate strategy into public planning, policy and other initiatives
- Integrate strategy into major investments
- Create integrated development plan

Implement Projects and initiatives

- Conduct detailed analysis of individual projects
- Raise investment funding
- Adopt supportive public policy measures
- Create new project delivery entities as necessary
- Implement projects and initiatives
- Develop and monitor an agreed set of indicators of progress
- Disseminate the Sustainable Glasgow approach to other cities

- Monitor impacts
- Publish progress reports
- Evaluate new opportunities
- Bring in new partners
- Review changing nature of city
- Review wider policy environment
- **Revise Strategy**

opportunities in the city; to integrate these so that projects and technologies support each other; to deliver these in a way that is both technically and financially achievable, to build powerful partnerships, and integrate these proposals with supportive public policy structures and financial mechanisms. Glasgow may present a viable model that other cities can learn from and adopt.

Endnotes

[1]This meets the Scottish Government's target of achieving a 42% reduction in carbon emissions by 2020 as this target is baselined against 1990 emission levels.