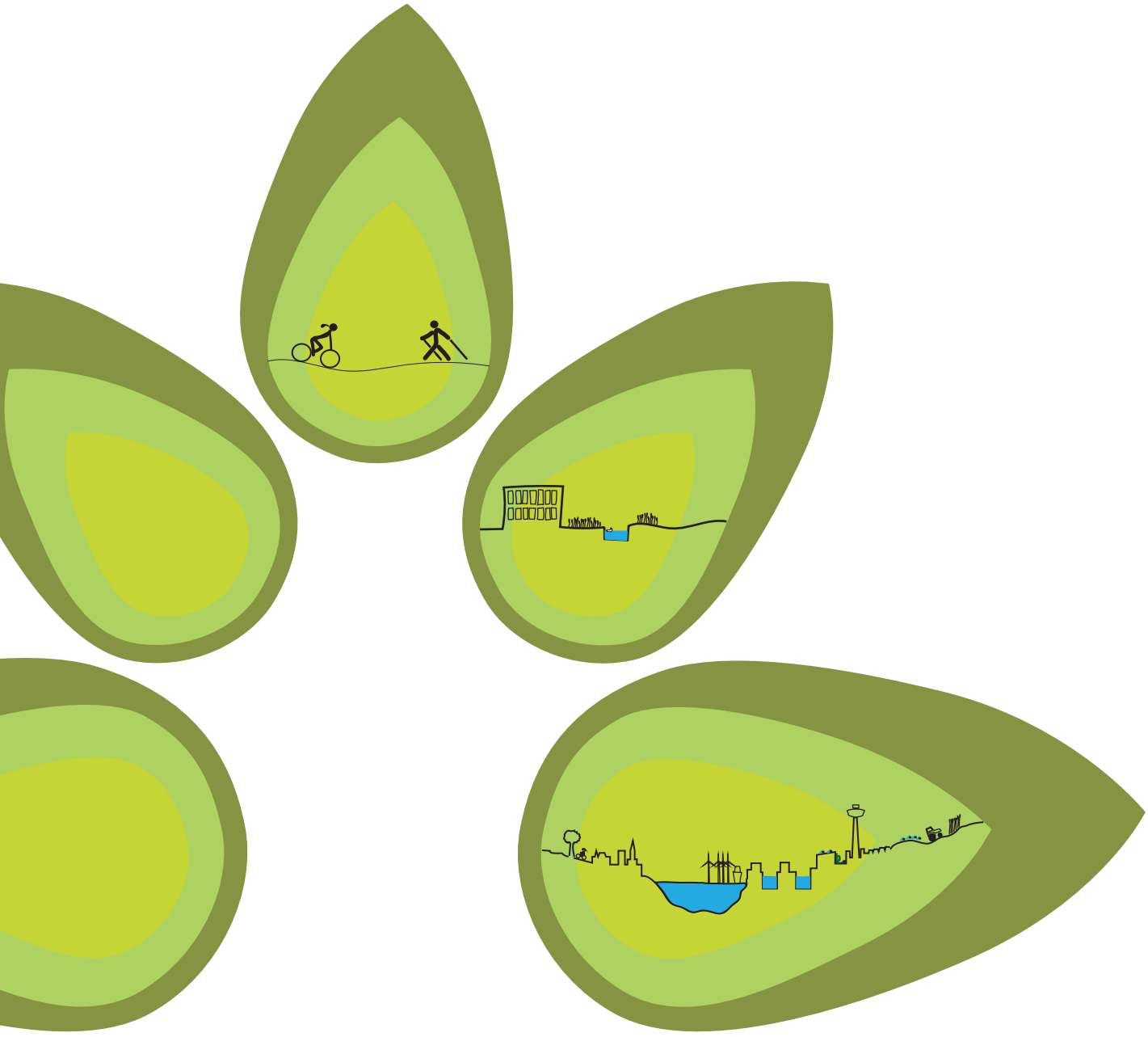
Green Infrastructure in the Liverpool City Region

A pipeline of commissionable projects



Liverpool City Region Local Enterprise Partnership

NATURE CONNECTED

Executive summary

The environmental assets of the Liverpool City Region can play a vital role in developing a sustainable economy. They already contribute to the City Region's distinctiveness making it an attractive place to live and work. There is now an opportunity for them to contribute to the region's competitiveness. Increasingly, evidence shows that investment in Green Infrastructure (GI) and renewables will bring measurable value to our local economy, improve health and wellbeing and deliver a wealth of other benefits.

A pipeline of commissionable projects in both GI and renewables at Strategic Investment Areas (SIAs) and DUN sites has been set out. The pipeline is supported by a robust method and assessment to make the business case for investment. Some sites include standalone GI interventions, renewable projects and some sites have a combination of GI interventions and renewables. These sites have been identified by an evidence-based assessment to create a ground breaking replicable process.

This report provides the technical background to an accompanying City Region GI Prospectus and builds on the sector-leading work in GI and renewables already underway in the City Region. It supports work being undertaken in the region to develop a commissioning framework for the EU2014-2020 programme and to deliver the Economic Union's Structural and Investment Funds Strategy. The report also highlights where investment can be secured from other sources, including a proposed Strategic Alliance - Green EnerGI - that could provide match and improve the gearing of secured EU funds.

Improving the environment is recognised as being critical to the City Region's sustainable economic growth; with GI interventions at the heart of this approach providing a vehicle to address the City Region's significant legacy of derelict, underused and neglected (DUN) land and renewable projects offering a potential way of funding GI.

There are many positive multifunctional benefits that investment in GI brings including, amenity value, creating high quality City Region gateways, increasing the value of commercial and residential property, improving the region's competitive business location offer as well as retaining and attracting a skilled workforce. GI also helps to ameliorate the effects of climate change by, for example, providing shade and flood attenuation.

Health and wellbeing is major issue for the City Region and GI provision can provide opportunities for recreation and physical activity which in turn improve individuals' well-being. Improved health and wellbeing not only increases opportunities to gain employment, it also increases productivity and the ability of individuals to stay in work, increasing their confidence, skills and knowledge.

The role that creating and maintaining GI can have in generating jobs in the City Region has been highlighted, in particular, the way in which it can offer job and training opportunities.

Maximising the City Region's ability to self-generate renewable energy is a key aspiration included in the ESIF, Strategic Economic Plan, Low Carbon Economy Action Plan and the emerging Blue Green Investment Framework with a key action to develop activities that ensure that a greater proportion of energy consumed in the City Region is from renewable and low carbon sources.

Potential solar PV and biomass schemes, on DUN sites, on SIAs and also in combination with proposed green structure projects have been identified and assessed. This has enabled the potential scale and the technical

and commercial viability of energy production and the sale of energy crops to be assessed as part of a LCR programme for investment.

The report sets out an outline timetable for project delivery as well as:

- the investment required for GI, solar photovoltaics (PV) and biomass crops;
- the potential annual income generated from sites with solar PV and biomass crops; and
- a budget, including match funding for ESIF for each GI project/area, with an indication of alignment with the ESIF Portfolios and EU Funding strands.

In total, 40 locations have been shortlisted for GI and energy opportunities:

11 SIAs identified as priority GI project opportunities

12 locations identified for solar PV

17 locations identified for energy crop production

Many sites are extensive and could potentially accommodate larger PV arrays than the conservative estimates of 5MW that were assumed in this study. It is also worth noting that while the costs for solar PV have been falling commensurate with a degression in the FiT the City Region should be acting quickly to take advantage of solar PV opportunities and associated FiTs while they last.

It has also been identified that GI and energy are readily integrated, and that there are potential opportunities for energy production to fund GI on sites. This approach is also in line with high level guidance from the European Union (EU) on the incorporation of green infrastructure into ESIF.

The competition for project funding is considerable. There are opportunities for strategic alliances with organisations from a range of sectors to investigate and access funding to enable match funding.

Through this study several key investors and developers in the City Region have been persuaded of the multifunctional benefits of GI/renewables to their business activities and agreed to join a strategic alliance, Green EnerGI, that will support project development and unlock ESIF to deliver GI and energy initiatives across the City Region.

This programme of commissionable projects will accelerate the delivery of investment that will lead to growth in terms of new jobs, training opportunities and GVA. These projects also offer opportunities for linking health and well-being into the programme as essential components of sustainable growth and reducing inequalities across the City Region.

There is a now a need to move to commissioning stage to realise the projects set out here, and in particular, to ensure that strategic alliance members can see progress in and the efficacy of this new alliance as well as prepare to access ESIF funding.

1.0 Introduction

This report provides technical background to Liverpool City Region's Green Infrastructure (GI) Prospectus and sets out a pipeline of commissionable and investible projects to deliver green infrastructure and renewable energy in the City Region.

These projects will deliver "whole place low carbon solutions" and create resilient areas by tackling on site pinch points through green infrastructure planning and delivery. They will accelerate investments that will lead to growth in terms of new jobs and GVA in the City Region. These projects will also reduce carbon emissions, improving environmental quality and health, well-being and reducing health inequalities.

A ground breaking approach building on the sector-leading work in GI and renewables already underway in the City Region has been taken. Considerable progress has been made to engage with key investors and developers in the City Region to persuade them of the multifunctional benefits of GI/renewables and of becoming part of a Strategic Alliance that would support project development and delivery.

This study also demonstrates how the assets of the natural environment can play a role in developing a sustainable economy for the City Region. It has been commissioned by Nature Connected and the Liverpool City Region Local Enterprise Partnership with support from partners: The Mersey Forest, Merseyside Environmental Advisory Service (MEAS), Atlantic Gateway, Forestry Commission, North West Coast Academic Health Science Network and the Liverpool City Region Local Enterprise Partnership (LEP).

Nature Connected is the Government-approved Local Nature Partnership (LNP). Its board brings together a range of organisations working to embed the natural environment into policy and strategy at the City Region level. It has a clear strategy to work with those involved in economic development and in the health sectors. Its ambition is to maximise the benefits of the City Region's green infrastructure assets and use GI approaches to tackle strategic challenges for the city region[1].

This study also supports work being undertaken by the LEP to develop a commissioning framework for the EU2014-2020 programme, and to deliver the Economic Union's (EU) Structural and Investment Funds Strategy (ESIF).

1 www.natureconnected.com

2.0 Context

2.1 The Strategic Policy Framework

Over the next five years, £190m of EU investment in the form of ESIF will be available to the Liverpool City Region (LCR). Europe 2020[2] is the overarching strategy for all EU Funds and it has three priorities:

1. **Smart growth:** developing an economy based on knowledge and innovation.
2. **Sustainable growth:** promoting a more resource efficient, greener and more competitive economy.
3. **Inclusive growth:** fostering a high-employment economy delivering social and territorial cohesion.

Underpinning these priorities are five targets that:

1. 75 % of the population aged 20-64 should be employed.
2. 3% of the EU's Gross Domestic Product (GDP) should be invested in research and development.
3. The "20/20/20"[3] climate/energy targets should be met.
4. The proportion of early school leavers should be under 10% and at least 40% of the younger generation should have a tertiary degree.
5. 20 million fewer people should be at risk of poverty.

2.2 The role of Green Infrastructure in the ESIF

The integration of GI planning and the delivery of the EU's Cohesion Policy 2014 – 2020 is supported in documents such as the 2013 "Guide to Multi-Benefit Cohesion Policy Investments in Nature and Green Infrastructure". These documents highlight GI as an important component in the future prosperity of City Region area.

At UK level, the current ESIF Operational Programme includes a specific Thematic Objective (TO6) for Protecting the Environment and Resource Efficiency (PERE) with GI presented as an example of the type of intervention that may be included.

"ERDF will be invested in the preparation and creation of multi-functional Green Infrastructure including through site clearance, soil desealing, decontamination and land remediation."[4]

Further details of the ESIF Programme can be found in Appendix A1

2 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

3 http://ec.europa.eu/clima/policies/package/index_en.htm

4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368808/bis-14-1179-united-kingdom-partnership-agreement-part-one.pdf (page 55)

2.3 The role of Green Infrastructure in the Liverpool City Region

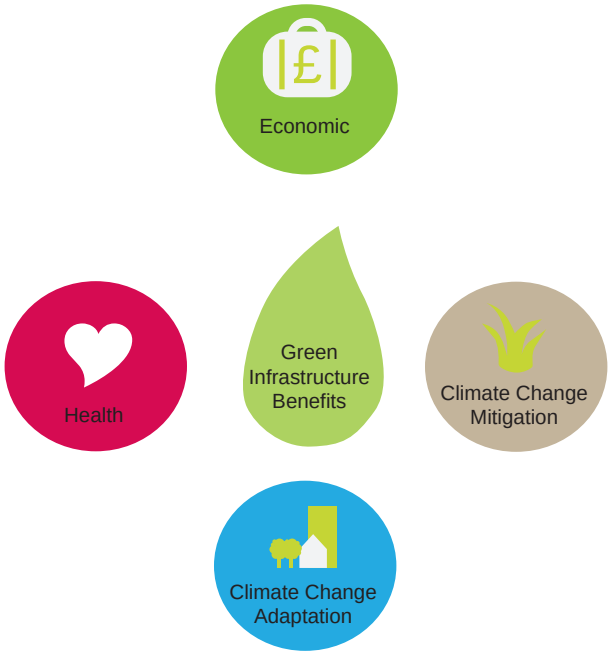


Figure 1: The four main benefits of Green Infrastructure.

Improving the environment is recognised as being critical to the City Region's sustainable economic growth, with GI interventions at the heart of this approach providing a vehicle to address the City Region's significant legacy of derelict, underused and neglected (DUN) land. DUN is acknowledged to bring a range of environmental, social and economic challenges which in turn can be addressed by GI solutions that will create high-quality gateways to the City Region, improve visual amenity, provide good first impressions for investors, increase the value of residential and commercial property and enhance environmental quality. This, in turn, will improve the competitiveness of business locations, and will attract and retain a skilled and productive workforce. More details on the economic benefits of green infrastructure can be found in Appendix B.

In terms of climate change adaptation and mitigation GI can: ameliorate extreme weather; attenuate flood events; provide shading; filter air pollutants, and screen visually intrusive infrastructure such as acoustic barriers.

Quality of life is becoming an increasingly important consideration in modern business location decisions, in particular for high-tech knowledge industries. Cities with attractive green spaces, parks and natural surroundings are more likely to attract and retain knowledge workers and individuals on high salaries. Quality GI also improves productivity and studies show that office workers who enjoy natural views report fewer physical ailments and express greater job satisfaction compared to workers without a view.

Health and wellbeing is also a major issue for LCR[5]. The City Region's population experiences high levels of health deprivation and inequality, coronary heart disease, obesity and diabetes and low levels of physical activity.

GI provides multifunctional benefits and can address a range of health policy objectives. Providing high quality GI can offer opportunities for physical activity which, in turn, reduce the prevalence of illnesses such as coronary heart disease, diabetes and obesity improving wellbeing and reducing the negative effects of mental illnesses. Green spaces mitigate the effects of climate change and its associated health challenges e.g. heat

5 Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy Technical Document 2010. http://www.ginw.co.uk/liverpool/Technical_Document.pdf

related deaths.

Improving the health and wellbeing of those currently out of work can have significant impacts on their ability to gain and retain employment. There is a clear link between poverty and poor health. Gaining employment is a route out of poverty, improving quality of life and life expectancy.

There is increasing evidence of the value of GI-based health products. Initiaitives such as the Natural Health Service[6] have shown significant health benefits and can be used to support people into work and whilst in work.

The Natural Health Service brings together organisations that deliver health products and activities, land owners and academics. A centre of excellence in the city region has been developed to accelerate the development of health products, improve the evidence base and increase utilisation of the Natural Health Service.

GI can also increase social cohesion by bringing people together and engaging individuals from different social groupings that may not normally interact. Green space provides opportunities for increasing social activity, improving community cohesion, developing local attachment and lowering crime levels.

This study has also considered the total number of jobs created expressed as Full Time Equivalent (FTE) and translated into the impact on Gross Value Added (based on GVA per job). More details on the economic and health benefits of GI can be found in Appendix B1 and B2.

2.4 The Role of Renewables the Liverpool City Region

Maximising the City Region's ability to generate renewable energy is a key aspiration included in the ESIF with a key action to develop activities that ensure that a greater proportion of energy consumed in the City Region is from renewable and low-carbon sources.

The ESIF also highlights the need to include Sustainable Energy Action Plan (SEAP) project support and drive initiatives such as the deployment of "“whole place" low carbon solutions, biomass and indigenous biomass supply chain development, community energy schemes, micro generation, and smart energy and demand management concepts. These solutions are all relevant to the GI agenda and renewables offer opportunities to bring DUN sites with limited positive use back into an economically viable use.

Renewables bring benefits to the wider economy arising from less dependency on fossil fuels and they bring carbon savings in terms of decarbonisation of the grid. The value of carbon saved can be translated into a benefit through the avoidance of a cost.

Renewables also bring social benefits – fuel poverty is a significant issue both nationally and in the City Region. Energy projects provide opportunities to provide competitively priced energy that is not subject to the volatility of the markets as well as create local employment.

6 http://www.naturalhealthservice.org.uk/

Energy crops offer better financial returns than conventional crops on non-prime land and are a potential source of commercially viable revenue generation. They offer more stable prices and long-term contracts compared with arable crops and have multiple markets and can be used by large power stations or attract a premium through the local heat market. They can be produced on less fertile land meaning that they do not occupy high-value agricultural land and they provide a more flexible land use than managed woodland ensuring that land can be used for alternative uses once the lifecycle of a crop has ended.

Energy crops are also a form of GI that provides functions such as reducing surface run-off and biodiversity gains. Renewables on some sites can also be exploited in conjunction with GI.

2.5 Strategic Investment in Liverpool City Region

Over recent years and in conjunction with other regeneration funds, EU funding has been invested to strengthen the Liverpool City Region economy. These investments have funded infrastructure and assets, transformed urban centres, increased the supply of commercial property, improved the visitor experience, and provided the City Region with building blocks for growth.

The City Region has set out a range of strategically important locations known as Strategic Investment Areas (SIA) and these assets have helped establish a strong record in attracting inward investment and business expansion.

SIAs are identified in existing City Region strategies (e.g. Strategic Economic Plan) as the most important areas for investment and have the potential provide the spatial framework for the City Region to target the GI and renewable projects included in this report. In all, there are 28 SIAs across the City Region's six local authorities. Many of these sites are also located within the strategically important Atlantic Gateway area.

2.5.1 Atlantic Gateway

Atlantic Gateway is an economic development and infrastructure strategy for the North West, centering on a corridor between Greater Manchester and Merseyside. The strategy links the approach set out in this report to wider Government aspirations to develop the "Northern Powerhouse".

By 2030, there is the potential for some 250,000 new jobs to be created in the Atlantic Gateway area. Approximately 140,000 of these jobs will be associated with Atlantic Gateway priority projects, involving £14 billion of new investment. With a private sector board, its vision is to maximise investment into the Atlantic Gateway area and support the delivery of major projects by LEPs and other partners.

Atlantic Gateway also provides a platform to promote low carbon sustainable growth and support the development of green infrastructure. At the heart of this vision is the knowledge that the natural environment and GI will play a fundamental role in helping to achieve the City Region's potential.

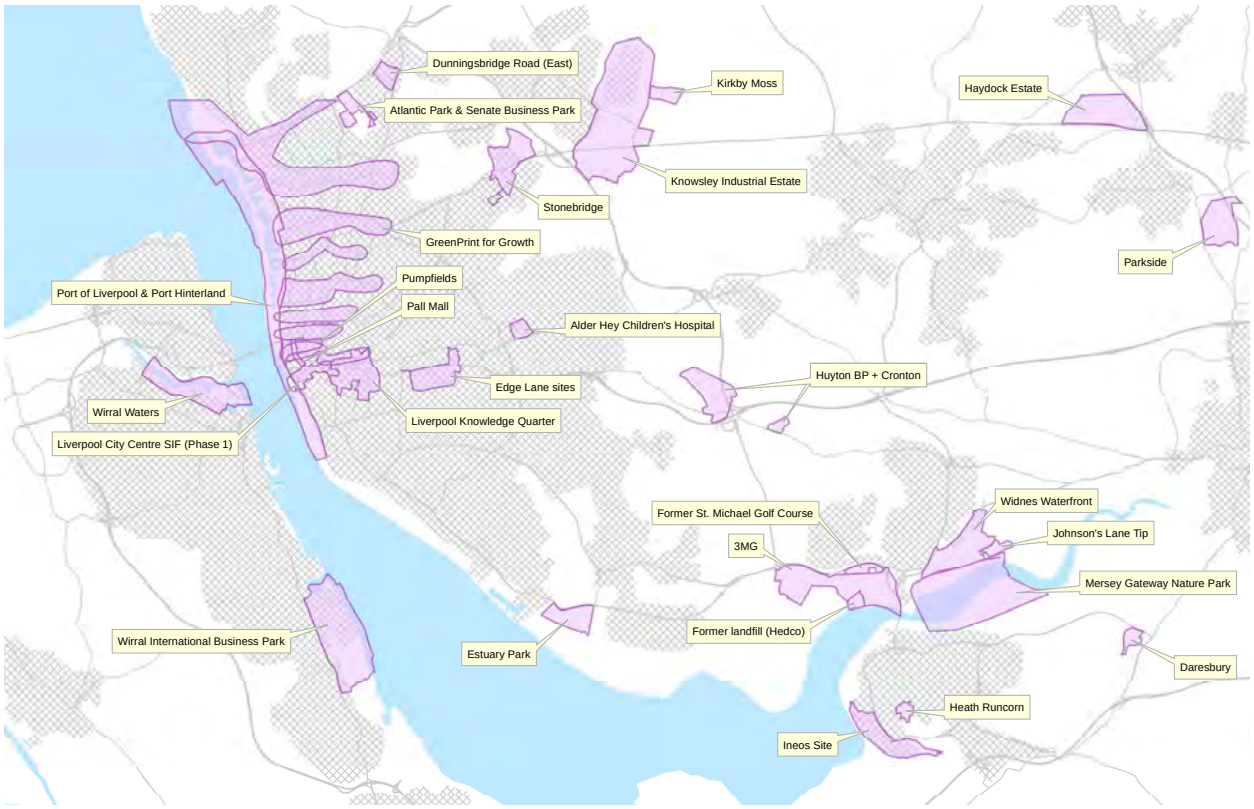


Figure 2: Liverpool City Region Strategic Investment Areas

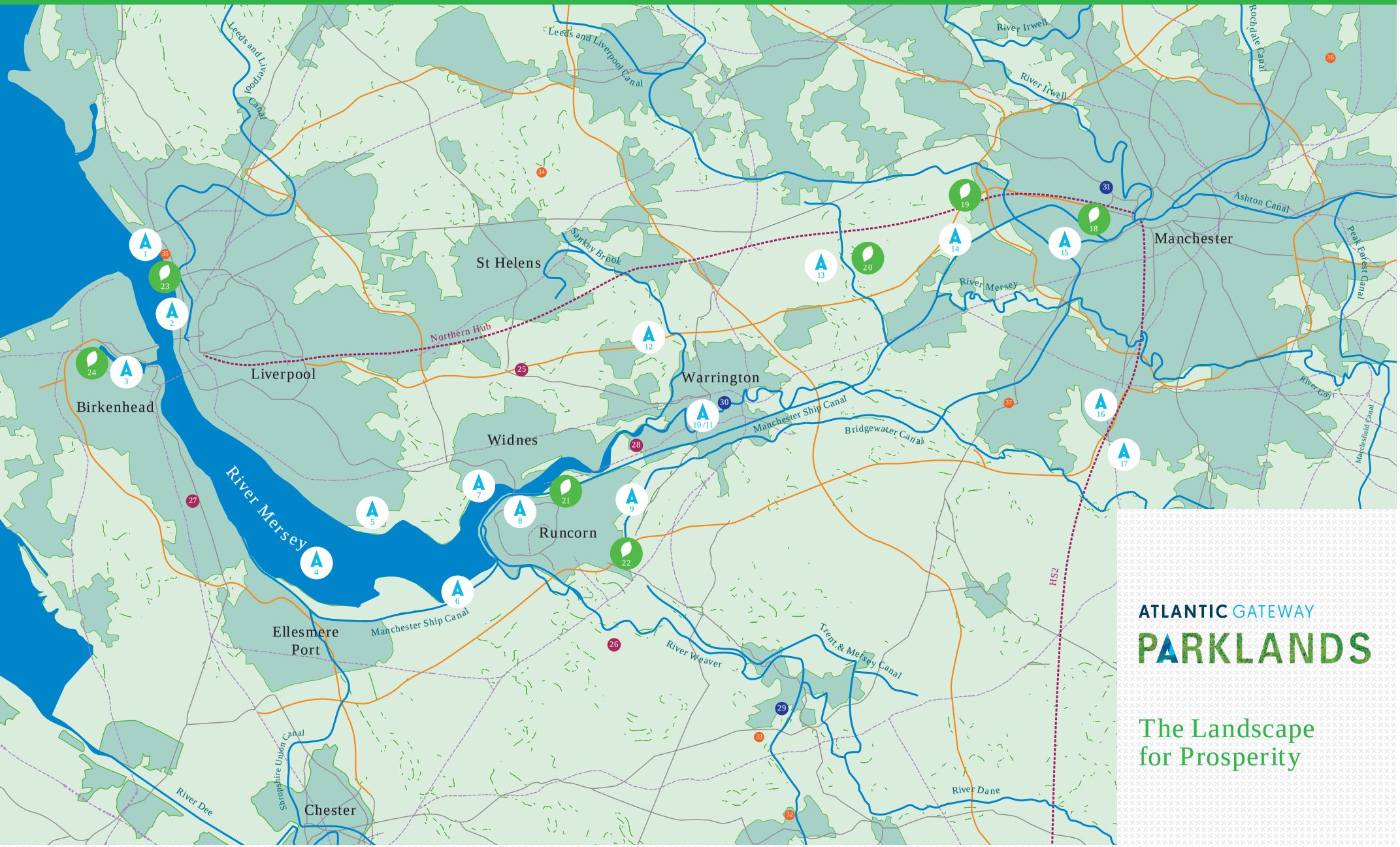
Figure 3: Atlantic Gateway area and key sites

Atlantic Gateway views GI as a critical infrastructure alongside road, rail, energy and telecoms and sees it as one which is fundamental to the way in which our cities, the economy and the region's communities perform and reach their true potential.

The 'Atlantic Gateway Parklands–the Landscape for Prosperity' strategy sets out the vision and ambition to make places investable and liveable through an exceptional environment. 'Parklands' centres on the concept that GI can support growth as an opportunity and is not a constraint. Atlantic Gateway's coast, rivers, canals and land are valuable assets and the key to smart and resilient development. Making the best of these assets will unlock barriers to sustainable growth.

'Parklands' acknowledges that the environment can support adaptation to, and mitigation of, climate change and flooding. GI and natural systems deliver direct benefits by cleaning our air and water. GI makes places more attractive, which in turn benefits the visitor economy, encouraging investors and attracting the best knowledge workers. It can form spaces for play, and for leisure; leading to healthier communities and reduced costs of illness. It is where food is grown, water managed and raw materials are sourced.

This transformation from grey to green is the main focus of 'Parklands'. The ambition is for the whole area to be a high quality environment, attractive to investors, residents, visitors and businesses alike. This is a generational task.



ATLANTIC GATEWAY

PARKLANDS

The Landscape for Prosperity

Atlantic Gateway Projects

1. Liverpool2
2. Liverpool Waters
3. Wirral Waters
4. Mersey Tidal Power
5. Liverpool John Lennon Airport
6. Ince Park
7. 3MG
8. Mersey Gateway
9. Sci-Tech Daresbury
10. Warrington Waters
11. Port Warrington
12. Omega
13. Northern Hub
14. Port Salford
15. MediaCityUK
16. HS2
17. Airport City

Parklands Opportunities

Strategic Environmental Initiatives:

18. Irwell River Park
19. Port Salford Greenway
20. Great Manchester Wetlands
21. Mersey Gateway Nature Park
22. Bridgewater Way
23. GreenPrint for Growth
24. Wirral Waters Green Grid

Emergent Landscape Assets:

25. Bold Forest Park
26. Cheshire Saltscape
27. Port Sunlight River Park
28. Upper Mersey Valley Forest Park

Strategic Flood Defence Investments:

29. Northwich
30. Warrington
31. Salford

Water Quality Investments

32. Winsford
33. Northwich, Oakmere and Cuddington
34. Billinge
35. Sandon Dock
36. Oldham / Royton
37. Altrincham

Places not visible on the map

- Nantwich and Crewe
- Burscough
- Hesketh Bank
- Whaley Bridge

Labelling key

Major rivers and canals | Motorways

Major roads | Railways | HS2

www.atlanticgateway.co.uk

Parklands' focuses on a resilient 'whole systems approach' that aims to:

- Green the cities – with street trees and enhanced green infrastructure;
- Embrace waterfronts – creating and improving access;
- Be productive – producing food and energy from natural sources;
- Create a setting for innovation – supporting a low carbon future;
- Make a playful landscape – cultural landmarks and bio-diverse habitats; and
- Create an accessible landscape – a network of routes, paths and bridges.

Partners in all sectors can play a part in delivering the green dividend from sustainable growth, and it must be a fundamental element of the City Region's future strategies.

2.5.2 Liverpool City Region's Combined Authority

The Liverpool City Region Combined Authority is focused entirely on strategic governance to facilitate economic growth. It provides accountable strategic decision making for economic development, transport, strategic housing and employment and skills functions. It also provides an opportunity to gain strategic support for the GI and renewables investment approach articulated via this study.

2.5.3 Creating a GI Prospectus of projects for ESIF Delivery

Over the past two years, the LCR LEP has worked with partners to develop the City Region's ESIF delivery plan. The plan focusses on five themes that include elements of the 11 Thematic Objectives set in the ESIF programme.

The ESIF programme amounts to £190m; of this, £73m funding is being made available to organisations and of this £31m for employment and skills, £15m for research and innovation, £15m for low carbon, £6m for increasing SME growth and £6m for boosting entrepreneurship.

LEP advice is that interested organisations consider developing collaborative, large-scale projects that work across the City Region geography.

To successfully secure funding, such projects will need to demonstrate that they will enable the City Region's economy to maximise benefits from any funding investments made.

The competition for project funding is considerable and opens up an opportunity to facilitate Strategic Alliances with organisations from a range of sectors in order to access funding, bring match funding, and investigate other sources of funding and added value.

Difficult decisions will therefore need to be taken by DCLG as Managing Authority for ESIF. The EUSIF Committee has an advisory role to the Managing Authority especially on strategic fit and the GI prospectus has a key role in making the case for "strategic fit" for GI interventions to both ESIF, the Managing Authority and its advisors.

This report sets out a portfolio level pipeline of commissionable projects which satisfy the requirements of ESIF and will deliver priority outputs for the LCR LEP. It also describes how a Strategic Alliance of key investors and partners can be developed and supported in order to:

- Deliver the "whole place low carbon solutions" by tackling pinch points through green infrastructure planning and delivery and creating resilient areas, where the EU and other investments are safeguarded.
- Accelerate the delivery of investment that will lead to growth in terms of new jobs and GVA.
- Target renewable energy and community projects on DUN sites.
- Reduce carbon emissions
- Reduce the time from project idea to project delivery
- Improve environmental quality, and in doing so improve health and wellbeing and reduce health inequalities

To identify the pipeline of sites this study has:

- Undertaken comprehensive engagement with partners and focused on key investment sites and derelict, underused and neglected sites across the City Region.
- Highlighted 'pinch point' issues that currently reduce investability and set out interventions for each site/area that can address these issues.
- Provided an overview of the benefits of setting up a Strategic Alliance of organisations to take the development of green infrastructure and renewables projects forward.
- Identified key members/partners for a Strategic Alliance of investors and developers.
- Highlighted project opportunities for local job creation and local health improvements.
- Identified the outputs against the ESIF targets.
- Calculated the investment required for GI, solar photovoltaics (PV) and biomass crops.
- Calculated potential annual income generated from sites with solar PV and biomass crops.
- Set out a budget, including match funding and need for ESIF for each GI project/area, with an indication of alignment with the ESIF Portfolios and EU Funding strands.
- Developed a project pipeline of 40 commissionable GI and energy projects across 32 sites.
- Identified where new jobs will be created.

2.6.1 Creating a GI Prospectus investment methodology and business case

The central proposition of this report is that by linking opportunities for GI investment and renewable energy generation, a compelling and investable portfolio of deliverable projects will emerge. The approach seeks to capture future revenue streams from renewable energy projects to enable GI investment in the long term which

will enhance the investment prospects of the City Region's SIAs.

In order to identify potential GI and renewable energy projects the following detailed steps were undertaken:

For Green Infrastructure sites:

1. A 'long list' of sites, including SIAs, was reviewed to identify where issues such as poor image, flood risk, contamination and climate change impacts exist. These have been presented as a series of pinch points that indicate where GI interventions are required.
2. GI interventions designed to work in isolation or in combination in order to address the Pinch points, were then established.
3. An outline of the benefits of GI interventions in terms of economic growth, health and climate change adaptation and mitigation was then set out.
4. A 'short list' of SIAs where GI projects should be prioritised and developed further to attract investment was identified.
5. The costs and economic value of GI interventions being delivered in the City Region in terms of new jobs and Gross Value Added (GVA) was then calculated.

For energy sites:

1. A 'long list'/ data base of derelict, underused and neglected sites produced by Merseyside Environment Advisory Services (MEAS) was reviewed to identify potential sites. Further sites and some premises were also identified in discussions with stakeholders engaged throughout this project. In total 90 sites and 2 buildings were considered.
2. A 'short list' of sites and premises to be considered for assessment for solar photovoltaics (PV) arrays and energy crop production was then created. Constraining factors were taken into account in the short listing process.
3. Technical and commercial assessments of short listed sites and premises for a solar PV and energy crop schemes were carried out.
4. The potential costs and revenues of solar PV and energy crop schemes were established.

The steps taken to identify the sites for GI and renewable energy are summarised in Figure 4 on the next page.

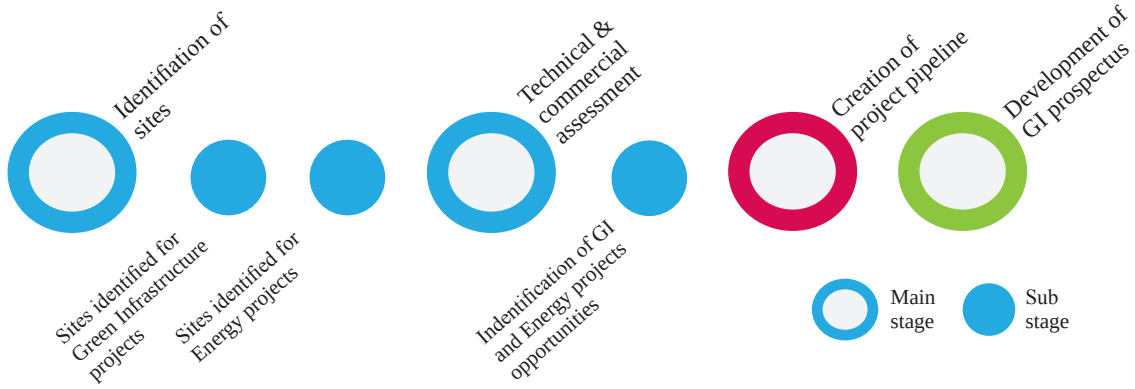


Figure 4: Summary of stages undertaken to develop the GI Prospectus for the City Region

Figure 5 below summarisies the total number of sites reviewed for GI and renewables considered in this study.

Summary of sites reviewed and identified		
90 sites and 2 buildings considered		
28 Strategic Areas considered	58 DUN considered	4 sites and 2 premises put forward by stakeholders
11 SIAs identified as priority GI project opportunities	12 DUN sites identified for solar potential PV	7 sites identified for potentially combined solar PV and GI projects
	17 DUN sites identified for energy crop production	
A project pipeline of 40 commissionable GI and energy projects have been identified		

Figure 5: Summary of all sites reviewed for GI and renewable energy options

The following sections discuss in more detail the approach taken to review sites and set out the research findings for GI and renewable energy.

3.0 Green Infrastructure

3.1 Introduction

There is already strong evidence that demonstrates how GI planning and delivery and can support jobs and growth, produce resilience for the City Region and support health and wellbeing agendas.

3.2 Defining Green Infrastructure

Green infrastructure can be defined as:

"Our life support system – the network of natural environmental components and green and blue spaces that lie within and around our towns and city, providing multiple social, economic and environmental benefits."

Green infrastructure is identified as:

- A system where the parts are interrelated and need to be planned and managed together and at the appropriate scale.
- Including both the vegetation and water elements of the natural environment.
- Both urban and rural.
- Providing multiple benefits. Where one intervention, if well planned, can provide many benefits.

The Liverpool City Region Green Infrastructure Framework – Nature at Work[7] sets out the GI evidence base in detail. It identifies six themes for the City Region, all of which (with the exception of Developing the Rural Economy) resonate with the sustainable development of Liverpool City Region and Warrington.

These priorities are set out in Figure 6, and are linked to the long term vision and the Key GI activities set out in Mersey Forest's Nature @ Work report.

7 Nature at Work www merseyforest.org.uk/Liverpool-action-final.pdf

Priorities	Long term vision	Key Activity
A Setting the Scene for Growth	As a low carbon economy, Liverpool City Region and Warrington maximise the benefits that are delivered through strategic green infrastructure planning to support sustainable economic growth.	1 3 5 9
B Supporting Heath and Wellbeing	The natural environment is seen as an essential health asset. People in the City Region and Warrington state that the natural environment and their enjoyment of it is a major contributor to their wellbeing.	1 5 8 9 12
C Adapting to Climate Change	The City Region and Warrington have adapted well to climate change and support others in making their change.	2 9
D Providing recreation, leisure and tourism	The City Region and Warrington is a playground, with paths and green routes offering opportunities for sustainable recreation and leisure and encouraging visitors to enjoy the natural beauty of the area.	2 9 10
E Enhancing the Ecological Network	The developing ecological network is a precious resource, providing critical functions and safeguarding our biodiversity.	4 6 11
F Developing the Rural Economy	An attractive and thriving rural economy is the key to the success of the City Region, providing valuable fuel and food resources, as well as the setting for a high tech and knowledge based economy	2 7 9 10

Figure 6: Priorities, long term vision and key activities for LCR's GI Framework

Influencing the ESIF, making strong links to health and wellbeing are highlighted as Key Activities to take forward from the GI Framework. Nature Connected oversees the delivery of these activities and has been at the forefront of this work by commissioning this study to develop a GI prospectus of commissionable projects. Figure 7 sets out the twelve key GI activities identified by Nature@Work.

1 Plan and deliver green infrastructure to help overcome 'pinch points' that undermine investment potential	**2** Engage the non-environmental sector more effectively through the Local Nature Partnership and Local Enterprise Partnership link and Community Environment Fund.	**3** Use green infrastructure to help adapt our area to projected climate change and assist in the creation of a low carbon economy.
4 Support the aspiration for the Mersey as the cleanest and most ecologically rich urban river in Europe	**5** Use the green infrastructure of the City Region and Warrington to promote and sell the area as a great place to live, work and invest. Use it to help bid for Green Capital.	**6** Deliver The Mersey Forest Plan increasing woodland cover in areas of greatest need, deliver 'more from trees' and achieve a 'woodland culture'.
7 Use the Green Infrastructure framework to shape the content and delivery of European Structure and Rural Development Funds.	**8** Fully utilise Green Infrastructure Planning, delivery and management to reduce the prevalence of poor mental and physical health in support of the Decade of Health and Wellbeing	**9** Build green Infrastructure Framework into City Region and cross boundary plans and strategies.
10 Create and develop green infrastructure tourism assets, for example our coastal areas, large parks, greenways such as Sankey Valley and the forest Parks.	**11** Through Green Infrastructure Planning and delivery enhance ecological frameworks by creation of more and larger areas for nature that are well managed and connected to form an ecological network.	**12** Use the green infrastructure assets of the City Region and Warrington to support increased active travel, walking and cycling for work, recreation and leisure.

Figure 7: Green Infrastructure activities identified by Nature@Work

3.3 Green infrastructure and the economy

The ESIF highlights green infrastructure as an essential infrastructure which is recognised as a main area for investment. It states that:

"…we have sufficient evidence to identify five areas which should be a focus for EU Investment: "Investment in key transport and economic infrastructure, including green infrastructure, to support growth and economic resilience, and the ability to compete nationally and internationally to attract investment and visitors."[8]

Also Nature@Work identifies the clear proximity between SIAs and the significant concentrations of existing green and blue infrastructure which is illustrated in Figure 8 below.

Figure 8: Relationship between SIAs and major concentrations of existing green infrastructure -Liverpool City Region and Warrington Green Infrastructure Framework.

8 LCR ESIF. page 15

There is substantial evidence showing how GI planning and delivery supports a sustainable economy. Recent research by BE Group for the Mersey Forest[9] has for the first time identified that GI can increase investment values by up to 20%, decreasing yields expected in financial appraisal. This is achieved by:

- Accelerating development times
- Reducing the period of vacant plots/buildings in a development
- Sustaining increased rental value, even in periods of poor economic growth

Each of the above factors would lead to better financial returns and more financially sustainable developments for investors and developers. They would also demonstrate how GI plays an important role in creating value[10].

In addition, previous studies[11] have shown that the implementation of GI at the pre-development stage can also increase the value of vacant land. These increased asset values are then reflected in a developer's balance sheet, enabling increased borrowing, quicker on-site investments and release of the full value of a development.

Studies show that GI planning has been explicitly developed as an approach that promotes the value of the natural environment to the wider economy. One particular study[12] shows that for every £1 invested in green infrastructure £2.30 of GVA was created, along with a further £6.90 of wider economic benefit. In the City Region 8,500 jobs are directly linked to, or depend on, GI. These generate £300m of GVA for Liverpool City Region, £37,000 GVA per Full-Time Equivalent job.

GI planning and delivery can enable cost-effective solutions to issues that act as barriers to growth. The term "Pinch points" has been used to identify areas of potential investment where current or projected issues, for example, flood risk, contamination and impact of climate change either limit or prevent present investment.

Using GI to overcome these issues (i.e. the pinches) will enable investment and help create sustainable, high quality places for people to live and work. GI can develop places that are resilient to environmental change and create attractive places for the establishment and development of SMEs. The economic, mitigation, health and adaptation benefits that GI brings are summarised in Figure 9.

9 Green Infrastructure – adding value, November 2014, Report by BE Group for the Mersey Forest

10 BE and Green Building ref

11 for example [1] Cousins and Land Use Consultants (2009). Economic contribution of green networks: current evidence and action. North West Development Agency, Manchester, Forestry Commission (no date) Bold Colliery Community Woodland. District Valuer's report on Property Values. Forestry Commission, Dunse N, White M & Dehring C (2007) Urban parks, open space and residential property values. RICS Research Paper Series. RICS, London. CTLA (2003) Summary of tree valuation based on CTLA approach. Council of Tree and Landscape Appraisers

12 Regeneris Consulting (2009) The economic contribution of the Mersey Forest's objective one-funded investments. Regeneris Consulting

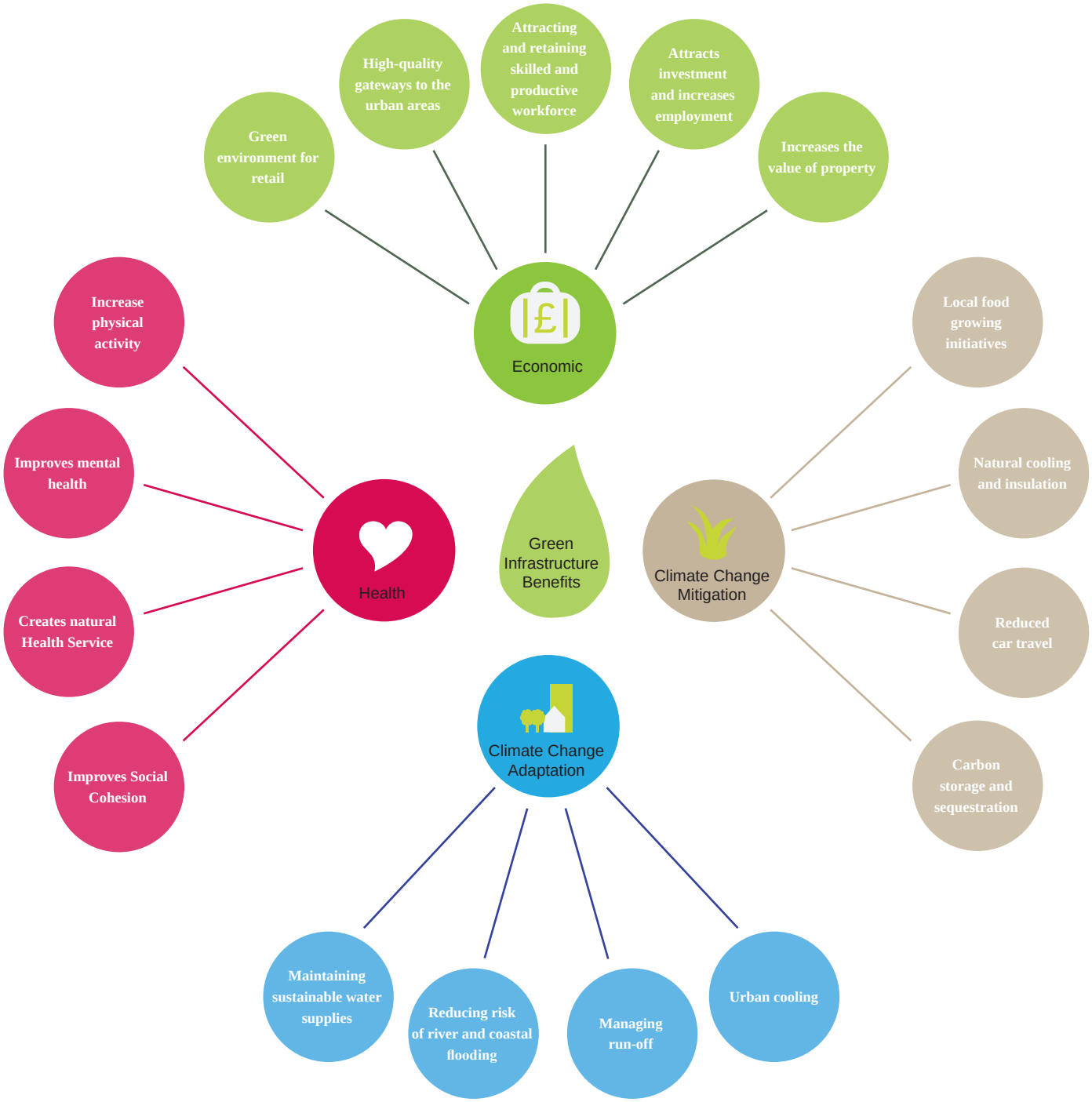


Figure 9: Benefits of Green Infrastructure

GI projects have an excellent track record in supporting excluded groups back to work offering them skills development, training and practical activity. The GI sector also needs a variety of skills and levels of knowledge. Development of the sector will provide opportunities for individuals to find the level that suits their capabilities. These skills and knowledge are also transferable to other sectors.

Labour-intensive and low skill GI jobs provide entry routes for people with learning difficulties or some form of physical disability. Other GI jobs are relatively high-skill such as tree surgery, horticulture, or communications offering entrants opportunities to aspire and progress. GI also offers educational opportunities through outdoor classrooms or laboratories, thus delivering on ESIF's skills agenda.

There is a wealth of evidence to support GI as part of an urban design approach to adapting areas to projected climate change and to reduce greenhouse gas emissions. GI planning and delivery can help deliver "whole place low carbon solutions" which is an aspiration for the ESIF.

3.4 Developing Green Infrastructure Interventions

This study has identified where GI planning and delivery options could help to alleviate a range of issues that effect investment; for example, helping to tackle poor air quality or risk of flood.

3.4.1 Strategic Investment Areas

SIAs were used as the starting point as they have already been set out in LCR strategies as the most important areas for investment. In the City Region there are 28 SIAs across all six local authorities and many have also been identified within the Atlantic Gateway Business Plan as strategic priorities.

Figure 10 Sets the stages undertaken to identify locations for GI investment.

In the course of this research, meetings were held with a range of organisations and investors with interests in the identified sites. These discussions established the planned investment and projected numbers of jobs (over a five year timescale) related to the selected locations and also identified that the interest in locations from investors is both direct and indirect. For example, Liverpool Waters is a major investment opportunity that can deliver jobs and growth. Peel Holdings Ltd are interested in being part of a Strategic Alliance that will aim to

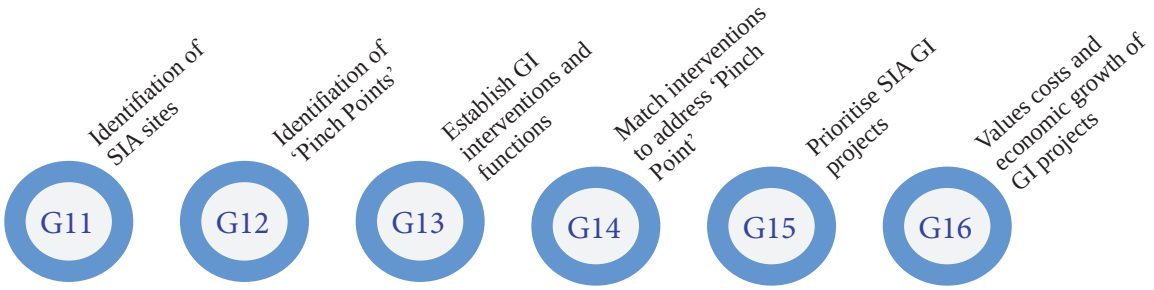


Figure 10: Key stages of research carried out to identify GI sites

address pinch points impacting on their sites and investment in the area.

United Utilities is interested in the impact of new development from a surface water perspective whilst the Environment Agency is interested in how GI planning and delivery can meet the requirements of the Water Framework Directive and deliver sustainable development.

3.4.2 Identifying Pinch Points

A pinch point location is where, due to one or more issues (the pinches), opportunities for investment and sustainable development are reduced. The result is that either investment does not take place, or that any investment made underperforms. Examples include poor image, risk of flood, poor air quality, security, access, anti-social use, high cost remediation and air pollution and noise issues.

The approach taken in this study has been to focus on issues where there is sound evidence that GI planning and implementation can help to alleviate the identified issue, reduce the pinch and then help to enable (sustainable) development.

The Liverpool City Region Green Infrastructure Framework provided the data and evidence base to identify the pinches in each SIA. Figure 11 sets out an overview of pinches and related GI functions that can address these issues. Such an approach provides a smart way of targeting investment to address constraining factors or “pinches” thereby improving conditions for economic growth.

Pinches on sites were identified by considering:

- The functionality of green infrastructure in the area of search i.e. what is the existing green infrastructure achieving?
- The identified needs in the area of search e.g. water management or air quality issues
- If GI planning and implementation on site is a suitable solution to address the needs of the site

Pinch points were then mapped by location and concentration across in SIAs across the City Region and are shown in Figure 12.

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- If GI planning and implementation on site is a suitable solution to address the needs of the site

Pinch points were then mapped by location and concentration across in SIAs across the City Region and are shown in Figure 12.

Figure 11: Overview of GI Pinches (blue) and GI Functions (green)

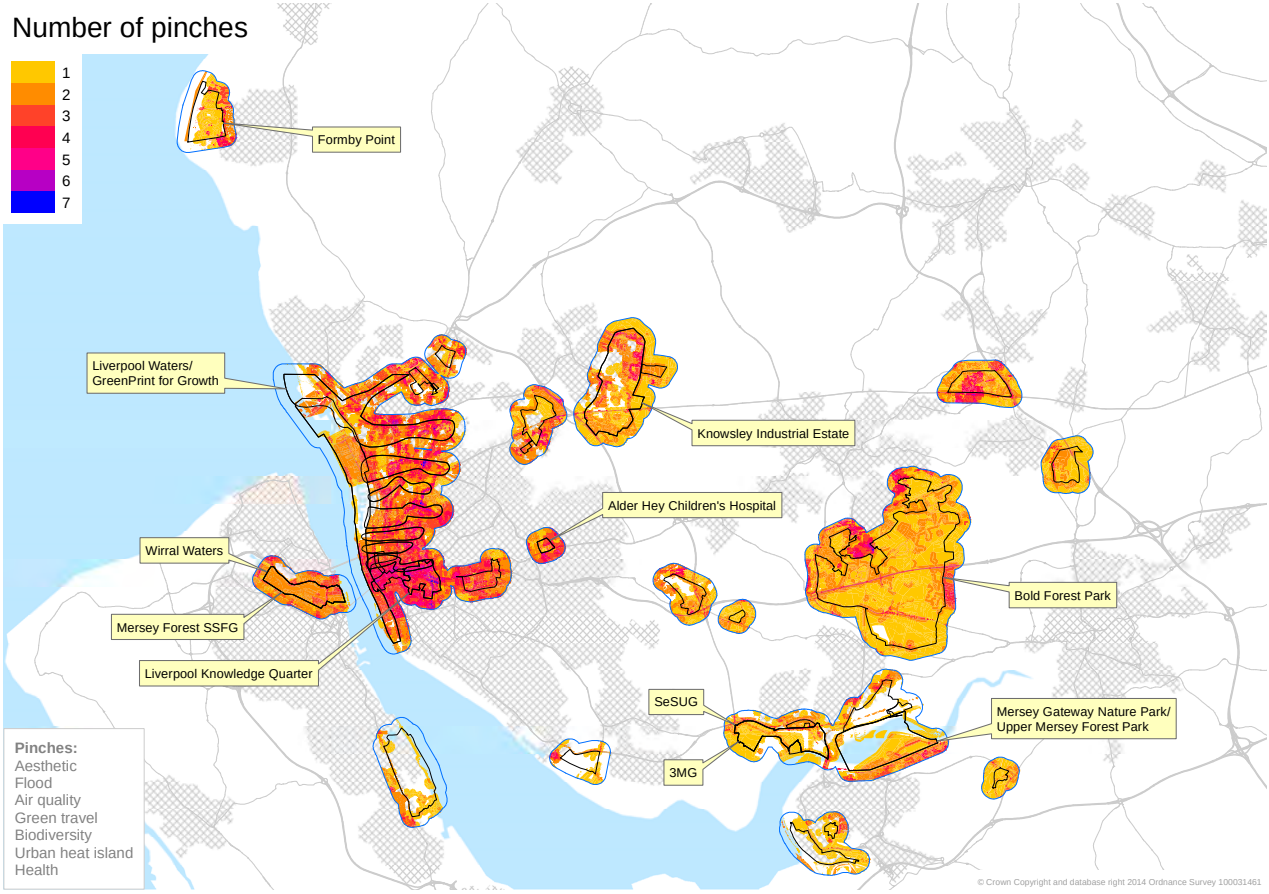
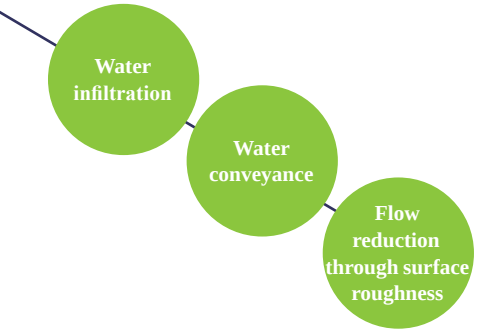


Figure 12: Locations and concentrations of pinch points in the City Region



Having identified the areas and pinch point issues that exist in these areas, the final step was then to determine the GI interventions required to these address issues. These GI interventions could, for example, include increasing tree coverage on site, biomass cropping, sustainable urban drainage options or habitat creation.

It is important to note the need to also address pinch points that are adjacent to, or within, an area of planned investment. To take account for this the redline planning area and buffer ring has been included on sites considered for this study. This can be seen in figure 12 above.

The range of GI interventions, and an indication of their potential application for each of the SIAs has been mapped out, and is included in Figure 13.

Suggested Green Infrastructure intervention	Increase tree cover on and around site	Install green roofs	Install green walls	Functional grassland and other GI types	Water-re-lated interventions	Linear features and connectivity
3MG						
Alder Hey Children's Hospital						
Atlantic Park & Senate Business Park						
Daresbury						
Dunningsbridge Road (East)						
Edge Lane sites						
Estuary Commerce Park						
Former landfill (Hedco), West Bank Dock Estate						
Former St.Michael Golf Course, south side						
GreenPrint for Growth						
Haydock Estate						
Heath Runcorn						
Huyton BP + Cronton						
Ineos Site						
Johnson's Lane Tip						
Kirkby Moss						
Knowsley Industrial Estate						
Liverpool City Centre SIF (Phase 1)						
Liverpool Knowledge Quarter						
Mersey Gateway Nature Park						
Pall Mall						
Parkside						
Port of Liverpool & Port Hinterland						
Pumpfields						
Stonebridge						
Widnes Waterfront						
Wirral International Business Park						
Wirral Waters						

Key

Low impact → Very significant impact

Figure 13: Summary to show suggested GI interventions and the significant impact they will have in addressing on site issues

The information on site location, issues and potential pinches was then used to inform shortlisting of the 28 SIA sites.

3.4.3 Developing a shortlist of projects

From the long list of 28 SIAs, eleven priority sites were shortlisted based on considering the existence of the following four factors on a site by site basis:

1. There are pinch points in the SIA that have a solution which includes green infrastructure
2. Partners are willing to engage in a Strategic Alliance to implement GI planning and implementation
3. Partners are willing to use their investment as match funding to support the approach set out in the prospectus.
4. The sites are ready to progress and they can deliver significant outputs for ESIF. The sites, locations, associated employment creation, cost for GI investment, match funding and percentage of total investment in GI per project is set out in Table 1.

Based on the pinch points found in each SIA, costings for the appropriate GI interventions were developed. These were based on previous experience in delivering similar projects and programmes across the City Region. For example, work at Wirral Waters by the Mersey Forest Team.

These first 11 project areas will pilot the GI interventions to address pinch points. The expected resulting jobs created, cost of GI investment, match funding and percentage of GI investment per project is set out in the table below.

Project location	Number of Jobs	Cost of GI Investment	Match funding	% of total investment in green infrastructure per project
SeSUG	20	£100,000	£1,000,000	1%
Alder Hey Children's Hospital	5	£1,000,000	£300,000	7%
Liverpool Waters/GreenPrint for Growth	200	£2,500,000	£14,000,000	17%
Liverpool Knowledge Quarter	2	£1000,000	£150,000	7%
Mersey Forest SSFG	2	£1,000,000	£240,000	7%
Mersey Gateway Nature Park/ Upper Mersey Forest Park	4	£2,000,000	£500,000	14%
Wirral Waters	2,042	£4,915,000	£146,900,000	33%
Knowsley Industrial Park	2	£700,000	£650,000	5%
3MG	1	£1,500,000	£10,000	10%
Formby Point	5	2000000	4000000	33%
Bold Forest Park	2	300000	300000	50%

Table 1: Summary of GI projects, jobs created and investment and match funding required

3.4.4 Designing green infrastructure interventions

GI strategies are already in place for several of the shortlisted sites. Table 2 sets out site locations and those associated existing GI strategies that can be used or adapted to deliver GI interventions.

Project	GI Strategy
SeSUG	NA – no GI strategy exits for this area
Alder Hey Children's Hospital	Children's Health Park Plan and wider green infrastructure work
Liverpool Waters/GreenPrint for Growth	GreenPrint for Growth
Liverpool Knowledge Quarter	Liverpool Knowledge Quarter landscape Masterplan
Mersey Forest SSFG	Mersey Forest Plan
Mersey Gateway Nature Park/Upper Mersey Forest Park	Upper Mersey Forest Park
Wirral Waters	Wirral Waters Strategic Landscape Plan
Knowsley Industrial Estate	KIP Master plan
3MG	AG Report on 3MG
Formby Point	Plan in preparation and will be out for consultation in Autumn 2015
Bold Forest Park	Bold Forest Park AAP

Table 2: Summary of locations and existing strategies in place that can be utilised and/ or adapted to deliver GI interventions

Whilst these existing strategies do not provide detailed guidance for the design of new GI, nor for the management of existing areas, they are however, more detailed than the GI Framework. Along with the GI Prospectus which show where GI investment can bring projects forward they can therefore be used by a guide to develop appropriate site designs to tackle identified pinches and deliver GI solutions.

3.4.5 Identifying match funding

ESIF funding will be key in delivering GI solutions and so in order to be able to apply for, and draw down ESIF monies, each of the identified projects will need to demonstrate that:

- Match funding is in place
- Outputs are in line with the ESIF programme outputs and match funding is at a level that is competitive with other projects and programmes in the City Region and, potentially competitive with projects nationally.

A major part of this commission has been to speak to a wide range of potential investors in SIAs, to explain the project background and the need to develop a Strategic Alliance and gain investors' support for the partnership approach that is being advocated to deliver GI solutions.

In discussions, investors have been very positive about the proposed approach, providing information on the likely levels and timing of investment in SIAs that could be used as match funding and also the likely number of jobs that developments will create.

It is clear that there is a good pipeline of projects and that investors are willing to engage in a partnership approach to drive a five year GI programme across the City Region

There is agreement that a proportion of the jobs associated with developments will be attributable to the more favourable conditions for investment created by green infrastructure interventions.

The eleven sites prioritised in the study are highly likely to progress, require GI interventions, have potential match funding and can deliver against ESIF outputs. The proposition made here is that the GI interventions identified will directly impact on investments and therefore the outputs that can be identified for ESIF.

The BE Group study for Mersey Forest[13] identified that up to 20% of the value of an investment, and therefore the outputs, could be attributable to GI. However, given the complexity of the investments, outputs and outcomes, it has been assumed here that a conservative estimate i.e. of 10% of the outcomes should be taken to be attributable to the GI interventions.

3.4.6 Economic Valuation of Green infrastructure

It is important to understand the economic benefits that GI can bring and these can be calculated using the GI Val tool kit. GI Val[14] is a relatively simple, high-level toolkit to identify the economic value of green infrastructure and planned green infrastructure interventions. Developed over several years, GI Val brings together models that have been prepared independently to ascribe value to particular GI benefits, such as carbon sequestration or water management. It can provide indicative cost-benefit analyses and information on:

- Gross Value Added.
- Impact on property value.

13 Green Infrastructure – Added Value report for Mersey Forest November 2014

14 www.bit.ly/givalvationtoolkit

- Wider (non-market) economic value.
- Quantification of the tangible benefits - e.g. GI can help to ameliorate air pollution or reduce risk of flooding already.

GI Val has already been used for several projects in the City Region, including in the development phase of Wirral Waters as part of the Setting the Scene for Growth project. It has been used in this study to determine tangible benefits and quantify the economic values of the GI on the 11 sites.

The results are included in Table 3 which provides an overview of the key outputs that could be achieved through the delivery of GI planning and interventions.

Summary of Key GI Findings for Prioritised GI sites	
Measure	Value
Total Number of Jobs attributable to GI	227.8
Total Investment made by Investors in buildings and infrastructure	£163,710,000
Attributable/match investment	£16,371,000
Total number of pinch points addressed on sites	49
Total Cost of GI Interventions (ESIF Investment)	£10,855,000
Area of Green Infrastructure created (Ha)	91.3
GVA from GI interventions	£17,955,910
Property Value	£207,752,064
Wider economic Value	£176,145,616
Ratios	
Cost per job	£47,651
Cost per hectare	£118,894
GVA/£ of ESIF	£2
WEB/£ of ESIF	£16
Leverage	£2

Table 3: Summary of key economic benefits brought by GI planning and interventions on prioritised sites.

Across the eleven sites a total investment of £163.7 million is expected to be made in buildings and

infrastructure. Alongside this, attributable match investment (10%) is expected to total £16.37 million.

Forty nine pinch points have been identified along with a GI intervention (ESIF investment) of £10.86 million this will lead to the creation of 200 hectares of improved GI functionality resulting in GVA from GI interventions of almost £18 million, property values of £208 million and bring a wider economic value of £176 million.

3.4.7 Jobs and Health

The results show that jobs could be created by investing in GI in the following ways:

- Jobs associated with developments where GI plays a role accelerating developments
- Jobs associated with the creation and management of GI

A forthcoming report by Regeneris[15] for Merseyforest has identified that there are currently 6,500 GI jobs in the City Region with an associated £300m GVA. Investing in a GI prospectus and the sites prioritised in this study will add jobs and training opportunities across the City Region.

Recognising that getting out and active in the environment is a way of motivating individuals has led Lancashire Wildlife Trust (LWT) and Groundwork to set up a new partnership. The partnership aims for access European Social Funds to build on both organisations' successful employment, training and skills programmes that target ' hard to reach' and marginalised groups also offer these individuals additional support e.g. clear on the job coaching and mentoring.

Plans are to offer three levels of activity in projects creating or maintaining GI: informal long term voluntary activities; horticultural Intermediate Labour Market (ILM) and apprenticeship programmes: or offer 12 week City and Guilds horticultural placements.

All of these options will offer wrap around support for those involved i.e. a case worker/support to help individuals move on to more training/ job opportunities. This programme is complementary to existing services and infrastructure and is targeted at individuals not in training education or employment (NEETs), those with long term health issues and individuals with complex needs as well as ex-offenders.

Gaining employment is an important route out of poverty and there is a proven link between poverty and poor health. Gaining training and job opportunities will improve the quality of life for programme participants as well as add to the region's GI workforce. The GI projects set out in this report could offer such jobs and training potential. The LWT/Groundwork partnership is exploring setting up a consortium to build a programme of opportunities, manage funding, involve local delivery organisations/social enterprises and provide overall management and quality control.

15 In publication - Contact Mersey Forest Team - info @merseyforest.org.uk

4.0 Considering Energy

4.1 Introduction

In addition to GI, the potential for renewables on DUN sites across LCR was investigated. The use of renewables offers both an alternative and a potentially complementary way of bringing back sites into use, as well as generating income, providing locally generated energy, and carbon reduction.

Maximising the ability to self-generate renewable energy is a key aspiration for the City Region's ESIF with a key action to develop activities that ensure that a greater proportion of energy consumed in the City Region is from renewables and low carbon sources.

The scope of this study focuses on biomass and solar PV opportunities, however, as part of the overall GI approach, other renewable technologies may also be suitable on DUN or SIA identified for GI interventions. This report does not preclude or act as a barrier to deployment of other renewable or low carbon technologies.

Potential technically viable solar PV and biomass schemes have been identified and assessed to understand their commercial viability, including the scale of investment required and the revenues that could be generated from energy production and sale of energy crops.

The renewable energy options investigated in this study included solar PV supply projects and energy crops in the form of Miscanthus production.

It was hoped to include wind energy but a recent report, (April 2015) for Liverpool City Council, to determine the suitability of sites in the city to generate wind energy, has been classified as commercially confidential and therefore its findings could not be included here.

Fifty-eight DUN sites, four other sites and two building roofs were shortlisted for assessment. Sites assessed comprised:

- 9 locations assessed for energy crop projects only
- 8 locations assessed for solar PV projects only
- 7 locations assessed for a combination of energy crop and solar PV projects

The assessment of solar PV energy projects focused on 15 locations i.e. sites that:

- have already been identified to have development potential
- are under construction; and
- have been identified by MEAS as being derelict, underused and neglected (DUN)

A further 17 locations were also identified and assessed to understand the potential revenues from energy crops. Of these 17 locations, 8 of them were also assessed for solar PV potential.

As discussed in Section 2.3, improving the environment is recognised as being critical to the City Region's sustainable economic growth. Whilst GI interventions are at the heart of the City Region's approach, energy projects also offer potential solutions that bring derelict, underused and neglected (DUN) land back into

positive use and GI and renewables can potentially be used in combination on sites.

Whilst locations have been identified through this method, other sites may also be feasible within the City Region, sites which currently have little positive use. The approach taken and method used in this study is therefore transferable and can be applied to further project opportunities such as meanwhile site use, buildings and parts of underused parks.

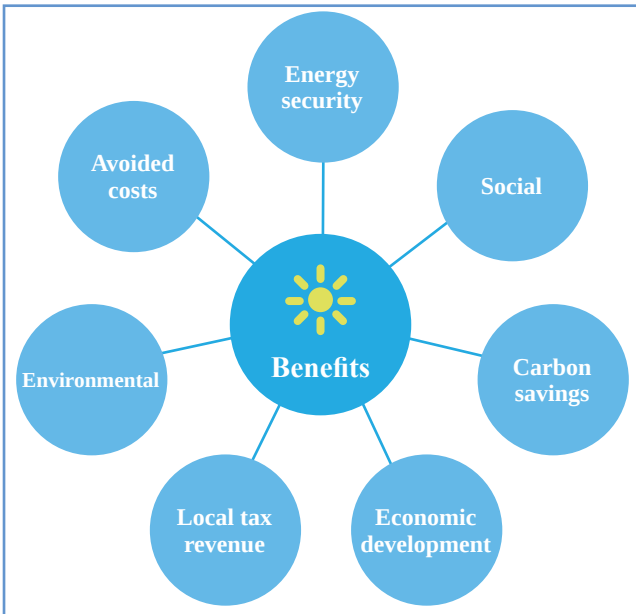
The potential for development of renewable energy and energy crops on DUN sites in the City Region was investigated to understand the range of technically feasible and commercially viable renewable energy options, to improve the diversity and quality of solutions available to the City Region, to provide further options to fund GI projects and to prioritise investment at a portfolio level and to offer low carbon solutions.

4.2 Benefits of Energy Projects

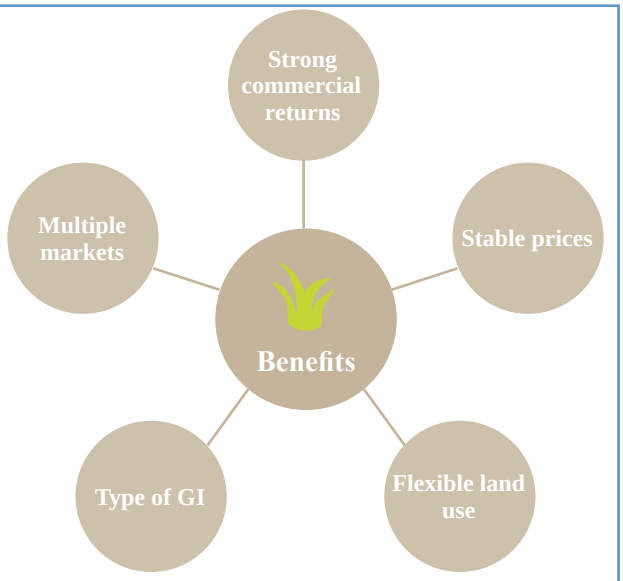
Status of sites and preferred renewable options are summarised below:

Location name	Status of Sites	Energy crop	Solar PV	Energy Crops & Solar PV
Bidston Moss Landfill Site	DUN	✓		
Bramley Moore and Nelson Docks	DUN	✓		
Buff Quarry	DUN			✓
Burton's Bridge			✓	
Carr Lane Brickworks	DUN	✓		
Cross Lane	DUN			✓
Former landfill (Hedco), West Bank Dock Estate	DUN	✓		
Foul Lane	DUN			✓
Gillmoss	Already developed		✓	
ICI C and P Muspratt Site	DUN	✓		
ICI Weston North Quarry	DUN	✓		
Johnson's Lane Tip	DUN			✓
Kirkby Moss			✓	
Lord St Helens Landfill Site	DUN			✓
Lyme and Wood Pits Country Park	DUN	✓		
Moreton Landfill Site	DUN	✓		
Project Perch	Site already being developed		✓	
Ravenhead Quarry NWDA - Waste Management	DUN			✓
Sefton Meadows – Site 1	DUN			✓
Sefton Meadows – Site 2	DUN		✓	
Town Lane	DUN	✓		
West Bank Dock Estate	Site with dev potential		✓	
Wirral Metropolitan College	Site already being developed		✓	
Wirral Waters Northbank	Site with dev potential		✓	

The economic, environmental and social benefits associated with energy projects are summarised in Figure 14 below:



Solar PV Projects



Energy Crop Projects

Solar PV Benefits

Energy security: The benefit to the wider economy arising from less dependency on fossil fuels resulting in potential Gross Value Added saved.

Social benefits: Fuel poverty is a significant issue nationally and the City Region. Energy projects provide opportunities to provide competitively priced energy that is not subject to the volatility of the markets.

Carbon savings: Energy projects can have an effect on carbon savings in terms of decarbonisation of the grid and the value of the carbon saved could be translated into a benefit through the avoidance of a cost;

Economic development: Energy projects have employment effects like other forms of investment in a local economy. In this study, analysis focused on the total number of jobs created expressed as Full Time Equivalent (FTE) and translated into the impact on Gross Value Added (based on GVA per job);

Avoided costs: Certain projects have the potential to avoid other costs associated with a conventional alternative. For example, it may be possible to forego grid connection costs;

Local Tax Revenue: Different projects will have a greater potential to generate local tax revenues mainly through the Business Rate; and

Other environmental benefits: Other environmental benefits relate to impacts like air quality where solar PV results in zero emissions.

Energy Crop Benefits

Strong commercial returns: Energy crops can offer better financial returns than conventional crops on non-prime land and a potential source of commercially viable revenue generation

Stable prices: More stable prices and long-term contracts compared with arable crops

Multiple markets: Can be used by large power stations or attract a premium through the local heat market. The crop can also be used for non-energy uses.

Flexible land use: Provides a more flexible land use than managed forest and woodland ensuring that land can be used for alternative uses once the lifecycle of a crop has ended. The crop can be produced on less fertile land meaning it does not occupy high-value agricultural land. Funding to deliver improvement management.

Form of Green Infrastructure that provides functions such as reducing surface run-off and biodiversity gains. Income generated could also assist in funding on-going and long term management of the land according to agreed site / project objectives.

Improve Site and Land Management

Figure 14: Summary of benefits for Solar PV and Energy Crop Projects

The delivery of energy projects in the City Region also assists the implementation of the Liverpool City Region Sustainable Energy Action Plan (LCR SEAP). Since its launch in 2012, the City Region has delivered various aspects of the SEAP. This has included a 'project pipeline' of renewable and low carbon energy projects across the City Region, with the assessment of solar PV potential and inclusion of viable project opportunities advancing the SEAP and project pipeline. Other renewable energy technologies such as wind or anaerobic digestion may also be suitable on some of the DUN sites or as part of an overall strategic approach to GI investment and development of the SIAs.

4.3 Assessing locations for Solar PV projects

A high level assessment of locations considered for solar PV projects was undertaken to understand the investment required and potential revenues that could be generated on sites from installing solar PV schemes. This was carried out using a technical and commercial model developed by Arup. However, it should be noted that in order to fully understand the potential of solar PV, each site will need to be subjected to an individual, in-depth feasibility assessment that includes detailed and consistent analysis, ground condition investigations and visual impact assessments.

The approach taken to identify sites for solar PV included the following steps:

1. Using the MEAS dataset which provided a long list of 58 DUN sites, including information on constraining factors for sites. *
2. Including further sites and buildings put forward by potential partners
3. Referencing constraints identified in the MEAS data set and a desktop analysis of the sites and application of technical and commercial models to understand which of those opportunities would be

technically feasible and commercially viable.

4. Estimating the revenues that could be generated from the renewables schemes and in doing so have an understanding of the proportion of those revenues that could be used to fund GI projects.

*Note: the MEAS database was prepared in conjunction with the City Region's Local Authority planning departments.

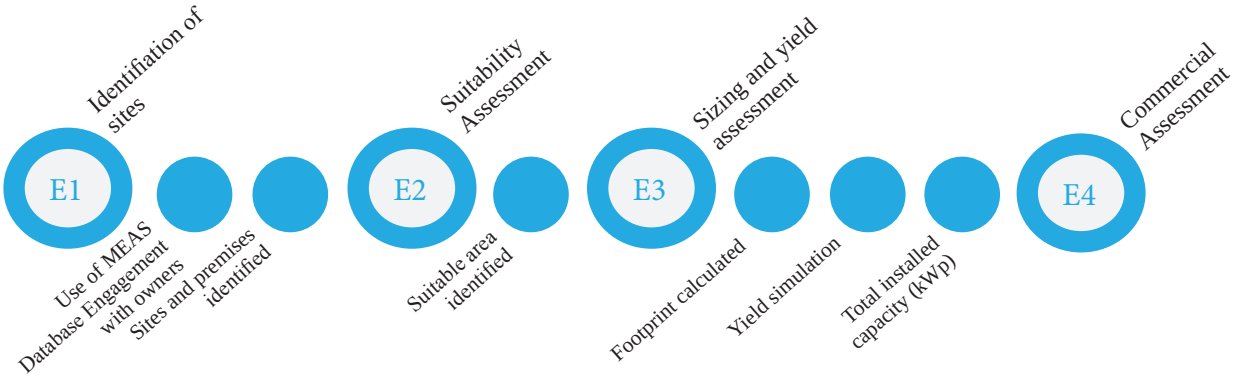


Figure 15: Summary of key stages undertaken to assess sites for solar PV potential and biomass production

Technical and commercial assessments were completed involving:

- Identification of sites and premises, with the aim being to get a good mix of locations across the City Region.
- Understanding the suitability of locations for solar PV arrays.
- Sizing the scheme and the potential yield, i.e. the amount of electricity it can produce.
- Undertaking a commercial assessment in order to understand the costs for designing, contracting, operating and maintaining the scheme

Key outputs from the site assessments are provided below. Further details of the methods used in site identification are presented in Appendix C.

Site analysis assumed the following:

- No shading issues.
- For roof mounted arrays, all electricity produced is consumed by the building that they are mounted on.
- For ground mounted arrays, all electricity generated is exported to the grid
- Feed in Tariffs (FiTs) and electricity tariffs are fixed at current market levels (i.e. December 2014).
- Only 80% of the site is available for PV use (due to access roads for ground mounted and mechanical plant for roof mounted).

- The occupancy ratio is 38.5%.
- Discount rate is 6.085%.
- Operational lifetime is 25 years.

A blended CAPEX rate (including grid connection costs) has been assumed in the modelling due to the limited information available on the sites. Grid connection costs are variable and in order to obtain costs a formal application to the DNO (ManWeb Scottish Power) is required. The blended CAPEX costs (£850/kWp) for the 5MWp schemes would generally hold up to a grid connection cost of between £50,000-£100,000 (or 2.5% of total CAPEX). If the grid connection costs were more than this then the business case would have to be altered.

Each of these factors was assessed at each site. Table 5 below sets out FiTs used in modelling and Table 6 sets out a summary of outputs provided from site identification assessments.

Installed Capacity	Lower Rate	Middle Rate	Higher Rate	Minimum Export Tariff
[kWp]	[p/kWh]	[p/kWh]	[p/kWh]	[p/kWh]
<4	6.38	12.49	13.88	4.77
4<capacity<10	6.38	11.32	12.57	4.77
10<capacity<50	6.38	10.54	11.71	4.77
50<capacity<100	6.38	9.31	10.34	4.77
100<capacity<150	6.38	9.31	10.34	4.77
150<capacity<250	6.38	8.90	9.89	4.77
>250	6.38	6.38	6.38	4.77
Standalone System	6.38	6.38	6.38	4.77

Table 5: Feed In Tariffs used for modelling valid between 01 January 2015 and 31 March 2015

Fifteen locations were prioritised for solar PV potential. The technical and commercial analyses undertaken identified that in order to deliver all 15 schemes a total investment of £36.8m would be required to deliver approximately 41MW of solar PV.

This capacity would generate over 33GWh of electricity per year (equivalent to supplying about 10,500 homes) and a saving of over 15 $ktCO_2$ a year resulting in a lifetime carbon saving in excess of 385 $ktCO_2$.

This would result in solar PV arrays that would generate an annual revenue in the order of £3.7m a year across 15 locations in the City Region.

A summary of the commercial performance that was carried out for the 15 locations assessed for solar PV is set out in table 6. It is important to note that no ESIF funding has been included in the investment and

33GWh of generation would provide electricity for approximately 10,500 homes based on an average power consumption of 3,200 kWh per home per year.

CO_2 savings were calculated using a carbon factor of 0.48 kg kWh of electricity.

revenue calculations because ESIF funding cannot be accessed alongside FiT payments in renewable energy schemes. However, ESIF funding could be used for site enabling works such as dealing with contamination. The requirement for this needs to be identified on a site by site basis. Further commercial analysis identified that 12 of the 15 sites assessed are likely to be commercially viable. The non-viable sites are Lord St Helens Landfill Site, Ravenhead Quarry and West Bank Dock Estate.

Figure 16: Location of sites assessed for solar PV potential

Site	Scheme Type	Total Install Capacity (MWp)	Theoretical Annual Electricity Generation (kWh)	Total CAPEX	First Year OPEX	First Year Revenues	Internal Rate of Return (IRR)	Net Present Value (25 Year)	LifetimeC:P Carbon Savings (CO_2 tonnes)	Ownership
Wirral Metropolitan College	Roof	0.0216	17,480	£43,200	£540	£2,066	7.14%	£3,942	204	Public
Project Perch	Roof	0.116	94,190	£209,520	£2,910	£9,739	7.59%	£27,575	1,100	Private
Foul Lane	Ground	3.33	2,730,600	£3,163,500	£59,940	£300,443	6.72%	£168,507	31,403	Public
Wirral Waters Northbank	Ground	1.55	1,271,000	£1,472,500	£27,900	£139,845	6.72%	£78,434	14,616	Private
Bramley Moore and Nelson Docks	Ground	2.49	2,041,800	£2,241,000	£44,820	£224,650	7.45%	£261,120	23,480	Private
Gillmoss	Ground	1.15	943,000	£1,092,500	£20,700	£103,760	6.72%	£58,190	10,840	Private
Johnson's Lane Tip	Ground	5.00	4,100,000	£4,256,000	£90,000	£451,120	8.25%	£795,660	47,150	Private
West Bank Dock Estate	Ground	1.50	1,230,000	£1,575,000	£27,000	£135,340	5.42%	-£86,890	14,150	Private
Kirkby Moss	Ground	5.00	4,100,000	£4,250,000	£90,000	£451,120	8.25%	£795,660	47,150	Private
Burton's Bridge	Ground	5.00	4,100,000	£4,250,000	90,000	£451,120	8.25%	£795,660	47,150	Private
Sefton Meadows	Ground	5.00	4,100,000	£4,250,000	90,000	£451,120	8.25%	£795,660	47,150	Public
Ravenhead Quarry	Ground	2.00	1,640,000	£2,000,000	36,000	£180,450	6.04%	-£7,320	18,860	Private
Lord St Helens Landfill Site	Ground	1.50	1,230,000	£1,575,000	27,000	£135,340	5.42%	-£86,890	14,150	Private
Buff Quarry	Ground	2.60	2,132,000	£2,470,000	£46,800	£234,590	6.72%	£131,570	24,520	Private
Cross Lane Site	Ground	4.60	3,772,000	£3,930,000	£82,800	£415,030	8.18%	£710,310	43,380	Public
Totals		40.8576	33,502,070		£736,410	£3,685,733		£4,441,188	385,303	

Table 6: Summary of the commercial performance of 15 locations investigated for solar PV

Figure 17 below summarises the proportion of the total £31.6 million required for 12 sites and the total £3.2 million annual revenue generated. It also shows a summary of the investment and breakdown of returns for publicly and privately owned sites.

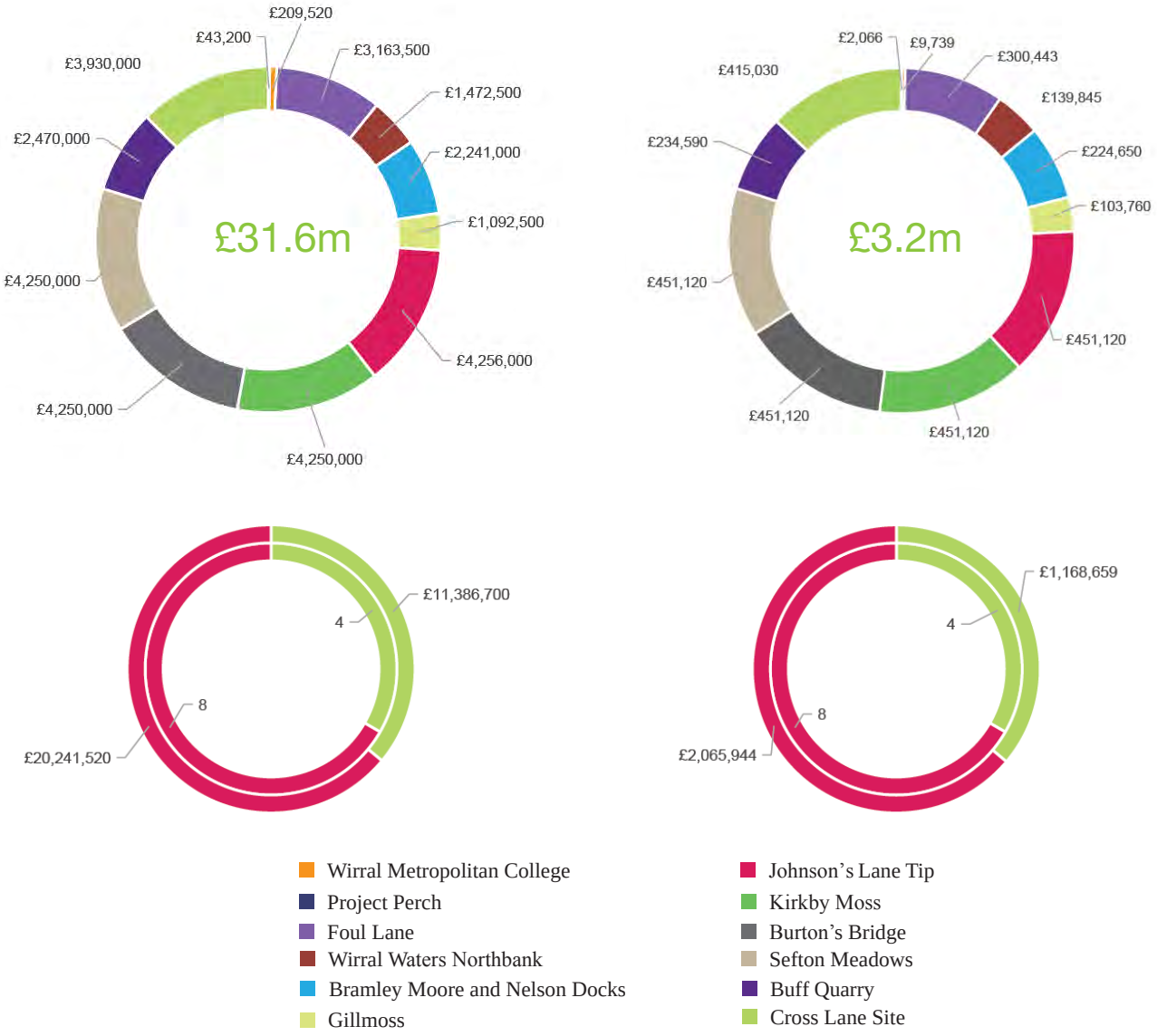


Figure 17: Estimates of total capital investment needed, annual revenues generated and apportioned to public and private land ownership

Table 7 details the issues considered in the technical and commercial assessment carried out for all 15 sites considered, while Figure 18 details the positive net present value identified for the 12 sites deemed to have potential commercial viability.

Site identification	Technical Assessment	Commercial Assessment
Schedule of sites and premises Plan of shortlisted sites and premises	Installed Capacity (kWp) Electrical Generation Potential (kWh/annum) Electrical Export (%) Lifetime Carbon Savings (Tonnes CO_2)	Capital Costs (CAPEX) Operational Costs (OPEX) Annual Revenues and Savings Simple Payback Period Discounted Payback Period Internal Rate of Return (IRR) Net Present Value (NPV)

Table 7: Summary of outputs produced from site identification, technical and commercial assessments

Figure 18 sets out the positive net present value identified for 12 sites deemed to have potential commercial viability.

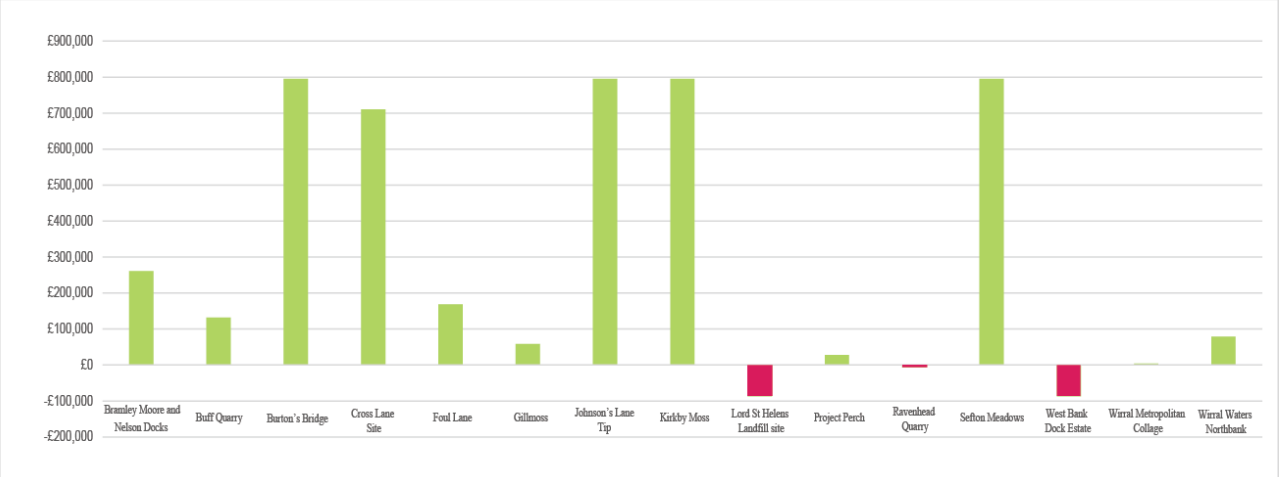


Figure 18: Positive net present value (25 years) of 12 of the 15 Solar PV sites

It is recommended that all schemes identified here are subject to detailed site investigation and that the commercial and technical information in this report is then revisited on a site by site basis. This will provide an understanding of the constraints of each site in detail, including any priority habitats that may be present, and may further reduce availability for on-site PV. Many sites are extensive and could potentially accommodate larger PV arrays than the conservative estimates of 5MW that were assumed in this study. It is also worth noting that while the costs for solar PV have been falling commensurate with a degression in the FiT, the City Region should be acting quickly to take advantage of solar PV opportunities and associated FiTs while they last.

Summary of findings for solar PV sites

- 12 sites identified to have commercial potential.
- 12 sites show positive Net Present Value of between £4k and £796k.
- Schemes range from 0.02MW to 5 MW in energy generation and £43k to £4.3m in costs.
- Lifetime carbon savings of 338 ktCO2
- Total investment of £31.6m
- Total revenues of £3.2m a year could be generated
- Internal Rates of Returns of between 6.72% and 8.25% are expected
- Analysis identified that generally the bigger the scheme, the better the commercial performance/ revenue generation and associated carbon savings
- Roof mounted schemes are a better option than ground mounted in terms of commercial performance due to better FiT rates; however this study has shown that there are fewer opportunities for large schemes to be created.
- FiT subsidies cannot be obtained, if public funding such as ESIF is used to fund/ part-fund an energy scheme instead private or other public sector investment must be found
- Both ground and roof mounted options provide potential to integrate with GI interventions to bring multiple benefits
- Ground mounted sites can be at risk should a site development opportunity come forward. They should ideally remain on site for a minimum of 15 years. This will ensure investment cost recovery.

Deploying renewables provides a mechanism to unlock under-used and derelict sites bringing sites back into economic activity and contributing to a whole place low carbon agenda. Greater value could be added via a City Region GI programme if some of the renewables' income was used to fund GI creation and management delivering functions such as enhanced flood protection or biodiversity and the associated job creation, health and well being benefits.

4.4 Assessing locations for energy crop projects

Energy crops are woody or herbaceous plants cultivated to produce biofuels for combustion to generate electricity and heat. They are a low-cost and low-maintenance crop and many of the herbaceous plants are grasses such as Miscanthus.

A high level assessment of DUN sites was undertaken to understand their potential for energy crop projects. It should be noted that in order to fully understand the potential of energy crops each site needs to be subject to a full economic feasibility assessment that includes site investigations.

The first stage of assessment involved reviewing DEFRA research[16] which has identified that Miscanthus crop production has the greatest potential in the City Region in terms of site suitability and revenue generation for a biomass capping.

The criteria used to determine suitability of sites for biomass cropping is summarised in Figure 19 below with a full description provided in Appendix D

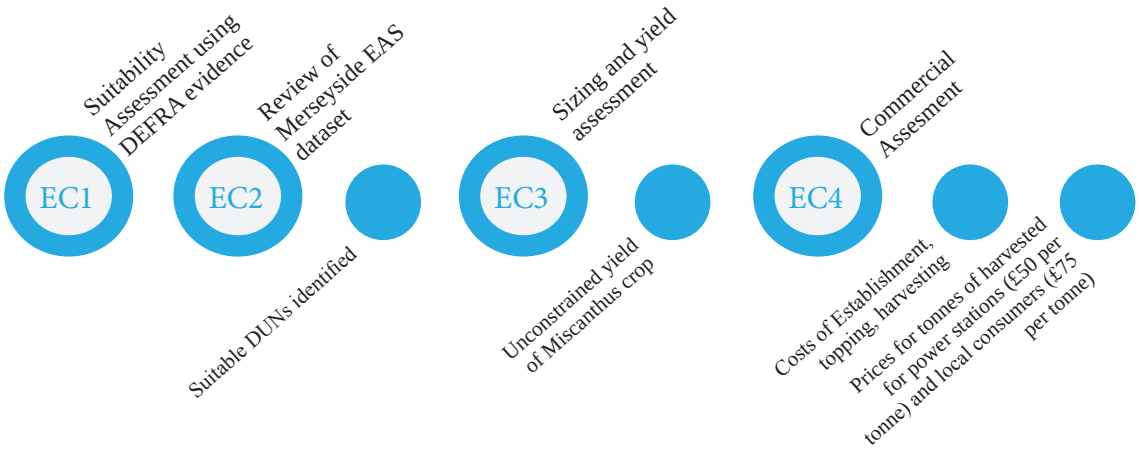


Figure 19: Summary of key stages undertaken to assess sites for Miscanthus production

Further assessment then established the 'unconstrained' potential for producing Miscanthus on 100% of each site. The optimal planting density for propagation is 15,000 to 20,000 plants per hectare, but this may vary from site to site.

A review of MEAS' DUN data base identified 17 locations totalling 413ha of land with the potential on which to crop Miscanthus. The majority of these locations are historic landfill sites.

16 http://webarchive.nationalarchives.gov.uk/20140605090108/http:/www.naturalengland.org.uk/ourwork/farming/funding/ecs/sitings/north_west_region.aspx

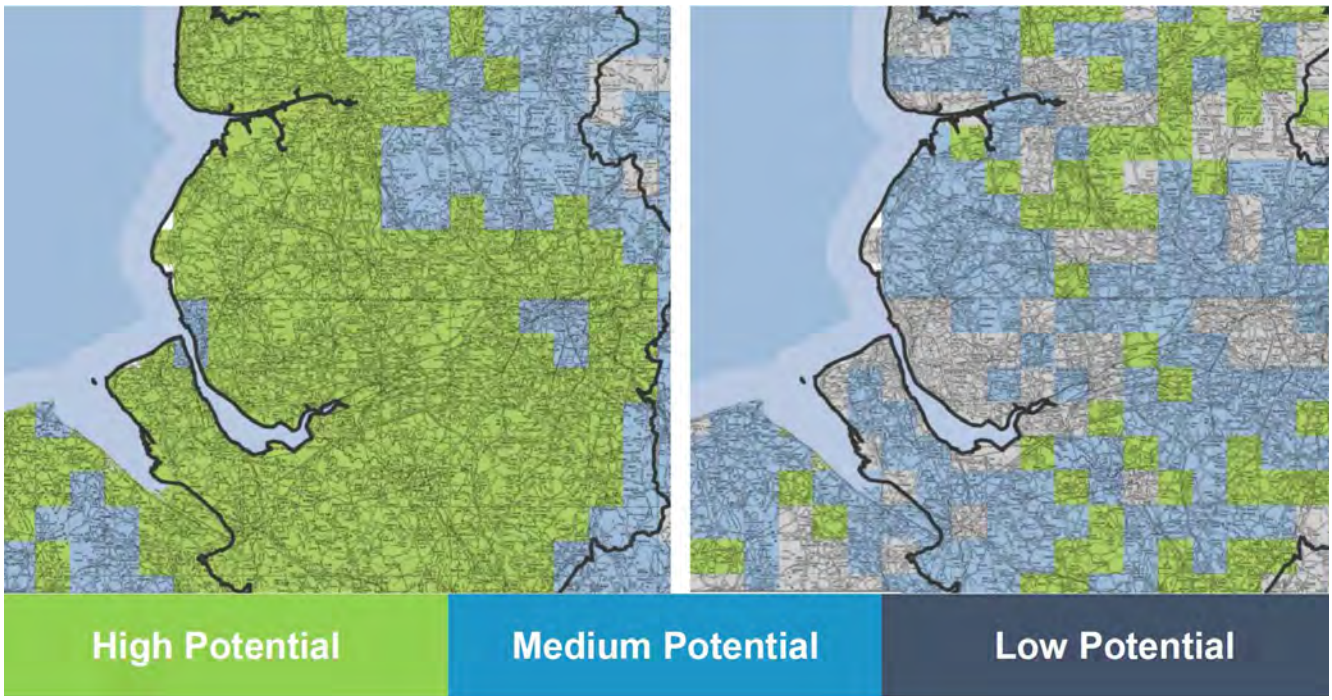


Figure 20: Maps produced by DEFRA that indicate the suitability of Miscanthus (left) and Short Rotation Coppice (SRC) (right)

Figure 21: Location of sites assessed for energy crop potential

Costs for the establishment of the crop, 'topping' the first year of growth and then subsequent harvesting of crops were calculated. From this an annual revenue was estimated for each site.

Cost and revenues where based on:

- Establishment costs of £2,000 per ha.
- 15,000 plants per ha.
- Harvesting costs of £200 per ha.
- An average yield of 15 oven dried tonnes (odt) per hectare.
- Costs of £50 per oven dried tonne (odt) for sale to power station and £75/odt for local consumers.

This is a high-level assessment and all sites will need to be subjected to a full economic feasibility assessment.

Table 9 sets out the sites and associated costs, yields, revenues and return on investment.

Site name	Owner-ship	AREA	Miscanthus Establishment costs per hectare (£2,000)	Total Plants	Miscanthus Harvesting Costs per hectare (£200)	Miscanthus Harvest Final Year Yield (15 oven dry tonnes/ per year / per hectare)	Miscanthus Final Year Harvest revenue (£50) per odt min	Miscanthus Final Year Harvest revenue (£75) per odt max	Revenues minus harvesting costs £50 odt min	Revenues minus harvesting costs £75 odt min
Johnson's Lane Tip	Private	18	£35,000	262,500	£3,500	262.5	£13,125	£19,688	£9,625	£16,188
Former landfill (Hedco), West Bank Dock Estate	Private	16	£32,400	243,000	£3,240	243	£12,150	£18,225	£8,910	£14,985
Foul Lane Landfill Site	Public	9	£18,200	136,500	£1,820	136.5	£6,825	£10,238	£5,005	£8,418
Ravenhead Quarry NWDA - Waste Management	Private	18	£35,600	267,000	£3,560	267	£13,350	£20,025	£9,790	£16,465
Buff Quarry	Private	7	£13,200	99,000	£1,320	99	£4,950	£7,425	£3,630	£6,105
Lord St Helens Landfill Site	Private	17	£33,800	253,500	£3,380	253.5	£12,675	£19,013	£9,295	£15,633
Cross Lane	Public	17	£33,200	249,000	£3,320	249	£12,450	£18,675	£9,130	£15,355
Kirkby Moss	Private	32	£63,200	474,000	£6,320	474	£23,700	£35,550	£17,380	£29,230
Lyme and Wood Pits Country Park	Private	111	£222,400	1,668,000	£22,240	1668	£83,400	£125,100	£61,160	£102,860
Sefton Meadows Ext No.1	Public	48	£96,200	721,500	£9,620	721.5	£36,075	£54,113	£26,455	£44,493
Sefton Meadows Ext No.3	Public	21	£41,800	313,500	£4,180	313.5	£15,675	£23,513	£11,495	£19,333
Moreton Landfill Site	Private	11	£22,200	166,500	£2,220	166.5	£8,325	£12,488	£6,105	£10,268
Bidston Moss Landfill Site	Public	33	£66,800	501,000	£6,680	501	£25,050	£37,575	£18,370	£30,895
ICI C and P Muspratt Site	Private	4	£7,600	57,000	£760	57	£2,850	£4,275	£2,090	£3,515
ICI Weston North Quarry	Public	7	£13,800	103,500	£1,380	103.5	£5,175	£7,763	£3,795	£6,383
Town Lane	Public	20	£40,200	301,500	£4,020	301.5	£15,075	£22,613	£11,055	£18,593
Carr Lane Brickworks	Private	25	£49,600	372,000	£4,960	372	£18,600	£27,900	£13,640	£22,940
Totals		412.6	£825,200	6189000	82,520	6,189	£309,450	£464,175	£226,930	£381,655

Table 9: Miscanthus sites, associated costs, yield, revenues and return on investment

A summary of capital costs and revenues for the 17 Miscanthus sites is set out in Figure 22 below:

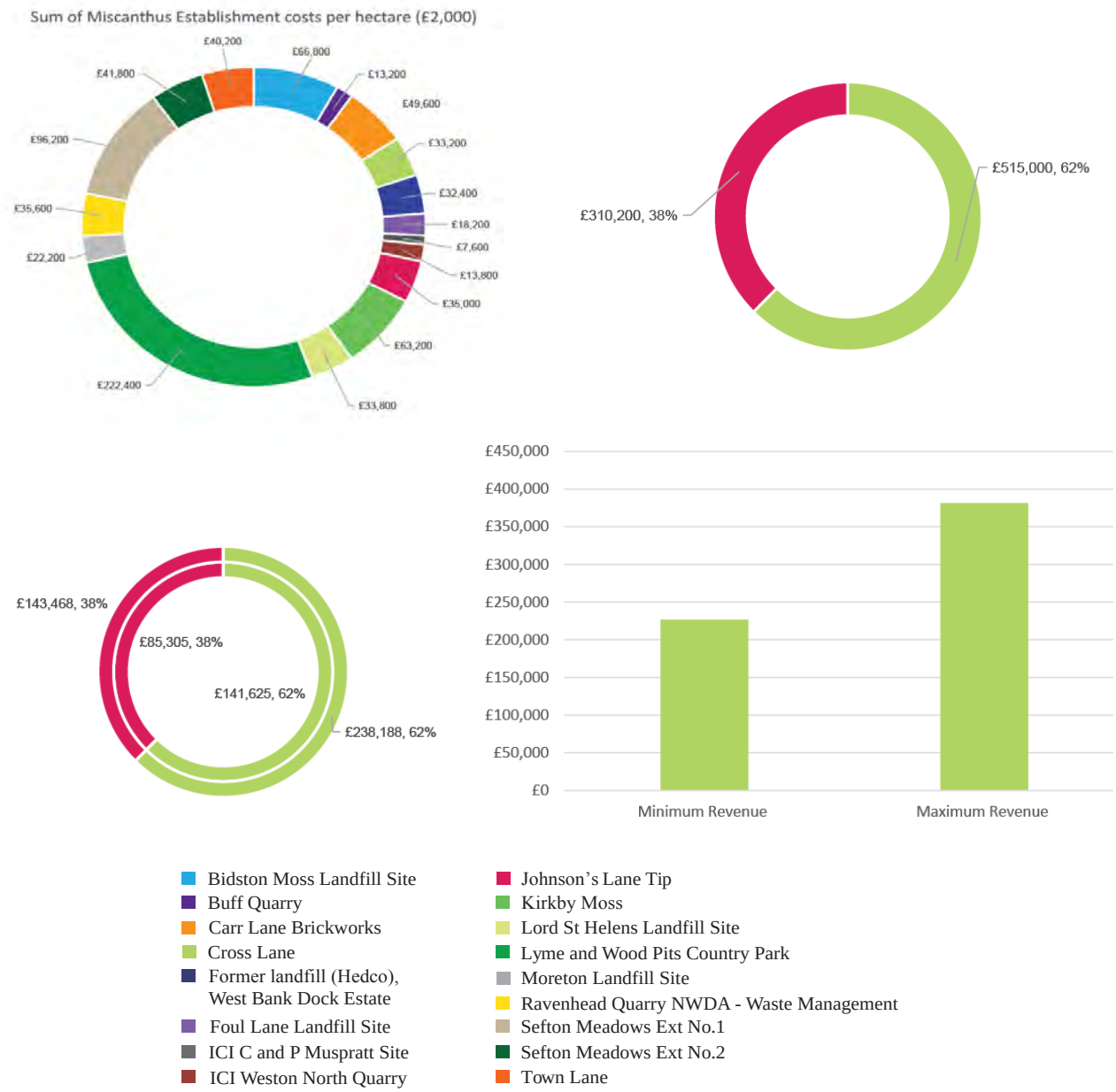


Figure 22: Assessments identified the total capital investment needed, and revenues generated as well as proportions based on public and private land ownership.

Summary of key findings for Miscanthus crop sites

- 17 locations amounting to 413 ha identified with commercial viability potential.
- The majority of sites assessed were historic landfill
- Ten of the locations assessed (59%) are in private sector ownership
- 62% of investment is on privately owned sites
- Capital investment total of £825k
- Total revenues between of £227k and £382k a year estimated
- Revenues on individual sites range between £2k and £61k a year
- IRR of 13% based on £50 per odt being achieved, increasing to 29% for £75 odt.
- Net Present Values range between £65k and £5.7m

4.5 GI solutions, Solar PV and Energy Crops summarised

GI sites, solar PV and energy crop sites have been mapped in combination to show location across the City Region and are summarised in Figure 23 below.

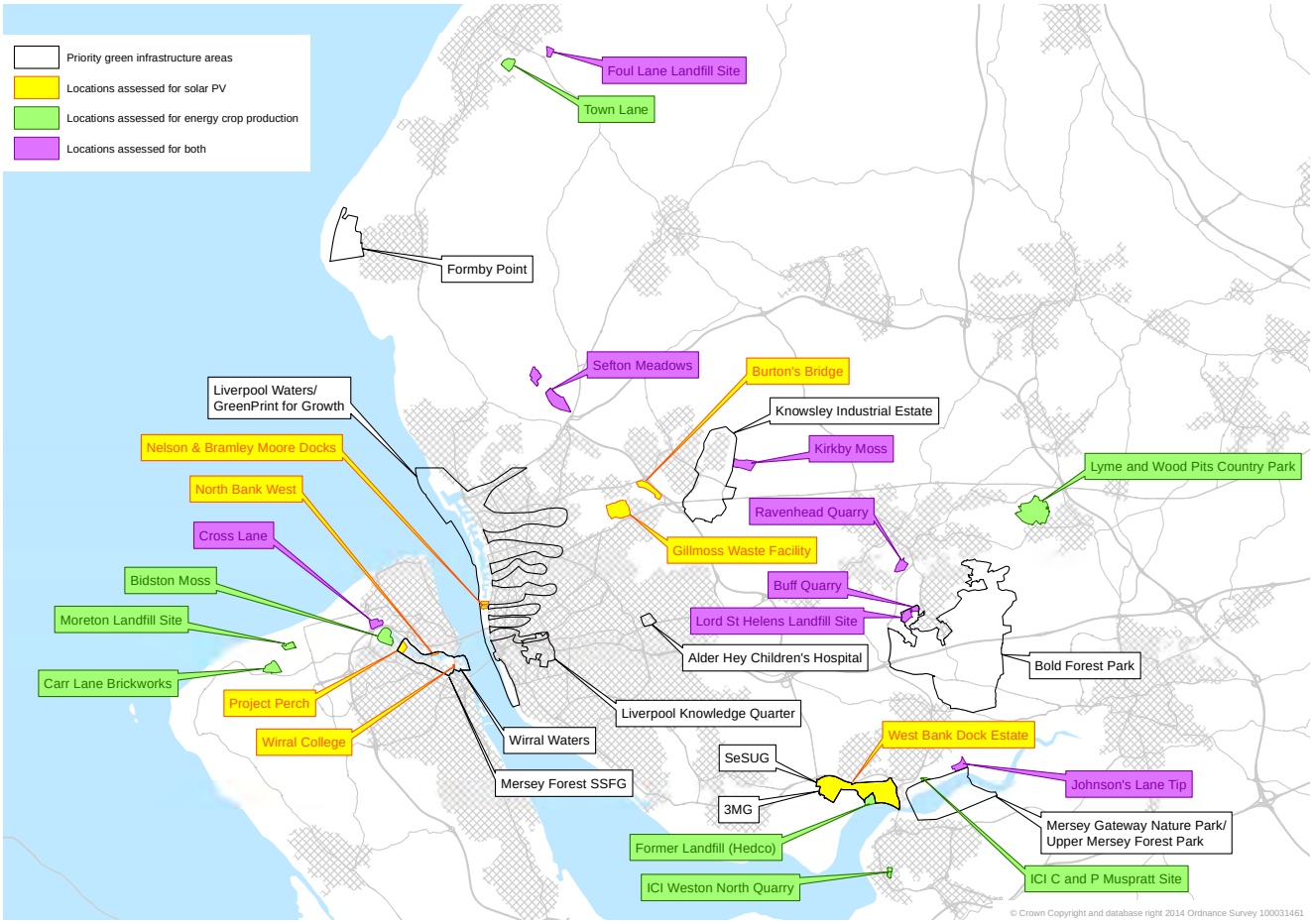


Figure 23: Locations of GI, solar PV and energy crop pipeline projects in the City Region

All commissionable sites and a summary of inputs and outputs are set out in Table 10 below for comparison.

Green Infrastructure	Solar PV	Energy Crops
• 11 locations • Area of Green Infrastructure created 91ha • Total number of pinch points addressed - 49 • Total Number of Jobs attributable to GI - 228 • Total Investment made by Investors - £163.7m • Attributable/match investment - £16.4m • Total Cost of GI Interventions (ESIF Investment) £10.8m • GVA from GI interventions - £17.9m • Property Value - £207.8m • Wider economic Value £176.1m • Cost per job - £47.6k • Cost per hectare - £118.9k • GVA/£ of ESIF- £2 • WEB/£ of ESIF - £16 • Leverage- £2	• 12 locations • Schemes range from 0.02MW to 5 MW in size and £43k to £4.3m in costs. • Lifetime carbon savings of 338 ktCO2 • Total investment of £31.6m • Total revenues of £3.7m a year • IRRs between 6.72% and 8.25% • NPVs between £4k and £796k	• 17 locations • Area of 413ha identified • Mainly historic landfill • Capital investment of £825k • Total revenues between £237k and £399k a year • On site revenues range between £2k and £61k a year • IRR of 13% • NPVs between £65k and £1.9m

Table 10: Summary of sites and associated inputs and outputs.

The following section discusses how the commissionable projects would be managed, what type of additional funding could be explored and sets out an estimated timeline for project delivery.

5.0 Programme Development

The purpose of this technical report and its accompanying Prospectus is to start the process of commissioning projects that use GI and renewables on DUN sites across the City Region to bring forward investment, jobs and growth. To develop this programme of projects it is recommended that an strategic alliance of organisations with an interest in project support and delivery is set up.

5.1 Green EnerGI

Green EnerGI – a strategic alliance of will bring organisations from the public, private and third sectors together to work collaboratively to link GI investments directly with built infrastructure across the City Region. Green EnerGI's strategic approach will accelerate project delivery, maximise economic, social and environmental outcomes as well as the economic value of projects.

There is already a track record of projects in the City Region where working in partnership has been very successful and has delivered valuable GI. These examples include the Atlantic Gateway Sustainability and Environment Group and The Mersey Forest's Green Streets.

Atlantic Gateway Sustainability and Environment Group

This group oversees the work on Atlantic Gateway (AG) Parklands and adds a new dimension to collaborative working across the Mersey Belt. For guidance it regularly brings together a sub-group of the AG board and draws upon the expertise of a wide range of organisations including: three Local Nature Partnerships; the Canal and River Trust; Groundwork; the Land Trust; Peel Group; United Utilities; Wildlife Trusts and, as a government Single Voice Pilot, all members of the DEFRA family. It has partnered project ranging in scale up to a £1 million in value.

The Mersey Forest's Green Streets

The Mersey Forest's Green Streets project is integral to the Peel Group's Wirral Waters scheme. Alongside the infrastructure of roads and utilities that accompanies new development will be a network of green infrastructure, turning a bleak urban landscape into one that is attractive, welcoming and colorful.

A network of tree-lined 'green streets' is just as important as the engineered infrastructure of roads and services and creating the conditions for economic growth. The Mersey Forest is planting relatively mature trees to ensure immediate impact. The project also links investment in green spaces, including the recently restored Birkenhead Park, as well as several smaller local parks and open spaces including the Forestry Commission owned Bidston Moss, a potential key recreational gateway to the area.

The overall programme, including complementary funding, includes street trees, the design of new green spaces, temporary uses of derelict sites and improved access to Bidston Moss is costed at £2m.

Using the Green Infrastructure Valuation Toolkit, it has been estimated that economic benefits worth £30m NPV, can be achieved through this investment, through a mix of: carbon reduction, rising land values, attracting visitors, creating jobs, and improving local health and wellbeing.

Suggested members of the Green EnerGI alliance are the organisations listed below who have, as part of this study, all been involved in discussions to identify sites and potential investments. This mix of private sector investors and public agencies has already expressed an interest in forming the Green EnerGI strategic alliance. Alliance membership should be flexible to allow new members to join so that additional sites for GI and renewables can be included at any time.

Nature Connected, the Government-approved Local Nature Partnership, will be a key alliance member. Nature Connected brings together a range of organisations working to embed the natural environment into policy and strategy at the City Region level. It is anticipated that the programme including all the projects identified through this research will continue to be coordinated jointly by the LEP and Nature Connected. This positive working relationship will be enhanced by the delivery of a live programme.

The Nature Connected Board may wish to consider acting as the formal coordinator of the partnership, using one of the board member organisations to act as accountable body or similar if needed.

It will be important that the GI prospectus and any projects proposals progressing through the EUSIF programme calls are co-ordinated as a City Region wide programme. Green EnerGI will therefore need to continue to develop strong relationships with the LEP, Nature Connected and also, the region's Combined Authority.

Alternatively, another organisations could act as lead with Nature Connected (as the environmental arm of the LEP), providing guidance and input to shape the submission to ensure that they are excellent examples of GI interventions that support sustainable development. There will be an onus on project partners to work together and drive the GI agenda.

5.2 Programme funding

Collectively the projects descibed in this document consitute a deliverable programme. Whilst a single commission for the programme would be the most efficient and effective way to procure the investments from a Strategic Alliance, it is likely that in realility that there will be a number of commissions but it is predicted that the biggest impact will be gained by coordination at a programme level. Also, that there may be other opportunities beyond ESIF to access funds that can support GI interventions in the SIAs.

It is recommended that the delivery partners in the Strategic Alliance are supported and guided by LEP and Nature Connected in the delivery of the programme through one or several commissions.

Further work is required to identify and explore these alternative funding sources. It is recommended that the Alliance explores the Community Environment Fund of Atlantic Gateway, and the recently launched Natural Capital Financial Instrument.

5.2.1 Community Environment Fund

Accessing new funds will require the Alliance to be flexible, to be able to shape the programme that has been developed effectively and to develop a mature partnership quickly so that trade-offs and long term plans can be discussed in a way that enables progress.

Atlantic Gateway's Community Environment Fund (CEF) is an innovative approach to stimulating environmental improvement directly linked to Atlantic Gateway Parklands strategic priorities. It has been supported by the Peel Group with an initial £290,000 and is open to all developers and businesses as a smart way of investing in the environment. The first projects have been in Liverpool City Region LEP (GreenPrint to Growth) and in Greater Manchester (Port Salford Greenway).

The concept of CEF is a voluntary levy of 1% on capital investment by partners in the Atlantic Gateway area. This is a contribution to environmental improvement for the benefit of local communities to ensure that they realise environmental gains as a positive contribution in addition to the economic advantages of development. An important aspiration of Atlantic Gateway Parklands will be to increase the funding available through CEF and then to deploy those resources to those projects / programmes with greatest impact and strategic fit. The GI prospectus programme is therefore well-positioned to take advantage of opportunity when they arises.

The Atlantic Gateway provides one option as it has the ability to hold public funds through its Accountable Body, Warrington Borough Council, and to disperse its own, and others, small grants to 'third sector' environmental organisations through its Community Environment Fund, held on its behalf by the Community Forest Trust.

5.2.2 Natural Capital Financial Instrument

Under the Natural Capital Financing Facility (NCFF)[17], the European Investment Bank (EIB) will provide loans and investments in funds to support projects which promote the preservation of natural capital, including

17 http://ec.europa.eu/environment/life/funding/financial_instruments/ncff.htm).

adaptation to climate change.

The main aim of the NCFF is to demonstrate that natural capital projects can generate revenues or save costs, whilst delivering on biodiversity and climate adaptation objectives. The NCFF is to establish a pipeline of replicable, bankable operations that will serve as a "proof of concept" and that will demonstrate to potential investors the attractiveness of such operations.

GI is identified as one of four potential areas for funding:

"GI can generate revenues or save costs based on the provision of goods and services such as water management, air quality, forestry, recreation, pollination and increased resilience to the consequences of climate change. Examples are green roofs, green walls, ecosystem-based rainwater collection / water reuse systems, flood protection and erosion control"

Developing work streams or work packages, similar to that developed in other EU Programmes such as Interreg, may be an effective way to match projects to funding opportunities.

This, and the funding approaches set out above, will need to be explored further as they are beyond the scope of this project.

5.2.3 Proposed funding mechanism

A suggested mechanism informed by the CEF model is that NCFF monies could be accessed by the Alliance to pay for GI interventions. This would match or be an addition to ESIF funding that had been accessed for GI or enabling works on sites. If the CEF model was used then the Community Forest Trust could be the agency that disperses this funding with Cheshire West Council acting as the accountable body.

Developers, landowners who are Alliance members and develop renewables projects could be persuaded to donate monies from the income generated from the sale of energy to pay back the loan granted from the NCFF. The collection of this levy/payback could be managed by the Community Forest Trust.

This suggested model and the funding approaches i.e. the CEF model and NCFF set out above will need to be explored further once the Alliance has been set up.

5.3 Jobs and health agenda

Developing GI and renewables across the City Region will bring job and training opportunities for those furthest from the job market.

The LWT/Groundwork partnership offers an approach to identify suitable job opportunities and also offer additional support to those with complex and/or health needs to maximise job retention rates.

There is increasing evidence of the value of green infrastructure based health products. Initiatives such as the Natural Health Service have shown that the significant health benefits it brings can be used to support people into work and whilst in work.

The Natural Health Service brings together organisations that deliver health products and activities, land owners and academics. A centre of excellence has been developed to accelerate the development of these health products, improve the evidence base and increase utilisation of the service. Incorporating the Natural Health Service into the delivery of this programme of green infrastructure will add significant value.

5.4 Timescale

The timelines below in Tables 11 & 12 set out proposed programmes for the GI and renewables projects identified in this study. It is also recommended that the Strategic Alliance set up as soon as possible to move projects forward and make submissions for ESIF funding.

	2015/16	2016/17	2017/18	2018/19	2019/20
SeSUG					
Alder Hey Children's Hospital					
GreenPrint for Growth					
Liverpool Knowledge Quarter					
Mersey Forest SSFG					
Mersey Gateway Nature Park/Upper Mersey Forest Park					
Wirral Waters					
Knowsley Industrial Estate					
3MG					

Table 11: Proposed timescale to develop prioritised GI projects

Site name	Potential Project	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020
Johnson's Lane Tip	Energy Crop					
Johnson's Lane Tip	Solar PV					
Former Landfill (Hedco), West Bank Dock Est	Energy Crop					
Foul Lane Landfill Site	Energy Crop					
Foul Lane	Solar PV					
Ravenhead Quarry NWDA - Waste Managem	Energy Crop					
Ravenhead Quarry	Solar PV					
Buff Quarry	Energy Crop					
Buff Quarry	Solar PV					
Lord St Helens Landfill Site	Energy Crop					
Lord St Helens Landfill Site	Solar PV					
Cross Lane	Energy Crop					
Kirkby Moss	Solar PV					
Kirkby Moss	Solar PV					
Lyme and Wood Pits Country Park	Energy Crop					
Sefton Meadows Ext No.1	Energy Crop					
Sefton Meadows Ext No.2	Energy Crop					
Sefton Meadows	Solar PV					
Moreton Landfill Site	Energy Crop					
Bidston Moss Landfill Site	Energy Crop					
ICI C and P Muspratt Site	Energy Crop					
ICI Weston North Quarry	Energy Crop					
Town Lane	Energy Crop					
Carr Lane Brickworks	Energy Crop					
Wirral Metropolitan College	Solar PV					
Project Perch	Solar PV					
Wirral Waters Northbank	Solar PV					
Bramley Moore and Nelson Docks	Solar PV					
Gillmoss	Solar PV					
West Bank Dock Estate	Solar PV					
Burton's Bridge	Solar PV					
Cross Lane Site	Solar PV					

Key to sites

Hybrid of crop and solar

Crop only

Solar only

Non-viable solar

Table 12: Proposed timescale to develop energy projects

6.0 Conclusions

This study has demonstrated how the assets of the natural environment can play a key role in developing a sustainable economy for the City Region and has set out a pipeline of commissionable projects in both GI and renewables at SIAs and DUN sites that will deliver whole place low carbon solutions. Opportunities are either GI projects, renewable projects or GI and renewables combinations. These have been identified by an evidence based assessment and this study has led to the creation of an innovative and replicable process. This report provides the technical background to an accompanying City Region GI Prospectus that highlights opportunities for investment in GI and renewables along with the benefits and added value.

Pinch point issues that reduce investability have been highlighted, together with interventions for each site/ area that can address these issues and increase investment returns. The findings show that GI planning and delivery, with renewable energy installations, can deliver whole place low carbon solutions and support the wider economy, improve investment opportunities, deliver jobs, urban resilience and sustainable communities.

Overall 40 projects across 32 sites have been shortlisted for GI and energy opportunities:

- 11 SIAs identified as priority GI project opportunities
- 12 locations identified for solar PV
- 17 locations identified for energy crop production

It has also been identified that GI and energy are readily integrated, and that there are potential opportunities for energy production to fund GI on sites. This approach is also in line with high level guidance from Europe on the incorporation of green infrastructure into ESIF. While this study focussed on renewable options of solar PV and biomass it is envisaged that, in the future, this will not provide other renewable technologies/integrated solutions if they are economically feasible.

Improving health and well-being is a critical element of the approach that is being promoted. Providing support through, e.g. the Natural Health Service, enables individuals to self-manage long term chronic illness. Improved health and wellbeing not only increases opportunities to gain employment in work it also increases productivity and the ability of individuals to stay in work, increasing their confidence, skills and knowledge.

This programme of commissionable projects will accelerate the delivery of investment that will lead to growth in terms of new jobs and GVA. The projects offer opportunities for linking health and well-being into the programme as essential components of sustainable growth and reduction in inequalities across the City Region.

Through this study a number of investment partners have been identified and engaged. They are very positive about partnering and are keen to develop Green EnerGI strategic alliance to unlock ESIF and explore other funding and investment mechanisms to progress the delivery of GI and energy developments across the City Region.

In addition match funding for GI planning and delivery for projects has been quantified and a timescale for project delivery has been set out.

There is a now a need to move to the next stage of commissioning for the GI work in particular, to ensure that the partners can see progress and the efficacy of the Green EnerGI new Alliance as well as prepare to access ESIF funding via a robust and transparent mechanism.

The need to capitalise on GI interventions and renewable energy sites opportunities is also pressing so that the benefits brought by these projects to the City Region can be realised to support growth and enhance economic prosperity as well as provide the City Region with an ability to compete nationally and internationally to attract further investment and a greater number of visitors and tourists.

Appendices

Appendix A

Understanding ESIF

A1 Understanding of the ESIF programme

In the City Region, the funding available from Europe in the new ESIF programme is to be targeted at five portfolios:

- Blue /Green Economy
- Business Economy
- Innovation Economy
- Inclusive Economy
- Place and Connectivity

The exact nature of the ESIF programme is still uncertain. It is likely that the management of the programme will be centralised, with calls for projects and programmes being issued by Government departments in consultation with local organisations, most likely LEPs.

The approach taken in this study is based on a strong evidence base and focuses on the achievement against the main programme outputs as set out in the ESIF, including:

- Enterprises supported
- New jobs created
- Amount of private sector funding levered
- Reduction in GHG emissions (Tonnes)
- Number of ESF beneficiaries / participants

Within the five portfolios there are a number of priorities and indicative strands of activity which will provide a framework for the development of the pipeline of projects that will emerge from this commission.

For example:

1. **Portfolio 1** Low carbon blue/green infrastructure. Support for knowledge and skills development to enable local people to take employment opportunities in the Low Carbon sector
2. **Portfolio 3** Social and Health Innovation
3. **Portfolio 4** Using the natural environment to improve health and employability
4. **Portfolio 5** Provides opportunity for the City Region to invest in green and blue infrastructure provision to support sustainable economic development, manage climate change and business resilience impacts and connect people to their places of work.

It is envisaged that projects will be developed that may cut across the several portfolio areas. This study has explored how this may be enabled and achieved through the planned Liverpool City Region ESIF procurement process so that the pipeline projects can be delivered without undue delay.

The programmes identified will deliver the cross-cutting priorities of sustainability, equality and social innovation.

Appendix B

Green Infrastructure Supporting Information

B1 Pinch points

This section presents a number of ‘Pinches’ the associated GI functions that would address the ‘Pinch’ and a description of the characteristics of locations where they exist.

Pinch	Function	Location of pinch points
Risk of inadequate non-potable water supply	accessible water storage	Parts of areas of search with little accessible water storage nearby (assume that they will all have strong need because they will all include important GI that will need to be irrigated)
Risk of inadequate non-potable water supply	water conveyance	Omitted due to lack of realistic risk
Risk of inadequate non-potable water supply	pollutant removal from soil/water	Parts of areas of search with little pollutant removal from soil/water within them/upstream and lots of polluted water within them
Risk of flooding	inaccessible water storage	Parts of areas of search with little inaccessible water storage upstream and a tendency to flood
Risk of flooding	accessible water storage	Parts of areas of search with little accessible water storage upstream and a tendency to flood
Risk of flooding	water interception	Parts of areas of search with little water interception within them/upstream and a tendency to flood
Risk of flooding	water infiltration	Parts of areas of search with little water infiltration within them/upstream and a tendency to flood
Risk of flooding	water conveyance	Parts of areas of search with little water conveyance within them/downstream and a tendency to flood
Risk of flooding	flow reduction through surface roughness	Parts of areas of search with little flow reduction through surface roughness upstream and a tendency to flood
Risk of loss of carbon storage	carbon storage	Parts of areas of search with lots of carbon storage (need is everywhere)
Risk of loss of biodiversity	habitat for wildlife	Parts of areas of search with lots of habitat for wildlife (need is within and near existing habitat)

Pinch	Function	Location of pinch points
Risk of loss of biodiversity	corridor for wildlife	Parts of areas of search with lots of corridor for wildlife (need is also near existing habitat)
Risk of urban heat island effect	shading from sun	Parts of areas of search with little shading from the sun and lots of people (especially vulnerable people)
Risk of urban heat island effect	evaporative cooling	Parts of areas of search with little evaporative cooling and lots of people (especially vulnerable people)
Risk of coastal storms	coastal storm protection	Parts of areas of search with little coastal storm protection near to the coast (all will include valuable assets)
Risk of poor air quality	trapping air pollutants	Parts of areas of search with little trapping air pollutants and lots of people and/or habitat for wildlife near main roads
Risk of soil erosion	soil stabilisation	Parts of areas of search with little soil stabilisation and lots of at risk soil and/or steep slopes
Risk to tourism growth	recreation - public	Parts of areas of search with little recreation - public nearby that is an attack brand (or equivalent)
Risk to tourism growth	recreation - public with restrictions	Parts of areas of search with little recreation - public with restrictions nearby that is an attack brand (or equivalent)
Risk to tourism growth	Heritage	Parts of areas of search with little heritage near heritage designations that is an attack brand (or equivalent)
Risk to tourism growth	cultural asset	Parts of areas of search with little cultural asset nearby that is an attack brand (or equivalent)
Risk of poor recreation resource	recreation - public	Parts of areas of search with little recreation - public nearby and lots of people (especially health-deprived people)
Risk of poor recreation resource	recreation - private	Parts of areas of search with little recreation - private and lots of people (especially health-deprived people)

Pinch	Function	Location of pinch points
Risk of poor recreation resource	recreation - public with restrictions	Parts of areas of search with little recreation - public with restrictions nearby and lots of people (especially health-deprived people)
Risk of poor green infrastructure support for heritage resource	Heritage	Parts of areas of search with little heritage near heritage designations
Risk of poor green infrastructure support for cultural resource	cultural asset	Parts of areas of search with little cultural asset nearby and lots of people
Risk of poor aesthetic	Aesthetic	Parts of areas of search with little aesthetic (all will have strong need)
Risk of little green travel	green travel route	Parts of areas of search with little green travel route nearby and high population gradient nearby
Risk of noise	noise absorption	Parts of areas of search with little noise absorption and lots of people near main roads, railways and airports

B2 Economic Benefits of Green Infrastructure

A summary of other significant economic benefits from GI is set out below:

B2.1 Green Infrastructure creates high-quality gateways to the City Region

Visual amenity of green space can create an attractive gateway to the City Region, which is often a good first impression for investors. Pleasant journeys to and from work also contribute to a higher quality of life of residents[18]. In the US, drivers' preference for roadsides increased with increased vegetation and greater height and density of trees, in particular, those that screened adjacent commercial land uses[19,20]. Commercial developments alongside major roads leading to the city, which contain trees, are generally preferred to both the developments without trees and the undeveloped agricultural land without trees.[21] In the UK, green commuting routes are

[18] Regeneris Consulting (2009). *The economic contribution of the Mersey Forest's objective one-funded investments*. Regeneris Consulting. Available at: http://www.merseyforest.org.uk/pages/displayDocuments.asp?iDocumentID=246.
[19] Wolf KL (2003) Freeway roadside management: the urban forest beyond the white line. Journal of Arboriculture 29(3): 127-136.
[20] Sullivan WC & Lovell ST (2006) Improving the visual quality of commercial development at the rural-urban fringe. Landscape and Urban Planning 77: 152-166.
[21] See 3.

preferred. The willingness to pay for woodland views on journeys to and from home has been estimated at £226.56 per annum per household (2003 prices).[22]

B2.2 Attracting investment and increasing employment

The presence of high-quality green space can improve the 'invest ability' of an area and its competitiveness as a business location.[23] A survey of real estate developers and consultants across Europe found that 95% of respondents believe that open space adds value to commercial property and would be willing to pay at least 3% more to be in close proximity to open space.[24] An example in returned investment in green infrastructure can be seen in Riverside Park Industrial Estate in Middlesbrough, where extensive planting of trees helped to create a setting for stimulating business growth, which attracted new, high profile, occupants; increased occupancy from 40% to 78%; levered over £1 m of private investment; and saw 28 new businesses and more than 60 new jobs.[25] Landscaping improvements in Portland Basin, Tameside and Winsford, Cheshire, yielded respectively over 16% and 13% of net growth in employment. [26]

B2.3 Green environment for retail

Green infrastructure can play a role in creating a pleasant environment in city centres that increases the footfall and revenue in retail areas. In a US study, presence of trees in central business districts was tied to more positive consumer experiences and a willingness to pay higher prices for goods and services (by ~11%).[27]

B2.4 Attracting and retaining skilled and productive workforce

Quality of life is becoming an increasingly important consideration in modern business location decisions, in particular for high-tech and knowledge industries. Cities with attractive parks and natural surroundings are more likely to attract knowledge workers[28].with regard to small businesses and individuals on high salaries, the quality of life becomes more important than remuneration[29]. Greener settings not only attract but also help to retain workers; businesses located next to just regenerated Glasgow Green recorded improved staff morale and staff retention rates due to the attractiveness of the location[30].

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[22] Garrod GD (2003) Landscape Values of Forests. Social & Environmental Benefits of Forestry Phase 2, Report to the Forestry Commission, Edinburgh. Centre for Research in Environmental Appraisal and Management, University of Newcastle upon Tyne.
[23] CABE (2004) The Value of Public Open Spaces. Commission for Architecture and the Built Environment, London.
[24] Gensler and Urban Land Institute (2011) Open Space: an asset without a champion? Available at: http://www.gensler.com/uploads/documents/Open_Space_03_08_2011.pdf
[25] CLES POLICY ADVICE. 2007. The Contribution of the Local Environment to the Local Economy presented to Groundwork UK.
[26] See 8.
[27] Wolf KL (2003) Public response to the urban forest in inner-city business district. Journal of Arboriculture 29(3): 117-126.
[28] Crompton JL (2007) Competitiveness: Parks and Open Space as Factors Shaping a Location's Success in Attracting Companies, Labor Supplies, and Retirees in de Brun C (Ed.) The economic benefits of land conservation. The Trust for Public Land, pp.48-54.
[29] See 11.
[30] Gen Consulting (2006) Glasgow Green Renewal Benefits Analysis. A report to Glasgow City Council. Gen Consulting, Glasgow.

Green infrastructure also improves productivity: office workers who enjoyed natural view out of the window reported fewer physical ailments and greater job satisfaction compared to those workers without a view.[31] Even the presence of office plants may increase the speed of completing tasks, lower the levels of stress and improve attention. [32]

B2.5 Higher property prices in greener areas

In London wards, on average a 1% increase in the amount of green space can be linked to a 0.3-0.5% increase in average house price[33]. In North West England, a view of a natural landscape added up to 18% to property, and residents in peri-urban settings are willing to pay £7,680 per household for views of broadleaved woods[34]. The development of a community woodland on the former Bold Colliery site in St Helen's has enhanced existing property values in the surrounding area by £15 million[35]. In Aberdeen, properties next to the park attract a premium of 0.4%-19% compared to a property located 450 m away from a park[36]. Trees have been reported to add between 4-25% to the total value of property, depending on their size, condition, location and species [37, 38.]

GI can play a part in generating value from new commercial development . A 2014, study considered a range of sites in the northwest and showed that developers who invest in quality buildings and the surrounding hard and soft landscaping can secure higher rents, around 20% above competing schemes [39]

Creating a resilient city region is a key issue. The 2009 Liverpool City Region Stern review identified climate change driven opportunities for jobs and business , but also highlighted the need for action to both mitigate GHG emissions and adapt to the inevitable impacts of climate change already locked into the climate system.

The evidence that GI can play a role in helping improve resilience is set out below under mitigation and adaptation headings.

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[32] Lohr VI, Pearson-Mimms CH & Goodwin GK (1996) Interior plants may improve worker productivity and reduce stress in a windowless environment. Journal of Environmental Horticulture 14: 97-100.
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[36] Dunse N, White M & Dehring C (2007) Urban parks, open space and residential property values. RICS Research Paper Series. RICS, London.
[37] Regeneris Consulting (2009) The economic contribution of the Mersey Forest's objective one-funded investments. Regeneris Consulting. Available at: http://www.merseyforest.org.uk/pages/displayDocuments.asp?iDocumentID=246.
[38] CTLA (2003) Summary of tree valuation based on CTLA approach. Council of Tree and Landscape Appraisers.
[39] BE Group (2014) Green Infrastructure – Added Value a report for Mersey Forest

B2.6 Mitigation

B2.6.1 Carbon storage and sequestration

Around 36.6 billion tonnes of potential CO_2 are stored in UK soils. Grassland and Arable soils provide the largest storage (due to their overall size)[40]. However, peatlands contain the highest concentrations of carbon and degraded peatlands release 2.8-5.8 million tonnes of carbon a year, making peat restoration a priority[41].

Saltmarshes are important for carbon storage and sequestration: returning 26 km2 of coastal land to intertidal area in Humber Estuary could result in storing about 800 tonnes of organic carbon and 40 tonnes of non-organic carbon.[42] The UK woodlands currently only hold as much carbon as the UK emits in one year of fossil fuel burning. However, an enhanced woodland creation programme involving planting 23,200 hectares could deliver abatement of approximately 15 mega tonnes of CO_2 per year by the 2050s[43] (10% of projected emissions at that time)[44]. Better management of woodland for fuel and timber can also reduce carbon emissions. Wood fuel is carbon neutral and timber can replace fossil fuel based products, such as building materials[45].

B2.6.2 Natural cooling and insulation

Green roofs act as effective insulators[46], reducing the requirement for both heating and air-conditioning. A study of wind sheltering by trees of a two storey office building in Scotland predicted a reduction of 400 kg/floor area on CO_2 emissions (if natural gas was used for the heating). [47]

B2.6.3 Reduced car travel

A study in Maastricht shows that the more parks people had within their neighbourhood, the more their commuted by bicycle[48]. In the UK, from a survey of 5844 respondents, 78% agreed with the statement 'Improved traffic free footpaths and cycle routes would encourage me to walk or cycle'.[49]

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[41] Thompson D (2008) Carbon Management by Land and Marine Managers. Natural England, Peterborough.
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[48] Wendel-Vos W, Schuit AJ, De Niet R, Boshuizen HC, Saris W & Kromhout D (2004) Factors of physical environment associated with walking and bicycling. Medicine and Science in Sports and Exercise 36: 727-730.
[49] GreenSpace (2010) GreenSTAT visitor survey system.

B2.6.4 Local food growing initiatives

About 50% of food consumed in the UK is from countries outside the UK[50] and nearly 90% of the UK's fruits are imported[51]. Food transportation accounts for one-quarter of all UK HGV vehicle mileage, and 10 M tonnes of CO_2 were emitted in the UK in 2002 as a direct result of food transportation[52]. A typical allotment plot for growing soft fruits, root vegetables, legumes, leafy greens and alliums provides a saving of approximately 1.5kg CO_2/m^2.[53]

B2.7 Adaptation

B2.7.1 Cooling the city

GI can significantly lower the temperatures in urban areas, thereby reducing the health risks to vulnerable people such as the elderly. Grassed surfaces in tree shade can be 15-20°C cooler than tarmac exposed to sun, and the air temperature in tree shade can be 5-7°C lower than in the sun.[54] Urban parks with dense vegetation are on average 1°C cooler than built-up areas during the day[55]. Research in Manchester suggests that a 10% increase of green space in densely built-up areas would reduce the urban heat island effect by 2.2-2.5% and would help to maintain the current temperatures at the end of the 21st century.[56]

B2.7.2 Managing the runoff

GI intercepts, infiltrates, stores and evaporates rainwater, thereby reducing the rate and volume of water entering drains and limiting the risk of them being overwhelmed during extreme rainfall. Runoff can be reduced by 60% by trees over hard surfaces and by nearly 100% by grassland[57]. A hectare of grassland and broadleaved woodland in the UK can evaporate, respectively, 3.4 and 4.0 million litres of water[58]. Modelling conducted in Manchester shows that adding 10% of green space can reduce runoff by 5-6%, and adding green roofs to all buildings in densely built-up areas could reduce runoff by 17.0-19.9%.[59]

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[50] Food Standards Agency (2010) Working together on imported food. FSA, London.
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[52] Department for Environment Food and the Rural Affairs (2005) A government report: The validity of food miles as an indicator of sustainable development. DEFRA, London.
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[56] Gill SE, Handley JF, Ennos AR & Pauleit S (2007) Adapting cities for climate change: the role of the green infrastructure. *Built Environment* 33: 115-133.
[57] See Ennos (2011)
[58] Hölzinger O (2011) TheValue of Green Infrastructure in Birmingham and the Black Country. The Total Economic Value of Ecosystem Services provided by the Urban Green Infrastructure. The Wildlife Trust for Birmingham and the Black Country.
[59] See Gill et al. (2007)

B2.7.3 Reducing the risk of river and coastal flooding

Trees increase the capacity of the soil to absorb water; a study in Wales found that infiltration rates were up to 60 times higher within native woodland compared to grazed pasture[60]; planting shelterbelts across the lower parts of grazed grassland sites could reduce peak flows by 13-48%[61]. A modelling study in Somerset showed that planting woodland along a 2.2 km grassland reach of the River Cary could reduce water velocity by 50%, increase the temporary water retention by 71% and delay the downstream progression of the flood peak by 140 minutes.[62] Salt marshes dissipate the wave energy before it reaches the shore: it has been estimated that an 80m wide zone of inter-tidal habitat fronting sea walls can save £4,600 per metre in sea defence costs.[63]

B2.7.4 Maintaining sustainable water supplies

Sustainable Urban Drainage Systems can also help to increase aquifer recharge through porous paving systems and detention ponds allowing water to reach the soil[64].

B3 Green infrastructure and health

LCR ESIF recognises that poor health found across the City Region is a brake on the economy, as well as being a social burden. There is a strong relationship between the health of individuals and communities and their economic status. Business and the wider economy prosper when their communities, employees and families are in good health and where there is less inequality.

"Our city faces some of the greatest health challenges in the country. It has some of the highest levels of deprivation and lowest levels of life expectancy. It has a high burden of disease and a relatively low take up of healthy lifestyles[65]."

Liverpool City Region has a history of leading the public health agenda[66], and maximising the use of the green infrastructure in the city can provide an additional element to support improving public health in the city. Liverpool is part of the "Healthy Cities" programme[67] and the "Zagreb Declaration"[68].

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[60] Bird SB, Emmett BA, Sinclair FL, Stevens PA, Reynolds A, Nicholson S & Jones T (2003) PONTBREN: Effects of tree planting on agricultural soils and their functions. Centre for Ecology and Hydrology, Bangor, Gwynedd.
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[65] Liverpool PCT (2009) Primary Care Trust Strategic Commissioning Plan 2009-2014
[66] http://www.liverpool.gov.uk/Images/tcm21-98273.pdf
[67] http://www.euro.who.int/healthy-cities
[68] WHO (2009) Zagreb Declaration for Healthy Cities: Health and health equity in all local policies

Liverpool City Region also celebrated the Year of Health and Wellbeing in 2010[69] and is currently running the Decade of Health and Wellbeing.

In 2012, the Natural Choices (http://www.merseyforest.org.uk/our-work/natural-choices-for-health-and-wellbeing/) programme in Liverpool showed how effectively a GI based programme could address health issues and enable opportunities for volunteering, skills development and paid work.

Independent assessment of the programme identified an 18% improvement in participant wellbeing, 867 volunteers recruited and135 people employed work in some of the most deprived parts of the city.

The Natural Health Service[70], a direct result of Natural Choices is looking to extend this work, continuing to maximise the value of green infrastructure across the city region for health, providing active travel routes to work and improved skills for future work. Increasing work with Liverpool and Liverpool JM Universities provides further opportunities for the city region to develop a centre of excellence in this area of improving health – with social, economic and environmental benefits.

GI can also address the negative health impacts of climate change by improving air quality, reducing flooding and providing urban cooling.

B3.1 Key health issues for Liverpool City Region

There are several key health issues across the Liverpool City Region[71]:

- Health deprivation and inequality
- High levels of coronary heart disease, obesity and diabetes
- High levels of people who feel in poor health and with poor mental health
- Low levels of physical activity
- Challenges associated with climate change

There is a correlation between low levels of GI and higher incidences of coronary heart disease, poor mental health and poor air quality. Many of the health issues for Liverpool such as high levels of poor mental health and obesity and coronary heart disease are highest in the Core Strategy Sub Areas of the City Centre and Inner Areas which account for areas with the lowest proportion of accessible GI.

B3.2 Health deprivation and inequality

Health inequalities are a symptom of other forms of inequity and unfairness in our society, and achieving health equity is therefore a matter of social justice[72]. It has been demonstrated that

[69] Liverpool PCT (2011) 2010 Year of Health and Wellbeing Evaluation Report
[70] http://www.naturalhealthservice.org.uk/
[71] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy Technical Document 2010. http://www.ginw.co.uk/liverpool/Technical_Document.pdf
[72] IHE (2010) the Mamot Review: Fair Society, Healthy Lives.

green space and green infrastructure improve mental and physical health and reduce health inequalities[73].

Improvements to access to green spaces could provide a preventive and synergistic approach to reducing health inequalities that has social, environmental and economic benefits[74].

There are 32 indicators shown in Liverpool's health profile[75], of these only six are better than the England average and the remaining 26 indicators are worse. Liverpool has amongst the highest mortality rates, lowest life expectancies and greatest health inequalities nationally.

Whereas in England the life expectancy rates are 79 years for males and 83 years for females in Liverpool, the life expectancy rates are less 76 years for males and 80 years for females and it is evident that health inequalities within Liverpool are high.

A male born in a disadvantaged ward can expect to live 10 years less than males born in the most affluent. This life expectancy gap for women is 9 years[76].

Similar to health inequalities, GI is not equally distributed across the city. For example, 22% of the Super Output Areas have 80% of the total accessible GI and some Super Output Areas have no accessible GI. The most affluent Super Output Areas of the city have 18% more GI than the most deprived. A UK study found that populations exposed to the greenest environments will have the lowest levels of health inequality related to income deprivation[77].

B3.2.1 High levels of coronary heart disease, obesity and diabetes

NICE guidance[78] [79] suggests that increasing physical activity can help to prevent or manage diseases including coronary heart disease, diabetes and obesity. In terms of cardio-vascular disease (CVD), residents of Liverpool's Picton ward are 2.5 times more likely to die of CVD than those in the more affluent ward of Mossley Hill[80]. The guidance also emphasises the importance of having high quality environments that encourage healthy lifestyles, creating opportunities to walk or cycle easily and in safety. Increasing physical activity levels in the population will help prevent or manage coronary heart disease[81]. Enhancing GI provision across Liverpool is a priority of the Green Infrastructure Strategy and targets areas of low GI health functionality[82].

Obesity is an increasing challenge in the UK and over half of all adults in England are now considered overweight or obese[83].

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[73] Mitchell R and Popham F (2008) Effect of exposure to natural environment on health inequalities: An observational population study. The Lancet 372 (9650):1655 – 1660
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[83] The NHS Information Centre (2007). Health Survey for England 2007.

It is predicted that by 2050, 60 per cent of adult men, 50 per cent of adult women and about 25 per cent of all children under 16 may be obese[84]. Lack of outdoor play[85] has been identified as a causative factor of the current high levels of child obesity[86]. In studies relating to obesity there is a positive association between access to greenspace and physical activity, weight and associated health conditions[87].

A study from the National Heart Forum[88] showed that if class inequalities in obesity were eliminated, obesity levels would decline, halving the NHS's 2009 obesity bill of £4.8 billion and reducing the 2025 estimate from £8.9 billion to £4.1 billion, given the predicted rise in obesity.

B3.2.2 Mental Health

There is strong evidence to suggest GI can help to support more active lifestyles and the evidence for positive impact on mental health problems is even stronger[89]. Across the UK, Mental health problems are increasing, it is estimated that 16 per cent of adults have mental health problems at any one time and it is estimated that around one in four people will suffer some form of mental illness at some point in their lives[90]. It is estimated the cost of mental health problems costs England over £77 billion per year[91]. Poor mental health is a significant cause of wider social and health problems[92], including: low levels of educational achievement and work productivity; higher levels of physical disease and mortality and poor community cohesion. In contrast, good mental health leads to better physical health, healthier lifestyles, improved productivity and educational attainment.

The Northwest Mental Health Survey 2009 showed that Liverpool had the highest reported levels of poor mental wellbeing and the lowest level of high mental wellbeing[93]. However the Northwest Mental Wellbeing Survey 2012/13 showed that Liverpool had improved and was just below the North West average[94].

There is a prevalence of low mental wellbeing in areas of higher deprivation, amongst racial minority groups and in older people. The incidence of poor mental health is not equally distributed across the city[95].

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[84] Butland, B., Jebb, S., Kopelman, P., McPherson, K., Thomas, S., Mardell, J., et al. (2007). Foresight. Tackling Obesities: Future Choices – Project Report. 2nd Edition. London: Government Office for Science.
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[87] Lachowycz K and Jones A (2011) Greenspace and obesity: a systematic review of the evidence. Obesity Reviews 12, e183–e189
[88] National Heart Forum (2010). Social Class and Obesity – Effects on disease and health service treatment costs. To be available at www.heartforum.org.uk
[89] O'Brien et al. (2010) Urban health and health inequalities and the role of trees, woods and forests in Britain: A review. Forest Research
[90] Department of Health (2009) The Future Vision Coalition
[91] The future vision coalition (2009). A future vision for mental health. http://tiny.cc/jSfWK
[92] Mental Health Foundation (2009). Mental health, resilience and inequalities. http://tiny.cc/xLQvl
[93] Northwest Public Health Observatory (2009) Northwest Mental Wellbeing Survey http://www.nwph.net/nwpho/NorthWestMentalWellbeingSurvey.pdf
[94] Public Health England (2013) Northwest Mental Wellbeing Survey 2012/13. http://www.nwph.net/nwpho/Publications/NW%20MWB_PHE_Final_28.11.13.pdf
[95] Liverpool PCT (2008) Mental Health Equity Profile for the Mersey Care NHS Trust catchment area

As the population of the city ages, an increase in mental health problems are anticipated, for example, Alzheimer's disease has been projected to rise.

Some of the areas of the Liverpool which have the highest levels of poor mental health are close to public parks and improving access could help with improving mental health[96]. In order to improve access to green spaces there should be an emphasis placed on design and quality. High quality green spaces benefit health inequalities due to increased usage as they have a positive perception and are perceived to be safe.

B3.2.3 Low levels of physical activity

According to the World Health Organisation, physical inactivity is now the fourth leading cause of death in the world and is now a greater risk factor than obesity. In the UK, about 70 per cent of the population are not active enough to maintain good health and in Liverpool, this figure is 86 per cent[97]. Within Liverpool nearly 50% of the population do not take part in any physical activity at all. People from low income households are the least likely to meet the recommended levels of physical activity. They are also the most likely to be sedentary – achieving less than 30 minutes of physical activity per week. For example, 44 per cent of women and 34 per cent of men in the poorest households in England are sedentary, compared to only 33 per cent of women and 28 per cent of men in the wealthiest households. These low physical activity levels are a significant cause of health inequalities, with inactive groups suffering poorer health and living shorter lives than the general population.

B3.2.4 Challenges associated with climate change

Climate change is a fundamental threat to health and wellbeing[98]. This has been highlighted in the Lancet and by the World Health Organisation. Like other health inequalities, poorer social groups are more likely to be more exposed to these risks, to have fewer resources to reduce the effects, and to lack insurance against them[99]. Health depends on a wide variety of determinants, and many of them such as temperature and pollution levels will be affected by climate change[100].

In the UK the positive effects of a warmer climate, such as a reduction in cold-related deaths, are likely to be outweighed by a series of negative impacts, such as[101]:

- an increase in heat-related deaths especially in vulnerable populations which are predicted to reach 20,000 a year in the UK by 2050 due to more frequent and severe heatwaves; in the northwest there were approximately 60 excess deaths in the heat wave of July 2006 which is approximately 15% above the baseline[102]
- increased cases of skin cancer and cataracts
- injuries and infectious diseases as a result of increased flooding; it is predicted that by 2080 over million people in the UK could be at risk from flooding

[96] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy
[97] Liverpool City Council (2014) Physical Activity and Sport Strategy 2014-2021
[98] IHE (2010) the Mamot Review: Fair Society, Healthy Lives.
[99] Sustainable Development Commission (2010) Sustainable Development: The Key to Tackling Health Inequalities
[100] Sustainable Development Commission (2008) Healthy Futures: The NHS and Climate Change
[101] Sustainable Development Commission (2008) Healthy Futures: The NHS and Climate Change
[102] Department of Health (2010). Heatwave plan for England.

- anxiety and depression linked to physical and economic insecurity
- respiratory disease, insect-borne disease, and food poisoning are also expected to increase.

GI can improve air quality and reduce noise that can lead to stress and poor health. Green spaces can mitigate the negative health impacts of climate change by reducing the urban heat island effect and the impact of flooding. Both of these risks pose risks to health in the city and region and widen already existing health inequalities.

There is a close relationship between the challenges of climate change and the challenges of health inequalities. Both health inequalities and the negative impacts of climate change give extra urgency to putting sustainable development at the heart of creating a fairer society[103].

B3.3 Green infrastructure benefits for health

The Liverpool Green Infrastructure Strategy sets out a vision for green infrastructure in the city which states:

'Green infrastructure is planned in Liverpool to support a safe, more inclusive, sustainable and enjoyable city; to provide essential life support functions for a world class city that is adapted to climate change and where healthy living is a natural choice'[104].

One of the key priorities in the strategy is relate to providing natural choices for health and evidence points to six main areas of health benefit that can be achieved through green infrastructure planning, management and delivery[105]:

- Increasing physical activity
- Improving mental health
- Social cohesion
- Natural Health Service
- Creating high quality environments
- Addressing the impacts of climate change

B3.3.1 Economic impact of Green Infrastructure on the health agenda

Poor health also has an economic cost and the Health is Wealth Commission set out the challenge of poor health in the City Region, and called for a greater use of the natural environment as a part of the solution[106].

Healthier employees benefit their employers through:

- Reduced absenteeism

[103] IHE (2010) the Mamot Review: Fair Society, Healthy Lives.
[104] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy
[105] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy Technical Document 2010. http://www.ginw.co.uk/liverpool/Technical_Document.pdf
[106] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy Technical Document 2010

- Lower turnover rates
- Improved productivity and employee morale
- Lower health care costs[107]

The benefits of reducing health inequalities are economic as well as social. The cost of health inequalities can be measured in both human terms such as lost years of life and active life, and in economic terms including the cost to the economy of additional illness. The estimated costs of these illnesses accounts, per year, for productivity losses of £31–33 billion[108] and lost taxes and higher welfare payments in the range of £20–32 billion[109].

Mental health problems are estimated to cost the economy £23 billion[110] a year in lost output. However, the application of monetary valuation to mental health is less well established, particularly compared with the valuation of mortality risks therefore may be harder to put into formal decision-making tools such as cost-benefit analysis[111].

In the Liverpool City Region, health has a direct economic impact illustrated by the following examples:

- The estimated healthcare costs of inactivity as a contributing factor to five major diseases has a value of almost £11 million annually to the NHS, This excludes additional costs from mental health and the cost to the economy due to time off work or the increase in social care budget.
- An intervention of £1 million a year to increase by 50% the number of people walking between 10 minutes a day to 20 minutes a day then using the World Health Organisation HEAT Model we can calculate that 29 lives would be saved each year. The value of a statistical life in the EU is £1,574,000 so the annual benefit averaged over 5 years is £9,733,000.
- Walking and Cycling are two of the most cost effective interventions to scale up levels of physical activity.

If 1% of Liverpool residents i.e. (4,950) received cycle incentives to increase cycling levels these can cost as little as £50, the average annual health benefits over ten years would be £370,440 per person. Research by Sport England[112] estimates that the cost of poor health due to lack of exercise could be as high as £6.5bn per year to the national economy. The same report estimates that a 10% reduction in those aged 16+ who are sedentary would benefit the economy by £500 million a year in reduced NHS costs, and increased economic output due to lower ill health and absence from work.

The availability of high quality GI and its use for physical activity could offer significant health care benefits and savings.

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[107] Sustrans (2008) Active Travel and healthy workplaces: Sustrans Information Sheet FH06
[108] Frontier Economics (2009) Overall costs of health inequalities. Submission to the Marmot Review. www.ucl.ac.uk/gheg/marmotreview/Documents
[109] Frontier Economics (2009) Overall costs of health inequalities. Submission to the Marmot Review. www.ucl.ac.uk/gheg/marmotreview/Documents
[110] The Sainsbury Centre for Mental Health (2003) Policy Paper 3: The Economic and Social Costs of Mental Illness
[111] TCPA (2014) Planning for public health
[112] Sport England (2002) A Strategy for Delivering Sport and physical Activity

B3.3.2 Increasing physical activity

Increasing physical activity is a priority for Liverpool[113]; studies have demonstrated a positive relationship between green space and population health[114]. For example, a study in the UK found. A higher proportion of green space in an area was generally associated with better population health". A Natural England study[115] showed that:

- People who live furthest from public parks were 27% more likely to be overweight or obese.
- Children able to play in natural green space gained 2.5 kg less per year than children who did not have such opportunities.
- 1,300 extra deaths occur each year in the UK amongst lower income groups in areas where the provision of green space is poor.

The Liverpool Green Infrastructure Strategy suggests there is an additional positive benefit of a walk or run in a natural environment in comparison to a synthetic environment[116]. In order for people to use green spaces for physical activity there is a need for safe access to high quality green infrastructure[117] which promotes high levels of physical activity[118] [119] and lower levels of obesity within communities[120]. Creating high quality environments is discussed further in Section B3.3.5.

Outdoor play is a vital part of childhood[121]. Lack of outdoor play[122] has been identified as a cause of increased mental health problems amongst children and young people[123] and the high levels of child obesity[124]. Access to green spaces improves concentration in children with attention deficit disorder[125] and has been shown to enhance the emotional development of schoolchildren[126].

There is a great deal of evidence on the health and wellbeing value of children playing in a natural setting; this was particularly noted in a review of natural play commissioned by the Children's Play Council, Play Naturally[127], and in Natural Thinking by William Bird for the

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[113] Liverpool Clinical Commissioning Group (2014) Healthy Liverpool Prospectus for Change
[114] Mitchell & Popham (2007) Green space, urbanity and health: relationships in England
[115] Natural England (2009) Green Space Access, Green Space Use, physical activity and overweight: a research summary.
[116] Bowler D, Buyung-Ali L, Knight T and Pullin A (2010) A systematic review of evidence for the added benefits to health of exposure to natural environments. BMC Public Health 10 (456) 1-10
[117] National Heart Forum (2007). Building health: Creating and enhancing places for healthy, active lives. London: National Heart Forum.
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[121] Department for Children, Schools and Families (2007). The Children's Plan: Building brighter futures. Norwich, UK: The Stationary Office
[122] Play England (2007). Play day 2007: Our Streets Too! Street Play Opinion Poll Summary. ICM.
[123] Mental Health Foundation (1999). Brighter Futures: Promoting Children and Young Peoples Mental Health.
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[127] Lester, S. & Maudsley, M. (2006). Play Naturally: A Review of Children's Natural Play. Commissioned by the Children's Play Council. London: National Children's Bureau.

RSPB[128]. Recent research in the USA has studied the effect of neighbourhood greenness on two-year changes in the body mass index of children and young people, finding that greenness is inversely associated with BMI. This study supports the exploration of the promotion and preservation of green space within neighbourhoods as a means of addressing childhood obesity[129].

Evaluation of the national Green Gym scheme concluded that the overall physical health status of participants improved significantly, with a stronger effect for people with the poorest physical and mental health[130].

In addition to this evidence directly relating to health inequalities it appears that green space is particularly influential on conditions which are significant contributors to health inequalities, such as obesity, circulatory disease, mental health, chronic stress and asthma[131]. The increased level of physical activity associated with green space also has mental health benefits[132].

B3.3.3 Improving mental health

Medical literature on the relationship between nature and wellbeing focuses on psychological health however the perceived greenness of a neighbourhood is more strongly associated with mental health than it is with physical health[133].

There is a strong correlation between physical activity and mental health[134] [135], but studies also suggest that exercising in green spaces can have more positive mental Health than other kinds of exercise[136]. A study by Mind found that self-esteem levels increased and depression levels decreased following a green walk[137]. Green gyms have been shown to result in positive physical and mental health outcomes[138]. The increased physical activity and social cohesion[139], associated with access to green space are known to increase resilience to stress.

There are a range of other mental health benefits attributed to interactions with natural environments including reduced anxiety, self-esteem, improved mood, academic performance and cognitive function. These benefits can come from both passive interaction such as views of green space and active interaction. There is evidence that the visual presence of natural views is enough to have a positive effect on stress levels and can promote a reduction in blood

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[128] Bird, W. (2007). Natural thinking. RSPB. http://tiny.cc/8X27v
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[130] BTCV (2008). BTCV Green Gym national evaluation report: Summary of findings 2008. http://tiny.cc/X89Vh
[131] Mental Health Foundation (2009). Mental health, resilience and inequalities. http://tiny.cc/Bxp5x
[132] Mind (2007). Ecotherapy: The green agenda for mental health. http://tiny.cc/KryDO
[133] Sugiyama T, Leslie E, Giles-Corti B and Owen N (2008) Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships? Journal of Epidemiology and Community Health 62 (5) e9
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[137] Mind. (2007). Ecotherapy: the green agenda for mental health. http://tiny.cc/KryDO
[138] BTCV (2008). BTCV Green Gym national evaluation report: Summary of findings 2008. http://tiny.cc/X89Vh
[139] Kuo, F.E., Sullivan, W.C., Coley, R.L. & Brunson, L. (1998). Fertile ground for community: Inner-city neighbourhood common spaces. American Journal of Community Psychology, 26:825-851

pressure[140]. A number of hospitals around the world including Alder Hey in Liverpool have ensured that wards have views of the natural environment[141]. The aim is to improve rates of recovery and quality of life of patients as well as reducing time spent in hospital, releasing more beds and improving the "productivity" of the hospital.

B3.3.4 Social Cohesion

Natural spaces offer opportunities to facilitate higher levels of social contact and social integration[142], particularly in underprivileged neighbourhoods[143]. Studies have shown that access to a natural environment provides a meeting place for all ages and has a positive effect on social interaction and cohesion for different age groups[144].

The presence of nearby natural spaces has also been related to reductions in crime due to stronger social connections[145]. Community gardens and green activities linked to clubs or groups have been shown to provide opportunities for socialising, helping to strengthen neighbourhood ties[146].

Building communities through participation in local nature activities has also been shown to increase a sense of community strength and pride[147].

B3.3.5 Creating high quality environments

Providing more green spaces is not enough, it is imperative attention is given their design and quality[148]. Vulnerable groups such as children and older people in particular often feel excluded from public spaces and high quality design and proximity to homes can improve the use of green spaces. CABE has suggested that there is a virtuous circle: where people perceive green space quality to be good, they are also more satisfied with their neighbourhood and have better health and wellbeing[149].

A barrier to choosing healthy lifestyles is linked to availability but is also reliant on perception. The City Centre and Inner Area[150] also have the highest levels of derelict land providing opportunities for interim uses that could help to improve health and improve the image of these areas to increase levels of physical activity.

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[140] DEFRA (2010) Benefits of Green Infrastructure
[141] Whitelaw et al. (2008) Physical activity and mental health: the role of physical activity in promoting mental wellbeing and preventing mental health problems: An evidence briefing. Edinburgh: NHS Scotland
[142] Sullivan, W.C., Kuo, F.E. & Depooter, S.F. (2004). The Fruit of Urban Nature: Vital Neighbourhood Space. Environment and Behaviour, 36(5):678-700.
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[144] Bird, W. (2007). Natural thinking. RSPB. http://tiny.cc/8X27v
[145] Kuo, F.E. & Sullivan, W.C (2001) Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Environment and Behaviour; 33(3):343-367.
[146] Maller, C., Townsend, M., Pryor, A., Brown, P. & St Leger L (2006) Healthy nature people: 'contact with nature' as an upstream health promotion intervention for populations. Health Promotion International, 21: 45-54.
[147] Inerfield, R., & Blom, B (2002) A new tool for strengthening urban neighbourhoods. Journal of Affordable Housing, 11:128-134
[148] CABE (2009) Future health: Sustainable places for health and well-being. London: CABE. http://www.cabe.org.uk/files/future-health.pdf
[149] CABE (2010) Community Green: using local spaces to tackle inequality and improve health
[150] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy

The Sustainable Development Commission[151] identified green space as a priority areas due to the positive effects of increased time spent in green spaces. The key challenges are creating safe, welcoming, interesting and free places to play in residential communities. Increasing the amount of green infrastructure or improving its quality can have positive physical and mental health benefits[152].

B3.3.6 Addressing the impacts of climate change

The creation of sustainable places and communities should be supported by the mitigation of climate change and have an integrated policy agenda with health[153]. Access to good quality green space contributes to reducing health inequalities as well as helping to create sustainable communities. Policies concerning sustainable places and communities and should include strategies to improve diet, physical activity, and mental health. Measures intended to respond to climate change must not widen health inequalities[154].

The North West Green Infrastructure Prospectus[155] includes building greater resilience to climate change as one of five essential actions for Northwest England. Green infrastructure networks reduce urban temperatures and improve drainage, reducing the risks to health associated with heat waves and flooding[156].

[151] Sustainable Development Commission (2007). Every Child's Future Matters. http://tiny.cc/i6Fxz
[152] Mersey Forest Trust (2010) Liverpool Green Infrastructure Strategy Technical Document 2010.
[153] IHE (2010) the Mamot Review: Fair Society, Healthy Lives.
[154] Porritt J, Colin-Thomé D, Coote A, Friel S, Kjellstrom T, Wilkinson P (2009) Sustainable development task group report. Task group submission to the Marmot Review.
http://www.ucl.ac.uk/gheg/marmotreview/Documents/Sustainable_development_report
[155] Natural Economy Northwest (2010). Green Infrastructure Prospectus. www.ginw.co.uk/resources/Prospectus_V6.pdf
[156] IHE (2010) the Mamot Review: Fair Society, Healthy Lives.

Appendix C

Energy Assessment Methodologies

C1 Solar Assessments

C1.1 Phase 1

C1.1.1 Identification of sites

The study has considered a diverse cross section of sites and buildings to understand what can be achieved in terms of energy generation and commercial performance. For this project two simple approaches were used to identify sites:

1. Direct engagement with developers and landowners
2. Use of established datasets with information on sites including:
    - Strategic Investment Areas that form the LEP's Growth Plan
    - DUN sites identified and assessed by the MEAS

A long list of DUN sites was reviewed a short-list sites that could be assessed for potential to deliver commercial scale photovoltaic schemes. Engagement with developers also highlighted two rooves with potential for solar PV. These sites were then subjected to a suitability assessment.

C1.1.2 Suitability Assessment

The suitability assessment involved establishing the area available for PV. This involved investigating the size and shape of land/ roof area to understand the potential configuration of a PV array. The topography, built and natural environment was also assessed to understand how the array would be constructed if any critical issues regarding shading were identified. The assessment then considered the type of PV modules and inverter that would be used, potential cable routes, as well as access and maintenance issues.

Assessments involved calculation of:

- Area available for PV
- Area of PV installed
- Type of PV module
- Fixing and support details for PV modules
- Inverter selection and location
- Cable routes from inverters to switch room and/or meter room
- Connection to electrical installation
- Access issues
- Maintenance issues

C1.1.3 Sizing and yield assessment

A technical assessment was then undertaken that investigating the shape and size of areas planned for a PV array in more detail. An outline scheme set out and from this the generation potential in kW/m^2 estimated. Optimising the return on investment is a key driver and provided the basis for undertaking a yield assessment.

A yield assessment using long term solar irradiance data and analysis to determine optimisation to involve maximum installed capacity. To do this industry standard software was used which considered a range of issues that can impact on the performance of a PV array. For example, reflection losses, irradiance level losses and shading losses.

The outputs of the suitability, sizing and yield assessments provide key indicators to the technical and commercial performance of each array.

Return on investment is a key priority and driver for the PV system and the following criteria was modelled:

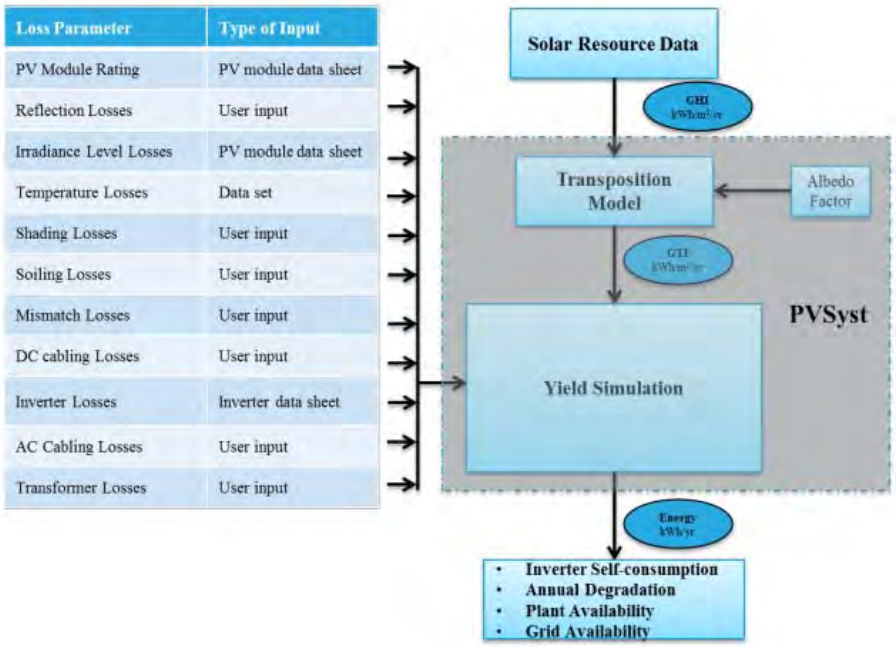
- Shape and size of site/ area
- For buildings - Type of roof, pitched, flat or system built and structural capacity
- Compatible PV systems with roof types
- Roof area available
- Horizon visible from the PV array
- Generation potential kW/m^2
- Optimising return on investment

Feed-in Tariff rate threshold was considered to optimise the return on investment- with consideration given that in some cases it could be better to limit the size of the scheme to maximise the financial performance.

For each scheme the resource and yield assessment involved:

1. Identification of suitable long term solar irradiance data set source
2. Determining optimisation to achieve maximum installed capacity
3. Defining project specific loss and uncertainty assumptions such as reflection losses, irradiance level losses, shading losses, soiling losses, DC cabling losses, inverter losses, AC cabling losses and transformer losses.
4. Constructing model and conduct solar resource and energy yield analysis utilising PVSyst-an industry standard software package.

For this project, Arup used industry standard software PVSyst to assist in the assessment. This software package has access to a wide range of PV module and inverter specifications and is compatible with weather data from a range of sources. The diagram below describes the simulation process which is followed by PVSyst in order to calculate the expected energy generated by the PV array arrays for each site and premises assessed.



C1.2 Assumptions used

This reports provides a high level outline of the commercial analysis of a solar PV array dependent upon capacity for both roof and ground mounted schemes. Analysis assumed the following:

- No shading issues
- For roof mounted arrays, all electricity produced is consumed by the building they are connected to.
- For ground mounted arrays, all electricity generated is exported to the grid
- Feed in Tariffs and electricity tariffs are fixed at current market levels (December 2014)
- Only 80% of the site is available for PV use (due to access roads for ground mounted and mechanical plant for roof mounted)
- The occupancy ratio is 38.5%
- Discount rate is 6.085%
- Operational lifetime 25 years

When considering a specific site, each of these factors were assessed and updated as necessary.

Appendix D

Energy Crops

D1 Understanding the Energy Crop Market

D1.1 About Biomass Fuelled Technologies

There are a wide array of technologies which produce heat from renewable sources, for a variety of uses. The most common uses are space and water heating, and industrial processes of various kinds. The types of renewable heat supported by the Renewable Heat Incentive (RHI) include: biomass, where wood pellets, wood chips or municipal waste is burnt in a boiler and heat pumps, where naturally occurring heat is extracted; solar thermal (up to 200 kW); small-scale biogas combustion (up to 200 kW) and, biomethane, where biomethane is produced and fed into the gas grid, (DECC 2011). The heat produced from these technologies is used to produce hot water or steam (DECC 2011).

D1.2 Barriers to energy crops

The barriers to energy crop production on sites are considered to be:

- Development pressures from other land uses
- Use of agricultural land for food production, supply of biomass for non-energy markets, other schemes e.g., agri-environment schemes
- Competition from established export markets (overseas sources)
- Land designations e.g., Public rights of way (PRoW), Common land, SSSIs, National and Local Nature Reserves, Scheduled Monuments, Registered Battlefields, Special Areas of Conservation (SACs),Special Protection Areas(SPA), World Heritage Sites and Ramsar Sites
- Site access for harvesting machinery
- Above and below utility lines such as water, gas and electricity lines.

D1.3 Biomass market / Supply Chain

The Biomass supply chain involves growers, aggregation, logistics, and storage and waste managers. Each component of the supply chain has land and spatial planning implications collectively if LCR is to develop a credible biofuel supply chain.

The National Renewable Energy Action Plan (DECC 2010) and the more recent Renewable Energy Roadmap (DECC 2011) both identify a larger role for biomass electricity and renewable heat (air and ground source pumps and biomass) in future.

A key driver is the market share of renewable heat being forecast to rise from 1% (currently) to 5% of heat demand in 2017 and 12% in 2020. The Committee on Climate Change's view that biomass will be critical in reducing heat emissions in the 2020s'(Climate Change Committee 2011).

The take up of biomass is likely to be slow, however subsidy through the Renewable Heat Incentive will improve the deployment rate if biomass heating is developed.

Figure 5: Example of a solid biomass to electricity supply chain: short rotation coppice pellets (Source Renewables Obligation: Sustainability Criteria for Solid and Gaseous Biomass)

The supply of biomass is expected to come from within the UK and from overseas. Investment in the supply chain is expected to lag demand as the market waits to see how quickly demand grows. A report commissioned by DECC on the availability of feedstocks suggests that most biomass will be sourced within the UK, but this supply may not grow as fast as demand and by 2020 the majority would be sourced from overseas (AEAT 2011). This is because considerable investment in collection, processing, logistics, transport and storage would be needed in order to expand UK supply.

As a consequence, fuel supply costs are likely to be higher than they might otherwise be if the UK was able to meet demand with domestic biomass fuel. Exchange rates also enhance the price risk as supply of biomass is required from overseas. A strengthening of sterling could increase the price of the imported biomass significantly.

Other biomass markets include the potential role for co-firing in existing coal-fired plants and in renewable heat, but substantial dedicated new-build is unlikely to occur without Carbon Capture & Storage (CCS). Without CCS, scarce biomass resources would probably be of more value when used outside the power sector (Climate Change Committee, 2011), for example in the use of consumer goods[157].

[157] The Green Investment Bank: Policy and Finance Context- Report prepared for the Department for Business Innovation and Skills Final Report, October 2011

D2 Energy Crop Land Use Capacities

Defra provide statistics on the total area of energy and fuel crops in the UK. In 2009 the total amount of land used across the UK for energy crops were estimated as follows:

- *Miscanthus* plantings stood at 12,700 hectares
- Short rotation coppice plantings stood at 6,400 hectares
- Oilseed rape plantings for non-food use totalled 85,700 hectares

D2.1 Biomass capacity

The North West Renewable and Low Carbon Energy Capacity Study produced in 2010, provides an indication of the total capacity for electricity and heat generation in Merseyside. By 2020 the plant biomass (consisting of managed woodland, energy crops, agricultural arising (straw) and waste wood) amounts to 21 MW capacity. Of this total, energy crops are estimated to amount to 12 MW capacity (2 MW electricity and 10 MW Heat).

D2.2 Woodland

The Forestry Commissions National Inventory of Woodland and Trees[158] was produced in 2002 for Merseyside. The survey includes a Main Woodland Survey (MWS) covering woodland of 2 hectares and over and a Survey of Small Woodland and Trees (SSWT) that covered groups of trees, linear features and individual trees. The surveys identified:

- The total area of wood land of 0.1 hectares and over amounts to 2,478 hectares (3.8% of the total land area)
- Broadleaved woodland represents 76.3% of all woodland. Conifer 5.1% and mixed woodland 15.7% and open space in woodland 2.9%.
- The main conifer species (45%) is larch which cover 125 hectares. The main broadleaf species is oak (29.5%) which covers 627 hectares.
- There are 279,000 trees located outside of woodland areas in Merseyside.
- Woodland land cover increased by more than 780 hectares from 2.6% to 3.8% of total land area between 1980 and 1998.

The impacts of energy crops can vary at local levels. In 2005, Defra set up a working group to develop and produce a set of regional maps identifying opportunities and optimum sittings for energy crops (short rotation coppice (SRC) and Miscanthus).

This work was referred to in the Government's Response to the Biomass Task Force and completed at the end of 2006 and provide an indicative guidance to organisations and landowners considering the potential to develop energy crops.

[158] http://www.forestry.gov.uk/forestry/HCOU-54PG9U

The maps indicate the best areas for growing the crops and the areas where this there is less potential.

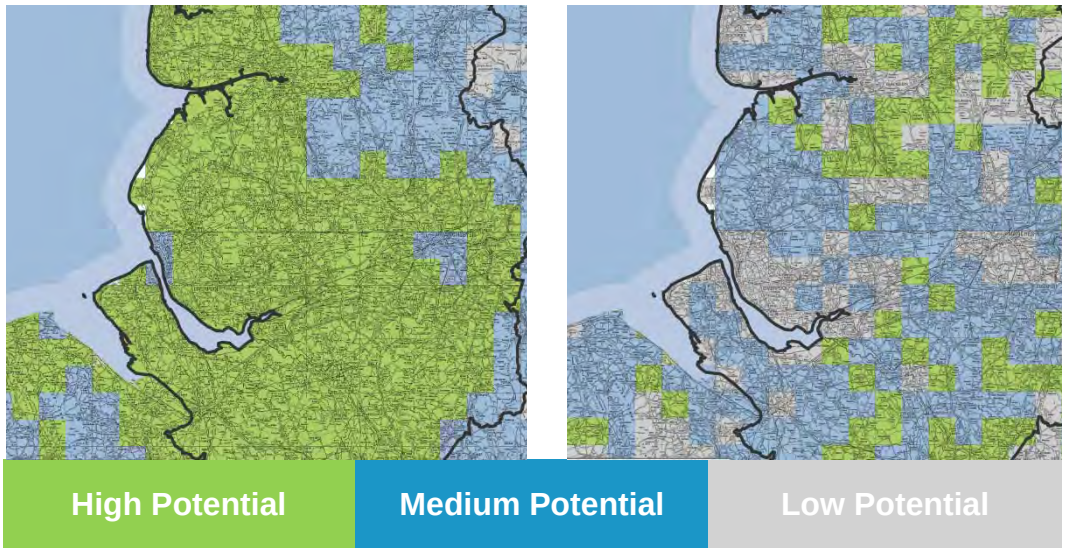


Figure 6 Potential for Miscanthus (left) and Short Rotation Coppice (Right)

The mapping in Figure 7 shows that the LCR is best suited to the production of Miscanthus which is identified to have a high potential across the all districts. Short Rotation Coppice production has less potential, however parts of Knowsley and Halton is identified to have areas of medium potential and is adjacent to an area of high potential.

D2.3 Identifying suitable areas for Miscanthus production in LCR

This study has utilised Industrial Crop research undertaken by DEFRA in 2008 in order to establish which was the most credible crop for the City Region. The potential impacts of energy crop production against this common framework. The research involved identification of key characteristics of Joint Character Areas (JCA) across England and the potential impacts and issues concerned with energy crop planting. The research provides an overall indication of the suitability for biomass crop establishment.

Views and inter-visibility are key characteristic of the landscape. These may be broad, sweeping views or local, intimate ones. A key concern will be whether biomass crops would obscure or otherwise have an impact on the nature of these views.

Generic landscape characteristics were developed based on those used in Natural England's Countryside Quality Counts (CQC) project. In addition topographical and views and inter-visibility information was used to define the physical and visual qualities of landscapes.

Key landscape characteristics highlight the generic categories, the specific landscape features and characteristics within each JCA that may be relevant to the growing of energy crops

Potential effects of SRC and Miscanthus on each of the key landscape characteristics and features.

Topography or landform, and how this will be constrain energy crops in some areas, or how they might fit in well in others.

Woodland - from ancient and semi-natural woodlands to commercial plantations of broadleaved, conifer and mixed woodland – and how biomass crops might contribute to or impact on local patterns of woodland cover, and what layouts or scale might be appropriate.

Boundary features are considered to understand whether the establishment, growth or harvesting of energy crops could have an impact in terms of direct damage (e.g. to allow access for farm machinery) or by obscuring or affecting the integrity of existing field patterns.

Agricultural land including arable, pasture (livestock), horticulture and mixed farming were considered. Energy crops in existing, intensively cropped land are likely to have beneficial or neutral impacts depending on scale, whilst adverse impacts are more likely in pastoral areas, particularly in low intensity, unimproved grassland areas.

Settlement and development was factored to establish the extent that the scale or pattern of planting could impact on the character of road networks, or significantly affect the setting of settlement areas.

Semi-natural habitats were considered where it is likely that biomass crops would impact on semi-natural habitats that are an integral part of the landscape.

Historic features were considered with respect to whether planting would obscure or damage historic sites, or affect the setting or integrity of a historic site.

Rivers and coasts and whether energy crops could obscure watercourses or disrupt drainage patterns, and any hydrological and coastal management issues.

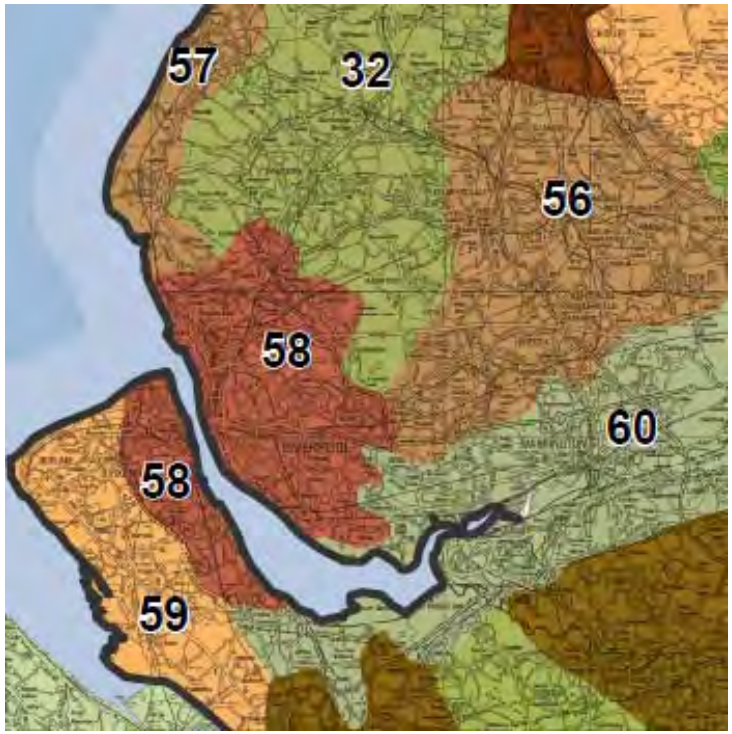


Figure 7 Four zones (57, 58, 59 and 60) were assessed by DEFRA that relate to the City Region

Merseyside Conurbation (58)

Sefton Coast (57)

Wirral (59)

Mersey Valley (60)

(58)	(57)	(59)	(60)
There is very limited space or potential for biomass crops in this densely built up character area other than on pockets of urban fringe farmland, or perhaps as a temporary measure on unused developme nt land (SRC only).	Low-lying flat landscape, generally expansive and open, with urban resort development contrasting with the relatively wild natural areas. Mosaic of land uses, all generally unsuited to anything other than very small scale biomass planting. The strong horizontal nature of the landscape could help to accommodate Miscanthus planting but SRC would be very alien in this sparsely wooded landscape.	The Wirral shares some characteristics with the nearby Cheshire Plain, Cheshire Sandstone Ridge, and Mersey Conurbation, but its unique character is due to its being a peninsula, with outward views from coast and sandstone ridges. Its physical characteristics lend themselves to limited biomass crop planting in low-lying areas, but the countryside is small scale, highly valued by urban population and at the same time vulnerable to urban pressures, and in practice opportunities for planting without adverse impact in some respect may be very limited.	There are opportunities within the Mersey Valley JCA for both SRC and Miscanthus to be accommodated without significant landscape effects, due to the low-lying valley character, the complex land use pattern including arable and mixed farmland, and the existing urban influence on the landscape. However this is also an area under much pressure where there are sensitive views, habitats and other interests to be taken into account.

Appendix E

Energy Supporting Information

E1 Understanding the Energy Market

The production of all goods and services requires energy and, in common with most of the developed world, the City Region's energy needs are largely met by fossil fuels (oil, gas, coal). The availability of these fuels has underwritten economic growth since 1945 and supported wealth creation for over half a century. Many of these fuels now come from ever more distant locations and from increasingly hostile environments that increase the costs of production for limited gains.

Access to fossil fuels has been taken for granted however this assumption is now threatened. The real cost of fuels relied upon for our energy requirements has been increasing to a point where it has been outpacing the growth in wages and salaries. The reasons for this are complex, however, many of these fuels now come from ever more distant locations and from increasingly hostile environments that increase the costs of production for limited gains. The use of fossil fuels also carries a future cost by promoting an increased likelihood that more extreme weather events, e.g. flooding, will inflict damage on coastal communities in the City Region.

This presents the City Region with an excellent opportunity to take positive and integrated action to embrace the economic opportunities this presents, to reduce carbon emissions, to address fuel poverty and to increase energy resilience.

The City Region has a significant role in contributing to national and international energy policy objectives. This sub-region has the potential to develop the energy sector, building on its existing skills base, using its natural resources and most importantly for this project, it underperforming. Central government energy policy is fluid allowing the City Region area to greatly benefit from a sound co-ordinated sub-regional approach to utilising sites and buildings for energy generation.

E1.1 Economic Opportunities

The energy sector provides an excellent opportunity for inward investment. Jobs are supported and created in a diverse range of business sectors including construction, manufacturing, installation, operations, management and fuel processing. The delivery of energy projects on sites across the City Region has the potential to contribute to economic growth, both directly and indirectly.

E1.2 Carbon Emissions

The last 50 years have seen changes only previously seen in millennia; the world's climate is unequivocally warming, greenhouse gases have increased and sea level has risen. Atmospheric carbon dioxide (CO_2), methane and nitrous oxide levels have increased to concentrations unprecedented in at least the last 800,000 years. A 40% increase in CO_2 since pre-industrial times is primary from fossil fuel emissions. These greenhouse gases have caused a global mean surface warming of between 0.5°C to 1.3°C, over the period 1951−2010[159]. Continued greenhouse gas emissions will cause further warming and irrevocable changes to the whole

[159] IPCC, *5th assessment report* (2013) http://ipcc.ch/report/ar5/wg1/

climate system. To limit this change a substantial and sustained reduction in greenhouse gas emissions will be essential.

E1.3 Fuel Poverty

The average domestic electricity bill in the UK has increased by 60% between 2004 and 2010 (compared to general price inflation of 17% over the same period)[160]. This is one of the three factors determining whether a household is fuel poor, alongside the energy efficiency of the property and the income of the household. There is massive variation in fuel poverty across the City Region sub-region.

E2 Energy and growth in the City Region

E2.1.1 Energy security

The UK Government defines energy security having three components:

- **Physical security:** avoiding involuntary physical interruptions to consumption of energy;
- **Price security:** avoiding unnecessary price spikes due to supply/demand imbalances or poor market operation; and
- **Geopolitical security:** avoiding undue reliance on specific nations so as to maintain maximum degrees of freedom in foreign policy.

Physical energy security risks arise from an excessive dependence on imported fuel from a small number of countries especially if the originating country is vulnerable to climate change, natural disaster or terrorism. Fossil fuel generators are highly dependent on international energy markets which set international commodity prices. The impacts of these higher gas prices are felt by consumers and commercial/ industrial users through higher electricity bills and higher charges for delivered gas.

Oil and gas will increasingly be imported to the UK from the Middle East, North and West Africa, and to a lesser extent central Asia together with Russia. Estimates by DECC suggest that oil prices will average $150 per barrel of oil in 2020[161]. Renewable natural resources insulate an economy against potential geo-political shocks. Currently the gas market has tended to shadow the oil price based on historical precedent and the potential for substitution. The gas price has a growing relevance as gas becomes the dominant fuel used directly for heating and in the generation of electrical power. While it is very difficult to predict the future overall level of oil and gas prices, the one reasonably certain prediction is that prices will tend to be volatile and are likely to periodically display the extreme volatility which has been experienced in recent times.

[160] Committee on Climate Change, *Energy prices and bills – impacts of meeting carbon budgets* (December 2012)
[161] DECC Fossil Fuel Price Projections https://www.gov.uk/.../130718_decc-fossil-fuel-price-projections.pdf

E2.1.2 Jobs

The deployment of energy projects are like any other investment projects and can be evaluated accordingly. Energy projects create jobs directly through employment required during construction, operation and (eventually) decommissioning. Indirectly, jobs are created through the purchase of goods and services required for the project and through the spending of workers in the wider economy. As the primary interest of this study is the City Region's economy, it is appropriate to use a methodology that accounts for employment impacts. The additionality method[162] allows the calculation of likely job impacts based upon assumptions concerning the degree to which benefit will be retained within the City Region and the degree to which an energy project will simply displace something else that would have employed people. The methodology has an advantage over a standard benefit cost analysis in so far as it captures job benefits rather than treating them as a financial transfer.

One of the more controversial issues concerns the capture of benefits arising from so called catalytic effects. Energy projects could act as a catalyst for growth by encouraging companies and individuals to invest in a locale where competitively priced and secure (in terms of price volatility and supply) energy supplies were available.

E2.1.3 Carbon savings

The third benefit of renewable electricity generation considered in this study is carbon savings. Savings in terms of costs of climate change can be attributed to CO_2 emissions saved resulting from the decrease in the use of fossil fuels under each scenario. The Government has provided advice on the valuation of carbon when appraising projects[163] which has been used in the calculations.

E2.1.3.1 Avoided costs

The Government's National Infrastructure Plan 2012 expects that £123 billion will be invested in energy generation with a further £53 billion in energy networks and other energy infrastructure. Based on the National Infrastructure Plan around 90% of this is supposed to be delivered by 2020. Some expert opinion suggests that National Infrastructure Plan underestimates the level of investment needed. Most of these costs will be paid by energy consumers through the bill they pay. The costs associated with the transportation of energy alone are considered to represent 23% of the final bill paid by consumers[164]. Any reduction in cost holds open the prospect of the consumer avoiding costs that would otherwise have to be paid leading to a curtailment in discretionary expenditure elsewhere in the economy.

[162] HCA (2014) Additional Guide, 4th Edition
[163] DECC (2009) "Carbon Valuation in UK Policy Appraisal: A Revised Approach Climate Change Economics", Department of Energy and Climate Change July 2009
[164]NAO (2013) " Infrastructure investment: the impact on consumer bills"

E2.1.4 Local Taxation Benefits

Energy projects can create opportunities for local authorities to accrue additional business rates from the project itself. Energy projects can provide a source of revenue to support activity both directly and through any catalytic effects on surrounding properties. The localisation of local government finance means that the opportunity to raise additional business rates may be a significant enabler for sustained investment e.g. Tax Increment Financing of local energy projects.

E2.1.5 Environmental Benefits

Energy projects may have a material impact on the physical environment. For example, a long term shift from petroleum based fuels to electrical traction for transport would have an effect on particulate matter and, therefore, assist air quality. Some of these benefits could be monetised as social benefits.

Benefits 4 to 6 could easily become negative especially for certain classes of project. Avoided costs could become negative in the context of renewable projects if there was a need to account for back up capacity or energy storage to manage down time. Local taxation benefits could become negative if a project were to create a basis for compensating residents for a worsening of their environmental context e.g. wind farm or shale gas projects.

E3 Energy Funding Mechanisms

E3.1 Feed in Tariffs (FiTs)

The Feed-in Tariff (FiT) scheme, introduced in 2010, provides incentives for the generation or low and zero carbon electricity from small installations. A range of technologies are supported and receive a payment for each unit of electricity generated from an eligible and accredited system. Systems up to a capacity of 5 MWp are eligible for the scheme.

Tariff rates are defined based on technology type and capacity and are originally defined on the basis of providing a return on investment of 5-8%. The scheme is funded through a levy on electricity suppliers

There are three bands for feed in tariffs; high medium and low.

- The highest band is payable when an installation provides power to a building that has an Energy Performance Certificate (EPC) rating of between A and D,
- The middle rate is paid if the conditions for the higher rate are met but the installation owner has 25 or more installations
- The lower rate is payable when the conditions for the higher rate are not met.

Stand-alone systems, not connected to a building, are subject to a flat rate, currently 6.38p/kWh.

Feed in Tariff rates are guaranteed for 20 years at the tariff level upon initial registration. The Feed in Tariff for solar PV installations current degresses based on deployment levels within the technology band over a 3 month period effective on 1st January, April, July and November each year.

The default regression is 3.5% however the regression for solar PV systems can be skipped for up to two consecutive periods if deployment is lower than the trigger level and increased if the deployment is higher

Table 1 below shows FiT rates for installations commissioned between January and March 2015.

	Tariff (p/kWh)		
Installed Capacity (kW)	**High**	**Middle**	**Low**
<4	13.88	12.49	6.38
4-10	12.57	11.32	6.38
10-50	11.71	10.54	6.38
50-100	10.34	9.31	6.38
100-150	10.34	9.31	6.38
150-250	9.89	8.9	6.38
>250	6.38	6.38	6.38
Stand-Alone System	6.38	6.38	6.38

Table 1-Feed in Tariff Rates for Solar PV Installations (January 2015)

E3.2 Feed-in Tariff Contract for Difference

The Feed-in Tariff Contract for Difference (FiT CfD) scheme was introduced in April 2014 under the Electricity Market Reform. The scheme is intended to replace the RO as the primary mechanism for incentivising the generation of low and zero carbon electricity. From October 2014 new generation projects of 5MW or more can apply for support under the FiT CfD scheme.

The CfD reduces the risks faced by low-carbon generators, by paying a variable top-up between the market price and a fixed price level, known as the “strike price”. The standard CfD contract terms are for 15 years with payments indexed to inflation (CPI) and obligations to deliver the contracted capacity in a timely manner.

Technology	Strike Price (£/MWh)				
	2014/15	2015/16	2016/17	2017/18	2018/19
Large Solar Photo-Voltaic	120	120	115	110	100

Table 2-Contracts for Difference for Large Scale Solar Photovoltaic Schemes

E3.3 Renewables Obligation Certificates (ROCs)

The Renewable Obligation Order came into force in 2002 and is designed to encourage the generation of electricity from renewable sources. Electricity suppliers meet the Renewables Obligation by presenting Renewable Obligations Certificates (ROCs) which are issued for each MWh of renewable electricity produced. Suppliers can meet the obligation by either presenting ROCs issued for their own generated renewable electricity or by purchasing ROCs from other generators on the open market.

The RO scheme is planned to be phased out under proposals within the Electricity Market Reform (EMR). As of 2017 new generators will not be eligible to sign-up for the RO scheme and will instead have access to the FiT CfD scheme.

Ground Mounted Solar PV qualifies to receive 1.6 ROCs per MWh under the current scheme however this is due to decrease to 1.4 ROCs per MWh in April 2015. The current value of a ROC, as of October 2014 is £42.45/MWh.

This scheme is currently available to all installations of a capacity of above 50 kW_p however there is currently a consultation set out by the Department of Energy and Climate Change (DECC) to close the RO to all new solar PV capacity above 5MW_p on 1st April 2015.

Technology	Renewable Obligation Certificates (Per MWh)		
	2014/15	2015/16	2016/17
Ground Mounted Solar PV	1.4	1.3	1.2

Table 3-Renewable Obligation Certificates for Large Scale Ground Mounted Solar PV

E3.4 Revenues and Savings from Electricity Generation

A PV scheme can derive a revenue or a saving through three different channels;

- By offsetting electricity currently used onsite;
- By exporting electricity back to the national grid;
- Through Financial Incentives (Feed in Tariff, Renewable Obligation Certificates or Contracts for Difference).

For the purposes of this study it is assumed that the PV schemes will be registered under the Feed in Tariff scheme due to the long-term predictable nature of the incentive payments.

The table below summarises the electricity cost assumptions used in the modelling exercise.

Assumption	Value
Electricity Purchase Tariff (p/kWh)	10.50
Electricity Export Tariff (p/kWh)	4.77

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