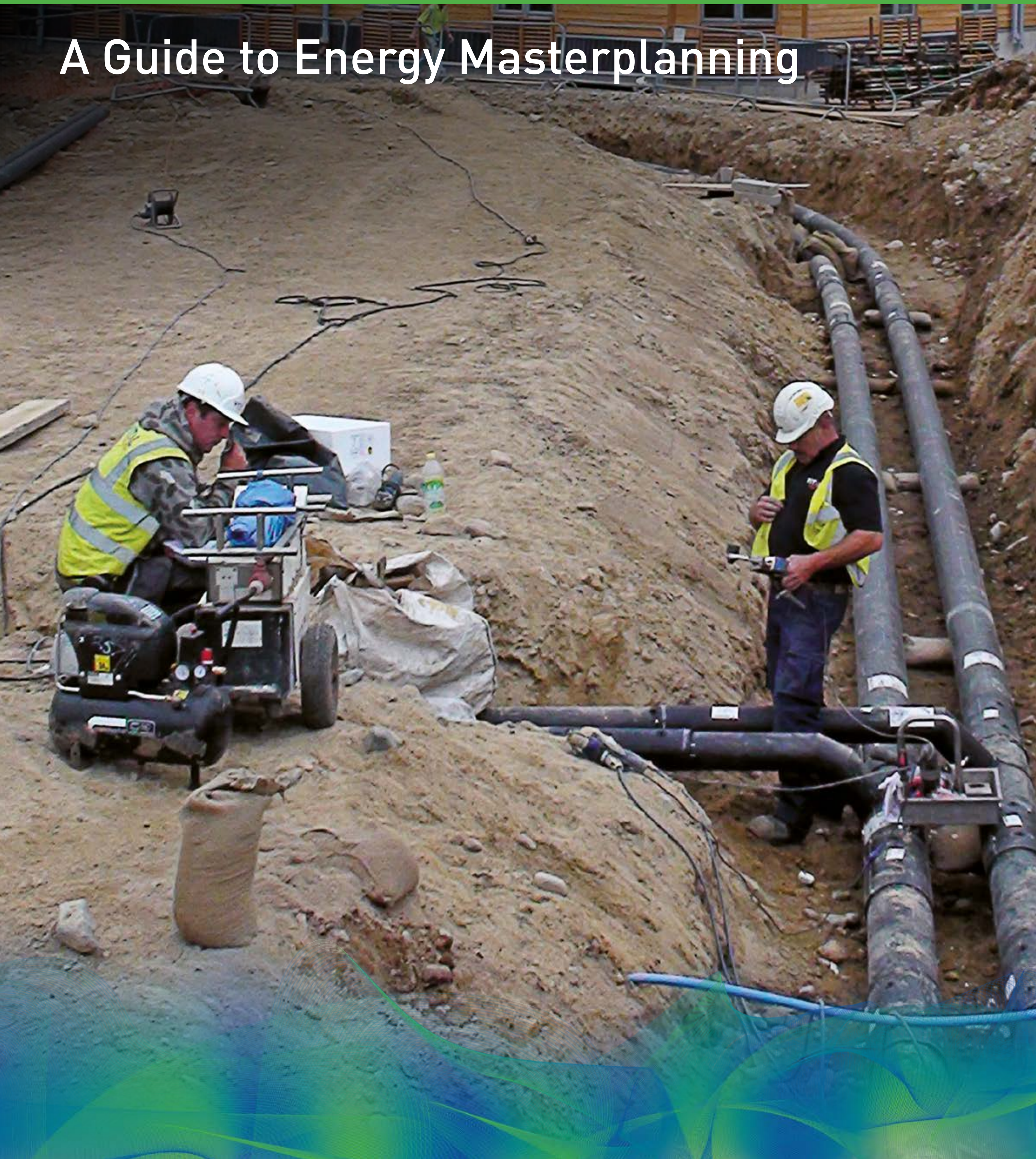
Scottish Enterprise

Developing Scotland's Energy Infrastructure

A Guide to Energy Masterplanning



Energy Masterplanning – Focussing on Key Areas

PREFACE

The Scottish Government's ambition is to see an increasing number of new energy and district heating networks developed across the country, and it is important to make the best use of the existing heat sources which we have, including unused and renewable heat. This in turn can help cut carbon emissions, reduce fuel bills and combat fuel poverty. Energy Masterplanning can assist developers and local authorities plan better, provide for 'future proofing' and in using energy more efficiently.

Energy Masterplanning approaches have already been used in a range of settings and locations across Scotland, but there is more that can be done. For example, there are significant opportunities for cities in particular and for our larger towns and settlements to use renewable and low carbon heat energy. The aim should be for new developments to be future-proofed to ensure that connections to existing or planned heat networks can be taken forward as soon as they are viable.

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Contents

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1. About the guide to energy masterplanning

The primary aim of this Guide is to set out the critical key stages and components of an energy masterplan and the benefits of developing energy efficient systems and decentralised energy systems. The requirements of an energy masterplan will be determined by local characteristics and this document describes a series of stages that typically may be used in preparing an energy masterplan. The methodology presented should be considered as a toolkit to aid development of creative low carbon solutions and delivering decentralised energy systems. The guide draws on examples and explains how this approach assists in the development and delivery of economically viable, sustainable projects.

The Guide provides advice on what information is publically available, additional data that needs to be collected, useful tools and a description of how all of these elements can be incorporated into a coherent energy masterplan. The Guide also contains a glossary of terms and key linkages.

Significant opportunities arise from the unutilised and underutilised heat loads from existing and proposed Biomass Plants, Energy from Waste (EfW) plants, and from Anaerobic Digestion (AD) plants too. Other opportunities for the focus of attention might include Geothermal and Mine-water opportunities, and there may well be scope for better utilisation of any surplus Biogas derived from our existing Waste Water Treatment Works also. Where there are clusters of energy intensive businesses their manufacturing processes may also present an opportunity to develop different forms of energy networks.

To be successful energy masterplanning requires that a lead organisation steps forward that has an appetite and commitment to bring stakeholders together, promote, develop and subsequently adopt and help deliver the energy masterplan.

Energy masterplanning is best used to identify opportunities to connect energy (including heat) resources with demands in the most cost effective, sustainable and low carbon manner. This can be developed strategically at regional geography scale, city scale or at a local level to identify a vision for the future energy system and will identify a number of cluster opportunities that can be developed collectively and/or individually.

The methodology section focuses on:

- Identifying energy demand;
- Identifying energy sources;
- Developing a strategic vision for a study area;
- Techno-economic evaluation of proposed schemes; and
- Planning, scenario modelling, and reporting of proposed technical solutions.

The objective of the energy masterplan is to provide a clear picture and sound evidence base outlining the potential for the delivery of decentralised energy networks with the relevant stakeholders. The energy masterplan should include spatial maps that allow area planners and project developers to identify energy opportunities at the earliest possible stage and can assist the commissioning of projects in consideration of the wider energy context. Energy Masterplans can help raise wider organisation awareness and political support, as well as providing a low carbon evidence base.

1.1 POLICY POSITION

Scottish Government has set itself a series of targets towards meeting international and national commitments to control climate change. The Scottish Government has published their Climate Change Act (Scottish Government, 2009) which is supported by the Electricity Generation Policy Statement (Scottish Government, 2013) and the 'Heat Policy Statement – Towards Decarbonising Heat: Maximising the Opportunities for Scotland' (Scottish Government, 2015), which outlines the ambition to move towards a fully integrated energy approach in Scotland.

ELECTRICITY GENERATION IN THE UK

Electricity has traditionally been generated at central locations through the burning of fossil fuels and from nuclear fission reactors to produce steam to drive a turbine to generate electricity. These large power plants require large cooling towers which emit water vapour, CO2 and other harmful gases to the atmosphere. The traditional fuels used to produce this electricity have been (in order of adoption) Coal, Natural Gas and Nuclear Energy. This primary mix of power sources has changed over time to include a substantial proportion of generation from hydroelectric and wind energy.

In these policy documents the Scottish Government has published targets for decarbonising the heat and electricity sector including:

- 80% reduction in greenhouse gas emissions by 2050;
- Total final energy consumption in Scotland reduced by 12% by 2020;
- Meeting at least 30% of overall energy demand from renewables by 2020;
- a largely decarbonised heat system by 2050, with significant progress made by 2030;
- Source 11% of heat demand from renewables by 2020;
- Delivering an equivalent of at least 100% of gross electricity consumption from renewables by 2020; and
- An overall target of 1.5 TWh of heat to be delivered by district heating by 2020; and 40,000 homes to be supplied with low cost, low carbon heat through heat networks and communal heating by 2020.

These are an ambitious set of targets and will require investment in both energy demand reduction and in energy infrastructure too. The planning and coordination of delivering de-centralised energy development along with district heating networks will assist the achievement of these targets.

1.2 CURRENT ENERGY SYSTEM IN THE UK

The current model for energy supply in the UK was built on economies of scale that relied on the historical abundance of coal and natural gas. At present the majority of electricity generation occurs at large centralised power stations primarily using carbon-intensive fossil fuels and nuclear fuel. Electricity and gas is distributed via national transmission networks to most of the UK.

ENERGY DISTRIBUTION

Electrical energy is transmitted from the generators via power lines to a series of local substations, each stepping down the voltage supply to smaller and smaller areas until the supply reaches the standard voltage which is used in homes and businesses across the country. The UK and Scotland also benefits from the ability to import and export electricity through interconnectors to England and Northern Ireland. These are used at a national level to balance energy demand and are managed by the National Grid.

Traditionally heat for space heating and hot water in the UK has been generated on a building by building basis, and originally on a room by room basis using solid fuel open fires. A significant shift in how we heat our homes occurred in the 1970s and 1980s when central heating became the norm. At present there is a third stage shift occurring in the heating market – a shift towards community and district heating. Whilst this is not the first time the concept of providing heat to multiple consumers from a single location has been considered in the UK (Nottingham has had a DH system since 1972, Sheffield since 1988) there is now a real impetus behind the expansion of this approach to heating, drawing largely from the Scandinavian model. This is primarily being driven by the fact that DH networks allow for a more efficient generation of heat (one boiler instead of many) and better utilisation of waste heat from power stations.

1.3 THE BENEFITS OF DECENTRALISED AND SMART ENERGY SYSTEMS

Decentralised Energy (DE) broadly refers to energy that is generated more locally to the source of demand than the traditional centralised energy system. This means local generation of electricity (or in some circumstances heat only) and where appropriate, the recovery of surplus heat from this generation or other industrial uses for purposes such as building space heating and domestic hot water production.

HEAT SUPPLY IN THE UK

The advent of industrial scale coal mining brought about a shift in the main heating fuel used in the UK as people moved away from the traditional home heating fuels such as wood and peat. While coal was originally used as a solid fuel it was also used in another form, as Coal or Town Gas. The first gas networks in the UK transported town gas to homes via networks of pipes, this gas was used for lighting, heating and cooking.

In 1966 the UK government decided to switch from town gas to natural gas with the discovery of the North Sea natural gas reserves.

Gas boilers are the most prevalent heating system in use across the UK serving homes and businesses. Oil, LPG, solid fossil fuel and electric heating also continue to be used, often in more remote areas where gas networks have not penetrated. 86.4% of Scotland's homes are currently connected to the gas grid, although only 76.0% heat their homes with gas from the grid (Consumer Focus Report).

Now as the natural gas reserves in the North Sea and fossil fuels in general become more difficult and expensive to exploit and as carbon emissions regulations have become more stringent, there is increasing focus on changing how heat and power is provided to homes and businesses. District heating and heat pumps have started to be implemented as solutions that meet both challenges noted above and hydrogen technologies are also emerging options.

Heat is commonly distributed in District Heating systems, with the heat generated being pumped into homes and non-residential properties usually as hot water, through networks of highly insulated and reinforced pipes.

Decentralised energy generation technology can include micro-renewables, hydroelectric, wind turbines, marine energy, energy from waste plants, combined heat and power, heat only boilers (including biomass), heat pumps, geothermal, anaerobic digestion and solar amongst others. Combining these solutions with smart network infrastructure as well as heat and electricity storage solutions allows the potential for balancing of the heat and power networks.

A further step in balancing the network is the adoption of a smart energy system that integrates hardware and system controls across a network. Smart grid technology can aid the:

- Transference of energy between gas, electricity, heating and cooling grids;
- Storage of energy over long and short timescales;
- Controlling demand by managing the energy supply to non-critical appliances; and
- Absorption and switching between a wide range of fuel sources, including intermittent renewables, low carbon waste to energy plants and low grade industrial waste heat.

The technical and economic benefits of investment in decentralised and smart energy systems are as follows:

- Application of technology to provide the most efficient use of the fuel content from primary fuels;
- District Heating Network energy solutions are suited to urban areas particularly those with high heat demand density and/or large cooling demands;
- Provides the flexibility to manage the evolution of power and heat generation sources within a network and to replace with more sustainable energy generation sources over time; and
- Network balancing effects can provide for the potential reduction in the overall capacity required for distribution network infrastructure.

The Energy Masterplanning toolkit can assist the delivery of a balanced overall energy system for the longer term by supporting the development of decentralised energy. In a decentralised energy supply system most individual energy "problems" will have a variety of possible solutions, the most appropriate of these will be determined based on a number of success criteria which includes amongst others:

- Economic performance criteria as measured against the "Business as Usual" case;
- Contribution towards national environmental policy, i.e. the reduction in carbon emissions over the "Business as Usual" case;
- Social benefits of the scheme, such as the alleviation of fuel poverty;
- Consideration of local constraints and opportunities, i.e. the potential for non-conventional technologies;
- Understanding that there will be different solutions for different areas based on varying concentrations of heat demand and differences in available supply options;
- The appetite of potential network developers and operators from both the public and private sector to invest in the conversion from the current energy systems; and
- Technology readiness and risk, including supply chain development.

2. Energy Masterplanning – Who is it for?

The key target audiences for this guide are:

1. **Local Authorities:** Energy Officers, Planners, Low carbon development teams, Asset Managers, Commercial Relationship Managers, and Social Housing departments;
2. **Local Communities:** communities who are thinking about a local energy scheme need to consider the stages in development and the various stakeholders;
3. **Other public sector developers:** for example, non-departmental public bodies, NHS campuses, Universities, Colleges, registered social landlords (RSL's) – helping to develop a common understanding of the stages of masterplan to overall project development;
4. **Property developers, landowners and building operators:** those with an interest in developing sites as energy customers or with the appetite to take on responsibility for some or all the development and energy services for a scheme; and
5. **Energy Companies/Decentralised Energy Developers:** prospective energy providers advancing proposals for deployment of technology as energy suppliers.

In order to achieve successful outcomes a lead organisation is required that has the appetite and commitment to bring stakeholders together, promote, develop and subsequently deliver the energy masterplan. Furthermore the energy masterplanning process should have a particular focus on stakeholder engagement activity in order to involve potential partners, customers and regulatory authorities, including particularly the Distribution Network Operators (DNO's). The type and level of engagement will vary depending upon the relative importance of each organisation or individual to the successful delivery of each project.

3. Energy Masterplanning – Why Do It?

The aim of a transition to a low carbon energy system will require a series of steps to plan and implement new solutions. This requires strategic planning and a phased approach to their physical implementation. Energy Masterplanning can assist the development of energy supply options. It can help achieve greater efficiencies, reduce costs, identify anchor load opportunities and help to meet carbon reduction targets too.

Figure 1 identifies the key stages, (highlighted in blue), involved in the implementation of energy projects from heat mapping through to the installation of the initial development clusters. The activity shown in green below refer to the project stages that contribute to the development and delivery of Energy Masterplans. This guide focuses on stage 1C but should be considered in the context of these wider activities.

Energy Masterplanning is defined as the assessment of the supply and demand of energy on a regional or sub-regional level, the overall aim of which is to ensure that energy projects are developed in a planned and structured fashion that ensures energy resources are used to their full potential and possible key opportunities are not lost.

Energy Masterplans are best focussed on specific spatial geographic areas that may have been identified as a result of an assessment of multiple opportunities or because a decentralised energy is identified as providing a strong benefit to a project. Figure 1 indicates that one region may support multiple clusters that could eventually merge.

Scottish Planning Policy (2014) is also helpful in this regard. SPP outlines that development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved. This is in line with national climate change targets, giving due regard to relevant environmental, community and cumulative impact considerations.

Strategic Development Plans should support national priorities for the construction or improvement of strategic energy infrastructure, including generation, storage, transmission and distribution networks. They should address cross-boundary issues, promoting an approach to electricity and heat that supports the transition to a low carbon economy.

Local Development Plans should support new build developments, infrastructure or retrofit projects which deliver energy efficiency and the recovery of energy that would otherwise be wasted both in the specific development and surrounding area. They should set out the factors to be taken into account in considering proposals for energy developments. These will depend on the scale of the proposal and its relationship to the surrounding area. The SPP also advocates the use of heat mapping to help identify the potential for co-locating developments with a high heat demand with sources of heat supply.

Importantly, new Building Regulation Standards come into effect in Scotland in October 2015, and useful detailed technical guidance and advice can be found on effective measures for the conservation of fuel, power and energy efficiency in new developments. The Scottish Government's website covering Building Standards provide further detail.

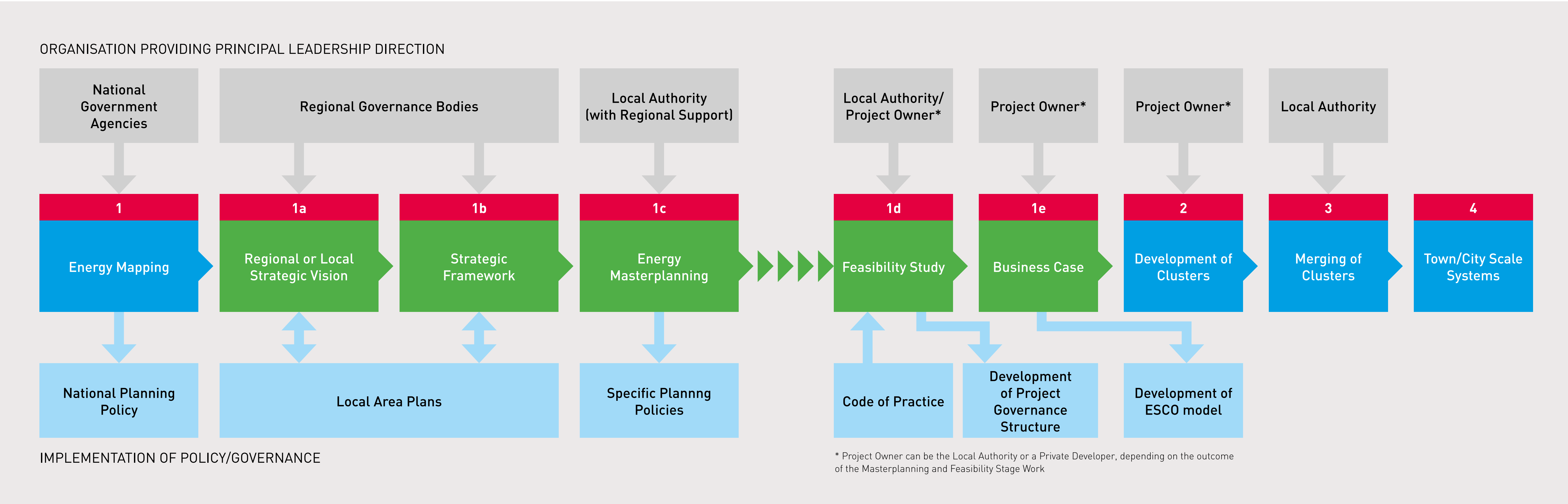

Figure 1: Development stages of strategic energy projects

3.1 BENEFITS OF ENERGY MASTERPLANNING

3.1.1 Efficient Use of Energy Resources

Using our energy resources in a more efficient way can bring economic and environmental benefits by reducing the cost of heat and electricity to customers and reducing the emissions of harmful gases to our atmosphere.

Energy masterplanning considers energy demand and supply as a complete system rather than in isolation. This allows for an integrated approach to the development of energy projects to provide a balanced energy supply solution by ensuring that different technologies can be developed to work together.

The co-generation of heat, cooling and power is one of the most efficient ways to utilise available energy resources. However, it needs to be approached in a coordinated manner, or opportunities may be missed. For example where power generation is developed with no reference to heat supply, significant amounts of heat energy can be lost through cooling towers and other forms of heat rejection.

By using energy technologies in a smarter way, renewable and sustainable solutions can be more readily integrated into the energy supply system to work with, and to create additional capacity within established infrastructure.

3.1.2 Economic

A relatively small investment at the beginning of the project can save substantially in the long term by avoiding common pitfalls associated with poor planning. Energy Masterplanning can assist in thinking about how a small scale project might grow over time. In the long term it might identify areas that are not financially viable as a stand alone scheme, but might become possible as part of a network of interconnected schemes.

Energy masterplanning can ensure that project costs are considered at the outset of the scheme to help in mitigating cost overruns and programme issues commonly associated with large-scale infrastructure projects.

The outcome of energy masterplanning is an initial assessment of the economic viability of a project at an early stage. This allows consideration of appropriate delivery vehicles that could be used and the value of pursuing the project in its proposed form.

3.1.3 Planning and Policy

The low-carbon energy solutions identified through masterplanning can help new developments and existing organisations meet both climate change goals and forthcoming changes in building regulations refered to earlier.

Energy projects often require significant investment in the wider network infrastructure. Engaging with planning departments and network operators at an early stage and looking at the project in a broader context may identify opportunities for linking in with other planned development that would not otherwise have been considered.

3.1.4 Data Collection

The data collation and assessment undertaken as part of the energy masterplanning process serves to define the scope of the energy solution for the area being looked at.

In particular it brings together disparate pieces of information into a readily understandable and usable format allowing for the development of powerful visual aids which can be used as part of the stakeholder engagement process.

Visualising energy flows (such as through GIS mapping tools) within an area helps greatly in the understanding of the project and the development of innovative solutions.

3.1.5 Identifying Opportunities and Constraints

Identification of barriers to energy projects at the very early stages can help considerably with the development of a successful project. Once a barrier is identified mitigation measures can then be explored and built into the project design from inception.

3.1.6 Technical

By considering the interaction of supply and demand across a wide area new innovative technologies can be considered.

3.1.7 Stakeholder Engagement

Energy masterplanning is, at its core an exercise in joined-up thinking and provides an opportunity to engage key stakeholders at the inception stage to ensure that their needs and concerns are sufficiently addressed at an early point in any energy project.

Early and meaningful stakeholder engagement and collaboration contributes greatly to the successful delivery of commercial projects which can provide low cost energy to homes, businesses and public bodies.

4. Energy masterplanning – how to go about it?

The approach to each individual project will need to be bespoke but this section sets out the key stages of energy masterplanning. In reality it may not be possible or beneficial to insist that all of these stages must happen or take place in the order outlined here.

The stages described in Figure 1 previously are further broken down in Figure 2 below with further details of the expected deliverables. In the context of this document energy masterplanning refers to Stage C. It is at this stage that a single regional strategic vision of a balanced energy system is converted into multiple project opportunities that require investment over a period of time to collectively achieve the intended vision.

A – Regional or Local Strategic Vision

- Policy context and targets
- Benefits of decentralised energy
- Vision for decentralised energy in the area

Development of a Regional Strategic Vision involves a high level assessment of the region and the intended benefits of adopting decentralised energy infrastructure.

B – Strategic Framework

- Opportunity mapping
- Appraisal, weighting and hierarchy
- Pipeline of opportunity areas

The Strategic Framework involves a characterisation of the area to set out a clear plan with the identification of Opportunity Areas and an assessment of their relative performance based on appropriate KPIs which can then be taken forward to Stage C.

C – Energy Masterplanning

- Assessment of a individual opportunity area
- Testing of project scenarios
- Refinement of project definition

The Purpose of Energy Masterplanning is to define the scope of individual projects within the opportunity area outlined in Stage B. This involves the development of hourly energy models and a technology options appraisal and high level whole life costing assessment.

D – Feasibility Study

- Confirmation of assumptions under C
- Targeted stakeholder engagement
- Commercial assessment of project opportunity

Feasibility Stage takes the project opportunity as defined in Stage C and tests the high level technical and commercial assumption. The definition of the project under Stage B allows for an in-depth interrogation and definition of all aspects of the proposed scheme under Stage D.

E – Business Case

- Delivery model and structure
- Financial model
- Finance options

Building on the work indertaken in Stage D the key financial and commercial aspects of the project can be fully determined in the Business case development phase. Project Goverance Structures and Financing Options can be investigated and approaches to market for delivery can be made.

Figure 2: Concept and detailed development of energy masterplanning and business case development

4.1 METHODOLOGY FOR ENERGY MASTERPLANNING

The methodology for achieving this is indicatively divided into six stages which should be addressed in the following order. Each stage is further described below.

DATA COLLECTION

- Heat demand, tenure, ownership, location, current heat and electricity supply;
- Develop energy demand map and database of the opportunity area; and
- Develop supply map, categorise each supply asset.

STRATEGY

- Decide the areas to be connected and the heat supply asset(s) to be used, taking into consideration information from stakeholder engagement and strategic objectives to be adopted (eg. fuel poverty and carbon reduction);
- Determine the modelling scenarios to be tested; and
- Determine the network route required (if applicable).

TECHNOLOGY OPTIONS APPRAISAL

- Develop hourly energy model for the system;
- Assess the low and zero carbon technology supply options for the project; and
- Size key technical assets such as the energy distribution network and supply assets.

ECONOMIC ASSESSMENT

- Determine capital and reinvestment costs for key assets;
- Determine fuel costs and other operational and maintenance costs; and
- Carry out whole life costing of the project opportunity in terms of payback, IRR and NPV.

COMPARATIVE ASSESSMENT OF THE SCENARIOS

- Assessment of each of the modelled scenarios based on the project owners' key drivers; and
- Ranking of the modelled scenarios and recommendations for feasibility assessment.

PROJECT REPORTING

- Report key recommendations;
- Produce high level maps of the proposed opportunity; and
- Set out key risks that need to be addressed at feasibility stage.

4.1.1 DATA COLLECTION

The initial stage will involve the collection of key data sets which will include:

- Characterisation of the properties within the study area in terms of their building type, tenure and heat demand which can be initially estimated from the Scotland Heat Map (www.scotland.gov.uk/heatmap) and then enhanced with supplementary local data. (See also section 5.3);
- Identification of initial groups of properties by ownership or property type that can be aggregated together under one company or community group to facilitate future stakeholder consultation activity;
- Understanding of grid infrastructure and network capacity constraints;
- Information on proposed new developments in the area, through consultation with local planners and developers, including information on proposed floor areas/number of dwellings and planned energy supply plant;
- The location, capacity and ownership of existing or potential heat generation sources including a review of potential energy resources;
- Collection of the above data into summary tables and production of a locally detailed Geographical Information System (GIS) showing heat demand and heat supply layers for the area of interest; and
- Additional GIS information that should be sought in order to assist with the development of the database can include: information on proposed infrastructure works, information on utilities where available, areas of proposed development etc.

4.1.2 STRATEGY

Working in consultation with the key stakeholders to identify the scope of the study, i.e. the geographical extent, potential infrastructure routes, proposed connections and the supply options. This may result in a number of modelling scenarios to be tested, in order to comparatively assess these scenarios key economic performance indicators such as hurdle rates, carbon emission reduction and fuel poverty alleviation etc. should be agreed with the key stakeholders. The approach to a wider stakeholder engagement should be agreed at this stage.

Stakeholders may have varying interests in the energy masterplan as follows:

- Strategic interest in the development potential of the area;
- Interests in the benefits to the communities within the area of interest;
- Interest in District Heat Networks as a heat customer;
- Interest in District Heat Networks as a heat supplier; and
- Interest in District Heat Networks as an investor.

Presentation of the overall strategy to stakeholders at this stage helps to ensure buy-in to the project by considering the views of those concerned, beyond the technical merits of the proposals.

4.1.3 TECHNOLOGY OPTIONS APPRAISAL

The design should assess the capacity constraints of existing energy infrastructure and the essential network upgrades and new infrastructure that may be required.

Network layout options should be taken beyond the strategic stage of the project to a high level options appraisal stage. This should take into account phased development opportunities, the need to safeguard for future capacity and the role of cluster networks. Constraints to development such as recent infrastructure works and areas unsuitable for network routing should be considered as part of this assessment.

An energy model should be developed that simulates the energy generation, distribution network operation and heat and power demands at a suitable time frequency (hourly modelling is generally appropriate) to reflect the potential peaks in demand. The energy model should include appropriate predictions of energy demand and plant replacement over an appropriate lifetime (for example 25 or 40 year duration).

The design should assess the annual energy demand including cumulative, peak and minimum loads. The design should consider the phased expansion of networks to supply expansion/growth areas or other future planned development.

The technical design stage should identify potential locations for energy centres considering existing and planned generation capacity. The design should also identify the role of thermal storage, including for local balancing of electricity and heat grids. This stage should provide concept layouts, pipe lengths, diameters and sizes for the heat network options and identify network routes taking into account potential risks, physical barriers and opportunities for additional connection relating to these routes.

The conclusions of the technical design phase should include a technical assessment of risk and opportunity to identify the main anchor loads that are required or could help to establish the infrastructure proposals.

The study should further discuss the primary energy generation options and identify suitable viable intermediate technology and peak energy supply plant to provide resilience. The report should provide the rationale for selecting the preferred technologies.

A detailed summary of the Technology Options is highlighted in Appendix A.

4.1.4 ECONOMIC ASSESSMENT

The economic assessment will include the development of an economic model for the technological solutions proposed in order to provide an indication of the comparative economic performance for a number of scenarios.

The economic model should identify key assumptions for the development of the analysis. The model should identify costs and revenues for the options and assess economic viability of the proposed solution(s) using a whole life costing approach including consideration of:

- Capital cost of generation plant, energy centre(s), thermal storage, electricity and heat network assets, customer interface units and smart metering;
- Operation and maintenance costs and planned asset replacement costs during the life of the project;
- Fuel costs, and wholesale price of heat from external energy sources;
- Energy sales income based on market competitive energy supply tariffs for each consumer type (options for electricity sales should include as relevant consideration of options for selling power wholesale, netting off and private wire);
- Support measures such as FiT, RHI, ROCs, and CfDs that could support the business case for the project;
- The business as usual case for each identified customer or groups of customers; and
- Calculate pay-back-period, IRR and NPV over an appropriate lifetime (for example 25 or 40 year duration) and based on public and private sector hurdle rates to be agreed with the project stakeholders.

The economic model should be capable of testing a number of technology options, and should be capable of taking into account inflation and forecast energy price rises over the life of the scheme. The model should also be capable of presenting a sensitivity analysis around the key variables that influence the project economics.

The commercial assessment of the project should include a discussion of appropriate delivery models (for example ESCo's) taking into account the results of the techno-economic analysis. Detailed business case modelling and delivery model assessment is generally carried out at the feasibility stage and beyond.

4.1.5 COMPARATIVE ASSESSMENT OF SCENARIOS

The analysis should make an assessment of the suitability of each of the modelled scenarios based on the project owners' key drivers. It may be appropriate to use a method of ranking of the modelled scenarios.

Depending upon the scope of the masterplan it may be necessary to develop further narrative around the most favourable scenarios identified. This may extend to evaluating the options available for delivery, ownership and management of the energy project.

4.1.6 PROJECT REPORTING

The report should present policy recommendations in consultation with the stakeholders to ensure that new development includes provision for safeguarding the proposed scenarios. It is advisable that this includes clear identification of policy and planning measures that incentivise developers to commit to appropriate infrastructure and oblige customers to connect.

The findings of the masterplanning phase should use mapping to clearly identify a spatial representation of high potential heat availability, potential energy centre locations, high density of heat demands and interconnecting networks which can be used to inform planning policy.

The report should identify any planning policy measures that could be adopted in the LDP including a zoning strategy for heat and development phasing.

5. Case studies

Energy masterplanning activities have been ongoing in the UK for the past few years, including a number of projects in Scotland. Examples of energy masterplanning activity that have been undertaken in the last two years include London, Newcastle, Leeds, Manchester, Merseyside, Nottingham, Sheffield, Birmingham, Oxford, Bristol and Cardiff amongst others. These projects are progressing to subsequent stages of feasibility and business case development and the installation of systems.

Examples of recent energy masterplanning activity in Scotland includes: Glasgow (Clyde Gateway and Commonwealth Games Village); Edinburgh (Edinburgh International, Fountainbridge, and Edinburgh BioQuarter).

The delivery of masterplanning activity in the UK is coordinated by various organisations. In London, England and Wales the lead organisations have been DEPDU (London) and DECC (through their HNDU unit), these are described briefly below. In Scotland, these activities are for the most part coordinated through the Heat Network Partnership (HNP) where funding for these kinds of studies may be available.

5.1 LONDON

Existing UK best practice originated with the Greater London Authority's (GLA) briefs to consultants for commissioning energy masterplanning work. The GLA template for engaging consultants has been refined and informed by the outputs of the masterplanning work which have been undertaken as a result of this. In particular a manual was developed on behalf of London Borough of Haringey titled Decentralised Energy Masterplanning – a Manual for Local Authorities (Ove Arup and Partners, 2011).

The masterplans undertaken under the GLA template were developed to also consider electricity and cooling in many cases and this has been built into the overall methodology.

The GLA provided grants to London Boroughs to carry out a heat mapping study for their area with additional support from the DEMaP team of experts. 29 heat mapping studies were carried out between November 2009 and March 2012. As part of this work, each of the boroughs developed implementation plans to help them take the decentralised energy opportunities identified to the next stages. The implementation plans include barriers and opportunities, actions to be taken by the council, key dates and personnel responsible.

The heat map reports provide a useful compendium of case studies that can be viewed at http://www.londonheatmap.org.uk/Content/resource_library.aspx. The ongoing delivery of these projects is being coordinated through the decentralised energy programme delivery unit (DEPDU).

[1] http://www.londonheatmap.org.uk/Content/uploaded/documents/EMP_Manual_lo.pdf

Some key exemplars from this process have been:

BUNHILL DISTRICT HEATING SCHEME PHASE 1:

Phase 1 of the Bunhill District Heating scheme was commissioned by Islington Borough Council in London in order to tackle fuel poverty in the local area. This project connects 850 homes and 2 leisure centres to a 1.9MWe gas CHP unit. The scheme itself is owned and managed by Islington Borough Council.

The project has subsequently gone through a further Masterplanning stage to consider a wider future proofed network and Phase 2 of the scheme is now underway.

http://www.isep.org.uk/wp-content/uploads/BUNHILL-case-study-2013.pdf

http://www.islington.gov.uk/services/parks-environment/sustainability/energy-services/Pages/bunhill-heat-power.aspx

Bunhill has gone through the process from strategic planning (as part of the London heat map project) to Masterplanning, Feasibility and Design and Build.

Other recent energy masterplans in London of note are:

London Borough of Brent Wembley Regeneration Area Energy Masterplan - June 2013 (Ramboll)

http://www.londonheatmap.org.uk/Content/uploaded/documents/Wembley%20EMP.pdf

This masterplan considered options for providing decentralised heating and cooling to a large area of regeneration around Wembley stadium.

Royal Borough of Kingston upon Thames: Energy Master Plan Final Report – July 2013 (AECOM)

http://www.londonheatmap.org.uk/Content/uploaded/documents/Kingston%20EMP.pdf

This project defined a core Phase 1 project to be developed in the Royal Borough of Kingston upon Thames based on a gas engine CHP with a clear vision for future expansion.

London Riverside Opportunity Area Energy Masterplan - October 2013 (Ramboll)

http://www.londonheatmap.org.uk/Content/uploaded/documents/London%20Riverside%20EMP.pdf

This project was centred on a planned Energy from Waste Facility in East London and involved the connection of various industrial and commercial loads to the scheme as well as safeguarding for connection to other areas of the city and planned large scale residential developments.

Euston Area Energy Masterplan - December 2013 (Arup)

http://www.eustonareaplan.info/wp-content/uploads/2014/04/EED5-EAP-Energy-Masterplan-Report.pdf

This project explored the potential for district heating associated with planned redevelopment in the Euston area.

5.2 ENGLAND AND WALES

It should be noted that there are few schemes in the UK that have been progressed through the full sequence of Energy Masterplannng stages outlined in Figure 2. Many schemes go directly to masterplanning, skipping regional strategic assessment and other small developer led projects go directly to feasibility. The decision as to which stage is the most appropriate will largely be dependent on the scale of the proposed project and any previous work that has been undertaken.

The Department of Energy and Climate Change (DECC) established the Heat Networks Delivery Unit (HNDU) to provide financial support and guidance to local authorities exploring heat network opportunities. This innovative support unit combines grant funding with guidance from a dedicated team of commercial and technical specialists. All local authorities in England and Wales can apply for support through a series of funding rounds. Round 4 closed in November 2014. It is understood that HNDU intends to publish the results of the masterplanning work.

At present the largest strategic level projects to have been carried out are in Leeds and Manchester. These have been led by a Regional Authority or an association of local authorities. The output from these regional assessments has been a pipeline of energy masterplanning and feasibility projects for decentralised energy schemes. Many of these are being progressed under the HNDU funding scheme and many are already underway.

5.3 SCOTLAND

Scotland's Heat Map was formally launched by the Scottish Government in early 2014, and is in the process of being rolled out to every Scottish local authority. The data sets and heat map for their area will also support local energy planning activity. These heat maps data sets are right up to date and provide the perfect starting template or toolkit with which to undertake low carbon energy masterplanning on a zonal basis. An additional benefit of the GIS based heat maps is the identification of key renewable heat opportunity areas within each council area. This will help provide clear guidance as to where the focus of energy masterplanning activity should be concentrated upon going forward, and will allow users to identify where there opportunities for decentralised energy projects across Scotland.

To date there has been a relatively modest amount of formal energy masterplanning activity in Scotland that has resulted in the delivery of projects on the ground. Information on some of these schemes is available on the HNP website. The examples presented below are primarily focussed on towns and cities where energy density is high and medium. However, the principles of energy masterplanning also remain applicable to a broad range of geographies.

5.3.1 Glasgow

There are a number of existing decentralised energy systems in Glasgow that have been developed at Wyndford Estate, Ibroxholm and at the Commonwealth Games Village. Further feasibility activity has been undertaken for decentralised energy to connect to heat networks has also been undertaken. The STEP UP project team at Glasgow City Council is currently working on producing an enhanced Sustainable Energy Action Plan (SEAP) which will be called 'Glasgow's Energy and Carbon Master Plan 2014 – 2020' .

The Clyde Gateway is a c.2000acres regeneration area in the east end of Glasgow and was earmarked as the primary site for the Commonwealth Games in 2014. Scottish Power Energy Networks (SPEN) was set the task of measuring and profiling the existing and proposed energy use and infrastructure requirements for the area in 2010/11, and produced a "Clyde Gateway: Energy Resource and Technology Assessment - Energy Masterplan".

SPEN investigated opportunities for supplying energy to the Clyde Gateway area from low and zero carbon technologies and carried out a network analysis and impact assessment for prospective developments. This led to the production of an Energy Masterplan and dynamic model which identified technically feasible projects. The initial business case that resulted led to the development of commercial and financial investment models including, amongst others CHP and DH network solutions that were implemented for the Games Village itself.

Following masterplanning work to date Glasgow City Council are considering plans to establish an ESCo which aims to develop a range of renewable energy initiatives across the city.

[2] www.scotland.gov.uk/heatmap

5.3.2 Edinburgh

The University of Edinburgh already own and operate a decentralised energy scheme comprising four separate networks supplying heat, cooling and electricity from gas CHP to a number of their campuses. A district heating connection also exists from the North British Distillery to Tynecastle School and a small district heating network supplies two residential blocks at Craigmillar. Waste heat supply and other future networks have been considered at a number of locations in the City.

Notably recent energy masterplanning activity has been completed for Edinburgh International (West Edinburgh), early activity has commenced in relation to opportunities at Edinburgh BioQuarter, and at Fountainbridge area sustainable energy principles have been applied to early stage place-making masterplanning work.

Ramboll Energy prepared an Energy Masterplan for Edinburgh International Development Partnership (EIDP) stakeholders in late 2012, and identified a number of viable opportunities for low Carbon electricity generation at the site from a number of technologies.

HEAT NETWORK OPTIONS

- Technology Based on Natural Gas CHP + Gas back-up boilers
- Heat Network Modelled at Five Scales:
  - EIDP PH1
  - EIDP PH2 (excl resi + RBS)
  - EIDP PH2 (incl resi + RBS)
  - Full Development (excl W. Craigs)
  - Full Development (incl W. Craigs)
- IRR ranged fron 5.9% to 15.1%
- Airport + RHASS + IBG Phase 1 most attractive

Copyright: Contains Ordnance Survey data © Crown copyright and database right 2012.

Figure 3: Extract from Edinburgh International Energy Masterplan – heat network options

The EIDP study also outlined potential viable heat network opportunities that could deliver carbon reductions against the business as usual alternative. Consideration of the opportunity to distribute heat outside the EIDP site by extending the heat network into RBS HQ, West Craigs, Edinburgh Park and South Gyle was also assessed.

Sustainability feasibility work has also taken place in support of the overall Fountainbridge place-making masterplan led by City of Edinburgh Council in 2014. This was carried out by 7NArchitects supported by technical input from AECOM. This work concluded that a district heating network across the development site could achieve in the order of 26% carbon savings. An extended district heating network, also supplying the neighbouring sites of Boroughmuir High School, Springside and West Register, could also achieve 27% carbon savings. CHP have been recommended as the initial heat source, with heat pumps introduced to supply the second phase of the Fountainbridge scheme.

[3] http://www.stepupsmartcities.eu/ToolsandInspiration/EnergyPlanning/SEAPEnhancement/ GlasgowEnhancedSEAP/tabid/4205/Default.aspx

6. Further support and contacts

This guide has been developed to support a broad range of organisations that may be seeking to undertake energy masterplanning activity in the near future. This document can be used to define help define the broad 'scope of works' and can assist organisations when developing their briefs and in commissioning studies too. The guide has also been developed to reflect best practice.

The recently launched Scottish Government's Low Carbon Infrastructure Transition Programme (LCITP) has been designed to drive investment and delivery of, low carbon infrastructure across Scotland. Its aim is to simplify the landscape for low carbon projects across Scotland, whilst strengthening the financial and technical support available to them. The programme will build on the collective project and programme experience of partners including Highlands and Islands Enterprise, Scottish Enterprise, Scottish Futures Trust and the Scottish Government and is being supported under the new European Structural Funds Programme which was announced in spring 2015.

The LCITP will provide advice and support to low carbon projects across the private, public and community sectors taking into account that projects are rarely exclusive to one sector and are more commonly delivered across communities and geographic locations. The programme will also be flexible, responding to both market trends and new emerging technologies. The LCITP has been developed to support potential projects through the various phases of their evolution.

Useful contact details for organisations who can offer a range of advice and support, including, amongst others, information on the Scottish Government's Low Carbon Infrastructure Transition Programme and Heat Network Partnership Scotland (general advice, template contracts, project register etc) can be found in Appendix B.

APPENDIX A: Technology Options

The detailed and rigorous assessment of the technology options available sits very much at the core of the 'energy masterplanning' approach. There are inherent challenges associated with delivering a shift from the current methods of generation and distribution of power and heat. These will apply, to a greater or lesser extent to all of the technologies discussed below and will need to be considered on a case by case basis. They include:

- The capital investment and operation and maintenance costs will have to be carried by the project and justified through a robust business case;
- Environmental impacts associated with the deployment of technology which will be permitted and mitigated through planning and environmental permitting regulations (noise, air quality, visual impact, ecology, etc);
- The establishment and development of supply chains for the supply and installation of technology, which may impact on the cost and quality of solutions;
- Resilience of the technology to deliver reliable power and heat to customers; and
- The selection of suitable locations for deployment of solutions with a supportive local planning policy.

A.1 Low and Zero Carbon Electricity Generation

The trend in the market at the moment is for greater efficiency in the consumption of electricity and low and zero carbon generation in a combination of large scale plants and decentralised generation.

A.1.1 Solar PV

Photovoltaic cells (PV cells) convert solar radiation directly into DC electricity. Due to its modular nature Solar PV can be installed in almost any location at any size, i.e. on individual houses, commercial buildings or as large scale installations and in fields, similar to wind farms.

A.1.2 Wind Turbines

Wind turbines harness the power of the wind to produce electricity by powering a generator on the axis of the rotor. They can produce electricity without carbon dioxide emissions, and range in outputs from watts to megawatts. Wind Turbines are considered to be one of the most environmentally favoured forms of electricity generation as carbon emissions attributed to them are only due to the manufacturing process in constructing them.

Wind turbines can be installed as both onshore and offshore technologies; offshore wind turbines can be much larger than onshore ones and as such can produce a lot more electricity.

A.1.3 Wave and Tidal Energy

Both of these technologies are progressing through the development process but neither have been proven to work on a particular large scale. Tidal has progressed significantly in the last number of years and a number of test projects are in place. Tidal energy is captured using turbines mounted in free flow or on tidal barrages. They use some similar engineering solutions to wind energy for foundations and generation and these technologies can in some cases be installed in the proximity of wind farms and may be able to share the same infrastructure to bring power ashore. Tidal energy is one of the most predictable forms of renewable energy in the world.

Wave technology has been in development for a long time and a number of technologies have been tested at pilot and full scale. Waves are considered to be one of the largest sources of renewable energy on the planet.

A.1.4 Hydroelectric Energy

Electricity from hydro-electric technology makes up approximately 12% of Scotland's electricity. Whilst the general consensus seems to be that the potential for significant numbers of additional large scale plants is limited, there is substantial capacity for small community scale hydroelectric schemes.

A.2 Low and Zero Carbon Heat Supply Opportunities

New fuels and technologies are required to meet the challenges we face. In some cases this is through the utilisation of new technologies or improvements to old ones such as gas CHP units making more efficient use of existing fuel supplies.

In some instances this is being achieved by thinking of heat in a different way, for example using low grade heat to produce higher temperature heat through a heat pump. Some of the key low and zero carbon technologies available at the moment are outlined below.

A.2.1 Solar Heating

Solar thermal collectors convert the sun's radiation into heat, which is transferred to a medium such as a water/glycol mix (to prevent freezing), this is then used to provide hot water to a building through a heat exchanger. Solar water heating is usually used for hot water generation, as this is a year-round demand. It is not normally used for space heating as the greatest demand is in winter, when the sun's rays are weakest.

A.2.2 Biomass Boilers

Biomass, such as straw and wood, have always been important energy sources due to their relative abundance, accessibility and cost effectiveness.

However, by increasing the scale of the system from a single installation in a family house to a larger boiler plant supplying a district or community heating scheme, the efficiency is increased and the emissions can be treated to higher levels while maintaining sustainable economics.

A.2.3 Heat Pumps

The heat pump is essentially a refrigeration machine used in reverse by cooling a body of water or air down and heating air or water on the demand side to above ambient temperature. Thermal energy is drawn from a low temperature source and passed through the heat pump extracting heat energy and supplying this to buildings at a higher temperature. The low temperature source can either be natural; meaning the surrounding environment e.g. the air, ground or water body, or it can be man-made in the form of process or waste heat from industrial and domestic utilities. While the heat source may be renewable, a heat pump does require electricity input to operate and as such is a low carbon technology not a renewable one. In the future as the grid decarbonises the carbon emissions associated with heat pumps will reduce. The three primary types of heat pump are as follows:

- Air Source Heat Pump (ASHP);
- Water Source Heat Pump (WSHP); and
- Ground Source Heat Pump (GSHP).

A.3 Combined Heat and Power (CHP) Solutions

These are plants which can generate both electricity and heat. Typically electricity is the primary export which drives the business case for the plant. These can range from retrofitting existing fossil fuel power plants for heat extraction to modern CHP-ready Energy from Waste facilities. In traditional electricity generating stations up to 70% of the primary energy can be wasted through cooling, in modern CHP plants this can be reduced to as little as 15-20% wastage.

CHP plants can be connected to absorption chillers to provide cooling which increases utilisation of waste heat. This is referred to as combined cooling heating and power (CCHP).

A summary of CHP solutions are discussed below and are distinguished by their respective fuel source.

A.3.1 Energy from Waste

Energy from Waste facilities are currently experiencing a growth in popularity in the UK, these plants combust residual (non-recyclable) waste from homes and businesses to raise steam which generates electricity through a turbine from which heat can be recovered. Recently gasification and pyrolysis plants are being developed which thermally treat waste producing a "syngas" that can be combusted to generate steam or diverted to a gas CHP engine. These technologies are also commonly referred to as "Energy Recovery Facilities" or "Advanced Thermal Treatment" Plants. These are typically mid-size plants in the scale of tens of megawatts.

A.3.2 Gas CHP

These plants combust natural gas to produce both electricity and heat. The scale of these plants ranges from micro-scale CHP of a few kW to large scale power plants (CCGT or OCGT). In the case of natural gas they are using a fossil fuel; however carbon emissions are reduced through the offsetting of more carbon intensive electricity sources from the grid.

A.3.3 Anaerobic Digestion and Biogas CHP

Anaerobic Digestion plants break down organic waste (principally from agriculture, food and other organic process industry and sewage effluent). The biogas that is produced by these plants is zero carbon and can be combusted in a gas engine CHP plant to produce both heat and electricity. The scale of these plants are normally small to mid-size plants of around 0.5 – 10 MW.

A.3.4 Biomass CHP

Biomass CHP plants combust wood chips, pellets, straw or other biomass material to raise the temperature of a fluid (commonly steam) which generates electricity through a steam turbine and heat can be recovered. An alternative technology is an organic rankine cycle engine. Biomass CHP plants are very low carbon due to their fuel source and additionally offset more carbon intensive electricity from the grid. The scale of these plants ranges from mid-scale of around 10-50 MW.

A.4 The Role of Storage

Energy storage is a key challenge to managing the inconsistent demand and supply of heat and electricity. The demand profiles for heat and power vary on a daily and seasonal basis and renewable energy generation, notably wind and wave power, can be unpredictable, or as in the case with tidal energy only available at specific times of the day. Efficient methods of large scale storage of energy to balance the heat and power system are currently being researched and proven.

Pumped hydroelectric schemes are the primary large scale electricity storage solutions that currently exist. Large battery storages have also been deployed to provide back-up electrical capacity. Another potential solution is to use excess electricity to generate production of Hydrogen through the electrolysis of water. Hydrogen offers a medium to store energy during times of peak generation and low demand and can produce electricity and heat through fuel cells. Other technologies such as compressed air storage are also being researched.

Large scale heat or thermal storage in steel tanks generally for daily balancing of heat networks or underground reservoirs for inter-seasonal storage has been demonstrated in Denmark. In Sweden and Netherlands there are a examples of many underground thermal energy stores (ATES and BTES) that store low grade heating and cooling and provide interseasonal storage. These thermal stores provide capacity to store heat and can be used alongside other technologies including heat pumps and may help to optimise the utilisation of renewable electricity in the system. The UK Parliamentary Office of Science and Technology issued a helpful briefing note about energy storage in April 2015.

A.5 Energy Distribution

Generating electricity in a more decentralised manner will reduce the costs of the major infrastructure associated with transmission whilst ensuring greater local resilience and reducing energy lost through transmission.

The energy system has to be capable of delivering energy to consumers when it is demanded. Demand varies significantly over fairly predictable daily and seasonal cycles but a conversion to smart network technology and innovation in energy pricing may allow the capacity of the network to be utilised better through Demand Side Management of the system. National Grid already balances the network by turning on and off energy generation but if they could do the same with appliances on the demand side then this could release capacity in the system.

APPENDIX B: Contacts, Websites and Tools

Useful Contacts and advice:

Low Carbon Infrastructure Transition Programme (Scottish Government)
http://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP

Scotland's Heat Map (Scottish Government)
http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/Heat/HeatMap

Scotland's Heat Map Guide (Scottish Government)
http://www.gov.scot/resource/0041/00418413.pdf

Resource Efficient Scotland
http://www.resourceefficientscotland.com/

The Heat Network Partnership Scotland
http://www.districtheatingscotland.com

Energy Savings Trust Scotland
http://www.energysavingtrust.org.uk/scotland

Energy Storage
http://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-492

Scottish Building Standards
http://www.gov.scot/Topics/Built-Environment/Building/Building-standards

Reports and Policy:

The Heat Policy Statement 2015: Towards Decarbonising Heat: Maximising the Opportunities for Scotland (Scottish Government)
http://www.gov.scot/Publications/2015/06/6679

Electricity Generation Policy Statement 2013: (Scottish Government)
http://www.gov.scot/Topics/Business-Industry/Energy/EGPSMain

Decentralised Energy Masterplanning - A Manual for Local Authorities (Ove Arup & Partners Ltd 2011)
http://www.londonheatmap.org.uk/Content/uploaded/documents/EMP_Manual_lo.pdf

Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050
Department of Energy & Climate Change and Department for Business, Innovation & Skills
https://www.gov.uk/government/publications/industrial-decarbonisation-and-energy-efficiency-roadmaps-to-2050

The London Heat Network Manual
http://www.londonheatmap.org.uk/Content/TheManual.aspx

CIBSE and CHPA: Heat Networks Code of Practice for the UK: Raising Standards for Heat Supply
http://www.cibse.org/getmedia/2b67857e-d29a-4d0c-a658-2fe7addf4f5d/Heat-Networks-Code-of-Practice-for-the-UK_draft_consultation.pdf.aspx

Background Report on EU-27 District Heating and Cooling Potentials, Barriers, Best Practice and Measures of Promotion
http://setis.ec.europa.eu/system/files/JRCDistrictheatingandcooling.pdf

UK Parliamentary Office of Science and Technology: Energy Storage
http://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-492

Energy Demand Estimation:

CIBSE Guide F: Energy Efficiency in Buildings – Available to buy from CIBSE
http://www.cibse.org/knowledge/cibse-guide/cibse-guide-f-energy-efficiency-in-buildings

CIBSE TM46 Energy Benchmarks - Available to buy from CIBSE
http://www.cibse.org/knowledge/cibse-tm/tm46-energy-benchmarks

CIBSE guide AM12 Combined Heat and Power for Buildings - Available to buy from CIBSE
http://www.cibse.org/Knowledge/CIBSE-AM/AM12-Combined-Heat-and-Power-for-Buildings

Scottish House Conditions Survey 2012
http://www.scotland.gov.uk/Publications/2013/12/3017

Other useful websites:

Carbonbuzz
http://www.carbonbuzz.org/

Zero Carbon Hub
http://www.zerocarbonhub.org/

Association for Decentralised Energy
http://www.theade.co.uk/

London Heat Map
http://www.londonheatmap.org.uk/Content/home.aspx

CHP installation map of the UK
http://www.chpa.co.uk/district-heating-installation-map_790.html

APPENDIX C: Glossary of Commonly Used Terms

AD	Anaerobic digestion
ADE	Association for Decentralised Energy (formerly the – Combined Heat and Power Association) (www.theade.co.uk)
Advanced thermal treatment plant	Disposal of waste and generation of electricity using thermal treatment technologies.
Allowable Solutions	Proposed mechanism to allow house builders to contribute to off-site carbon abatement measures where all carbon emissions cannot be reduced on-site
Anchor Loads	Large buildings with relatively consistent heat demand such as leisure centres, hospitals or hotels that can act as a signficant heat offtaker and 'anchor' heat networks.
APEE	Energy Saving Trust's Advanced Practice Energy Efficiency Standard
ASHP	Air Source Heat Pump
ATES	Aquifer thermal energy storage
bara	Absolute Pressure Unit (bar)
barg	Gauge Pressure Unit (bar)
Biofuel	Organic material in either solid, liquid or gas state that is used in a combustion or thermal process to generate energy or synthesis fuels
BTES	Borehole thermal energy storage
Building Regulations	Regulations that ensure building work is carried out in line with defined minimum standards
CCGT	Combined Cycle Gas Turbine
CfD	Contract for Difference
CCHP	Combined cooling heating and power
CHP	Combined Heat and Power
CHPQA	Quality Assurance Scheme for Combined Heat and Power
CIBSE	Chartered Institute of Building Services Engineers
CoP	Coefficient of Performance
C&I	Commercial and industrial
DEC	Display Energy Certificate
DECC	Department of Energy and Climate Change
Decentralised Energy Systems	Decentralised Energy (DE) is defined by the GLA[4] as "energy which is produced close to where it's used." This means local generation of electricity and where appropriate, the recovery of surplus heat from this generation or other industrial uses for purposes such as building space heating and domestic hot water production. Heat is commonly distributed in District Heating systems, with the heat generated being pumped into homes, usually as hot water, through networks of reinforced pipes. Combining these solutions with heat storage allows the potential for balancing of the heat and power networks.
Delta T	The temperature difference between water flowing in the flow and return sections of the network.
Demand management	An automated control of demands within systems, usually non-critical appliances or processes, that provides a network operator with pre-defined authorisations to balance the demand with capacity in the network. The term usually applies in the context of smart energy systems.
DEMaP	Decentralised energy masterplanning programme
DEPDU	Decentralised energy programme delivery unit
Discount Rate	A rate, usually expressed as a percentage, which reduces the real value of an item over time.

District Cooling	A system of distributing cooling to residential and commercial properties through a network of pipes by pumping the energy in a carrier fluid (normally a water/glycol mix)
District Heating	A system of distributing heat to residential and commercial properties through a network of pipes by pumping the energy in a carrier fluid (normally a water or a water/glycol mix)
Energy centre	Building that houses heating plant for a district energy scheme
Energy Company Obligation (ECO)	Energy efficiency programme obliging large energy suppliers to deliver energy efficiency measures to domestic energy users
Energy storage	Storage systems that may be capable of retaining energy for short or long periods of time. These systems include fuel storage, multiple forms of thermal and electricity storage some of which are proven but more are being developed
EPC	Energy Performance Certificate
ERF	Energy Recovery Facility
ESCo	Energy Services Company – a professional business entity which provides energy and related services (usually for specific projects but may also provide more general energy efficiency/energy management services); designs, builds, operates and maintains a facility; and may offer performance and operating guarantees, including energy cost savings/CO2 emissions and reductions
FiT	Feed in tariff
GFA	Gross floor area
GIS	Geographic Information System
GSHP	Ground Source Heat Pump
GWh	Gigawatt hour
Heat Pump	A low temperature heat source can be converted to a higher temperature source by essestially using the refrigeration cycle in reverse.
HNDU	Heat Networks Delivery Unit (England and Wales)
HNP	Heat Network Partnership (Scotland)
Horizon 2020	EU funding programme covering research and innovation, including energy
IRR	Internal Rate of Return
JV	Joint venture - a legal entity that is created for a particular financial transaction or series of transactions that involves more than one organisation.
KPI	Key Performance Indicator
kWe	Kilowatts (electrical)
kWh	Kilowatt hour
kWth	Kilowatts (thermal)
LECs	Levy Exemption Certificates
Linear heat density	Heat density per metre of network (in one direction only) (MWh/m)
LZC	Low and zero carbon
Microgeneration	Small scale generation of energy (usually renewable) by a single residential or commercial unit and mainly for self-supply
MSW	Municipal solid waste
MWe	Megawatts (electrical)
MWh	Megawatt hour
MWth	Megawatts (thermal)

Netting Off	Commercial agreement between the generator and their electricity supplier where the generator is both buying and selling electricity the cost of any electricity bought from the supplier is considered to be the net of the value of electricity impoted and exported by the generator. (A higher value for electricity sold, may be acheived in this way)
NPV	Net Present Value
OCGT	Open Cycle Gas Turbine
OFGEM	Office of Gas and Electricity Markets
Organic Rankine Cycle Engine	The Rankine Cycle extracts energy when a working fluid undergoes a phase transformation between liquid and steam. The working fluid is boiled by the heat source, the steam powers a turbine, after the useable energy is released, the steam condenses back to a liquid, expelling its own waste heat in the process. The Rankine Cycle is widely used both in fossil fuel power generation and in solar thermal, biomass, and nuclear power plants, generating about 90% of all electric power used worldwide today.
Peaking plant	Heating plant that is in place to meet the peak demand in the scheme
PED	Pressure Equipment Directive
PFI	Private Finance Initiative
PPS	Planning policy statement
Private Wire	Electricity from a CHP is not exported to the grid rather provided to customers directly from the network operator
PV	Photovoltaic – panels that convert solar radiation into electricity
RHI	Renewable Heat Incentive
RO	Renewable Obligation
ROC	Renewable Obligation Certificate
Safeguarding Direction	Sets out areas where statutory consultation is required on planning applications, allowing planning authorities to avoid new obstacles to strategic developments
SHLAA	Strategic Housing Land Allocation
SHQS	Scottish Housing Quality Standard
SHW	Solar hot water – heated using thermal radiation from the sun
Smart energy systems	A smart energy system integrates hardware and system controls across the network. They require the investment in upgraded network infrastructure, domestic and non-domestic appliances as well as the control systems to allow smart management of the grid. Smart management includes the ability to optimise the use of storage and to implement demand management.
SPV	Special purpose vehicle – a legal entity that is created for a particular financial transaction or series of transactions and to isolate financial risk from one or more lead organisations.
Syngas	Fuel gas mixture consisting primarily of hydrogen, methane, carbon monoxide, and very often some carbon dioxide produced from the thermochemical conversion of biomass.
tphe	tonnes per hour equivalent (steam)
VRF	Variable Refrigerant Flow (type of air conditioning system)
WRAP	Waste and Resources Action Programme
WSHP	Water Source Heat Pump
WWTW	Wastewater Treatment Works
Z Factor	Ratio defining the amount of power reduction in a steam turbine per unit of heat extracted as steam from the turbine

[4] https://www.london.gov.uk/priorities/environment/vision-strategy/london-sustainable-development-commission

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Scottish Enterprise
Atrium Court
50 Waterloo Street
Glasgow
G2 6HQ

Helpline: 0845 607 8787
E-mail: enquiries@scotent.co.uk
www.scottish-enterprise.com

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