Guidance on project level socio-economic assessment

Draft methodology

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1. Non-technical summary

1.1 Introduction

Energy Efficient Scotland is the cornerstone programme for delivering Scotland's low carbon heat and energy efficiency priorities. Given the need for strategic planning of Energy Efficient Scotland across the 20 years of the programme, the Scottish Government has consulted in detail on the introduction of a new statutory duty on local authorities to develop Local Heat and Energy Efficiency Strategies (LHEES) . The Scottish Government has proposed that local authorities would be required to undertake a socio-economic assessment in developing their LHEES. This assessment should demonstrate that priorities have been designated appropriately according to national and local objectives, including fuel poverty.

Meanwhile, the Scottish Government has also proposed a district heating consents and licence regime, such that in their application for a district heating consent developers would be required to undertake a project level socio-economic assessment.

The aim of conducting any socio-economic assessment is to identify and evaluate the financial, environmental, social and resilience impacts associated with a given strategic intervention or project. Socio-economic analysis sits alongside the technical and financial analysis of any strategy or project.

In the context of energy and heat, socio-economic assessments can be utilised to provide an indication as to the effect that an intervention will have on indicators such as decarbonisation and fuel poverty across an area.

The Scottish Government has proposed that guidance for socio-economic assessments for both LHEES and district heating consents would be made available in the form of detailed methodologies, laying out the overarching process and standard assumptions.

This document provides the methodology and guidance on how to **appraise the socio-economic impacts of district heating projects** appropriately, through the implementation of Cost Benefit Analysis (CBA).

A similar but separate document details the methodology and guidance for assessing the socio-economic impacts of LHEES, through the application of Multi-Criteria Analysis (MCA). This is also available from the Scottish Government's website.

1.2 What is a Cost Benefit Analysis?

CBA assesses the costs and benefits from a proposed intervention against a baseline scenario, in this case a 'do minimum' scenario that complies with current legislation and regulation.

The principles of CBA are based upon the assumption that most (if not all) of the significant impacts from a given intervention can be monetised. This allows CBA to generate a single numerical value which can be used as a means through which varying interventions can be compared against the baseline.

In the context of appraising proposed district heating interventions, indicators such as the economic Net Present Value (NPV) can be used to determine whether a proposed intervention is better for society than the status quo. This is clearly an important consideration when Local Authorities are assessing proposed district heating interventions for consent, and will help to ensure that projects granted consent add value to society. An approach of this nature ensures that subjectivity in decision making is kept to a minimum, keeping the focus on quantified, verifiable inputs and objective analysis.

1.3 Who should use this document?

The methodology developed and presented here is directed at public and private sector practitioners and project managers across Scotland who may be required to appraise various district heating interventions through project level socio-economic assessments, as part of the proposed district heating consents and licence regime.

1.4 When should this guidance be implemented?

The step-by-step processes and guidance outlined throughout this methodology will provide a robust approach for conducting project level socio-economic assessments through CBA, and also provides the user with detail on how to set an appropriate baseline scenario for use in the assessment. The guidance can also be used to identify the types of outputs that can be expected, alongside the key uncertainties that are present when undertaking a socio-economic assessment.

The concepts outlined within this document are based on best-practice guidance and all approaches are illustrated with relevant examples.

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Abbreviations

BAU	Business as usual
BCR	Benefit-cost ratio
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
LHEES	Local Heat and Energy Efficiency Strategy
MCA	Multi-criteria Analysis
NPV	Net Present Value

2. Context

2.1 Introduction

2.1.1 Policy context

The Scottish Government's Climate Change Plan sets ambitious pathways for the decarbonisation of heat supply to buildings and reduction of their energy demand. Energy Efficient Scotland is the cornerstone of delivering these low carbon heat and energy efficiency priorities. The programme will be a strategic partnership with local government, building upon the successful components of existing programmes.

Given the need for strategic planning of Energy Efficient Scotland across the 20 years of the programme, the Scottish Government has consulted in detail on the introduction of a new statutory duty on local authorities to develop Local Heat and Energy Efficiency Strategies (LHEES)[1].

LHEES would be the link between long term targets, national policies and the delivery of energy efficiency and heat decarbonisation on the ground. They would allow local authorities to prioritise and target work, whether that is supporting owner occupiers and SMEs to install energy efficiency measures or encouraging the development of district heating or other low carbon heat.

The Scottish Government has proposed that local authorities would be required to undertake a socio-economic assessment, following guidance, in developing their LHEES. This assessment should demonstrate that priorities have been designated appropriately according to national and local objectives, including fuel poverty.

In addition to LHEES, to further strengthen local authorities' existing powers and support the delivery of low carbon heat infrastructure, the Scottish Government has proposed a district heating consents and licence regime. In their application for a district heating consent, developers would be required to undertake a project level socio-economic assessment[2]. The local authority would use the project level socio-economic assessment submitted by the district heating developer to decide on district heating consent applications. It would also use assessments as part of the criteria to judge tenders.

The Scottish Government has proposed that the guidance for socio-economic assessment for both LHEES and district heating consents would be made available in the form of a detailed methodology, laying out the overarching process and standard assumptions.

This document provides the methodology for assessing socio-economic impacts of district heating projects. There is a similar document detailing the methodology for assessing socio-economic impacts of LHEES, which can also be found on the Scottish Government's website.

2.1.2 What is socio-economic assessment

The purpose of conducting a socio-economic assessment is to identify and analyse the net impact on society of a given strategic intervention, relative to its closest alternative course of action.

[1] https://consult.gov.scot/energy-and-climate-change-directorate/lhees-and-dhr2/
[2] https://consult.gov.scot/energy-and-climate-change-directorate/local-heat-and-energy-efficiency/

In contrast to technical and financial analyses, socio-economic analyses assesses the impacts of a project or programme for the community beyond those directly involved in the formulation and negotiation of the content and scope of what is being delivered. In particular, in the context of energy and heat, socio-economic assessments allow consideration of impacts on fuel poverty and decarbonisation to be considered alongside the financial and technical viability of an intervention.

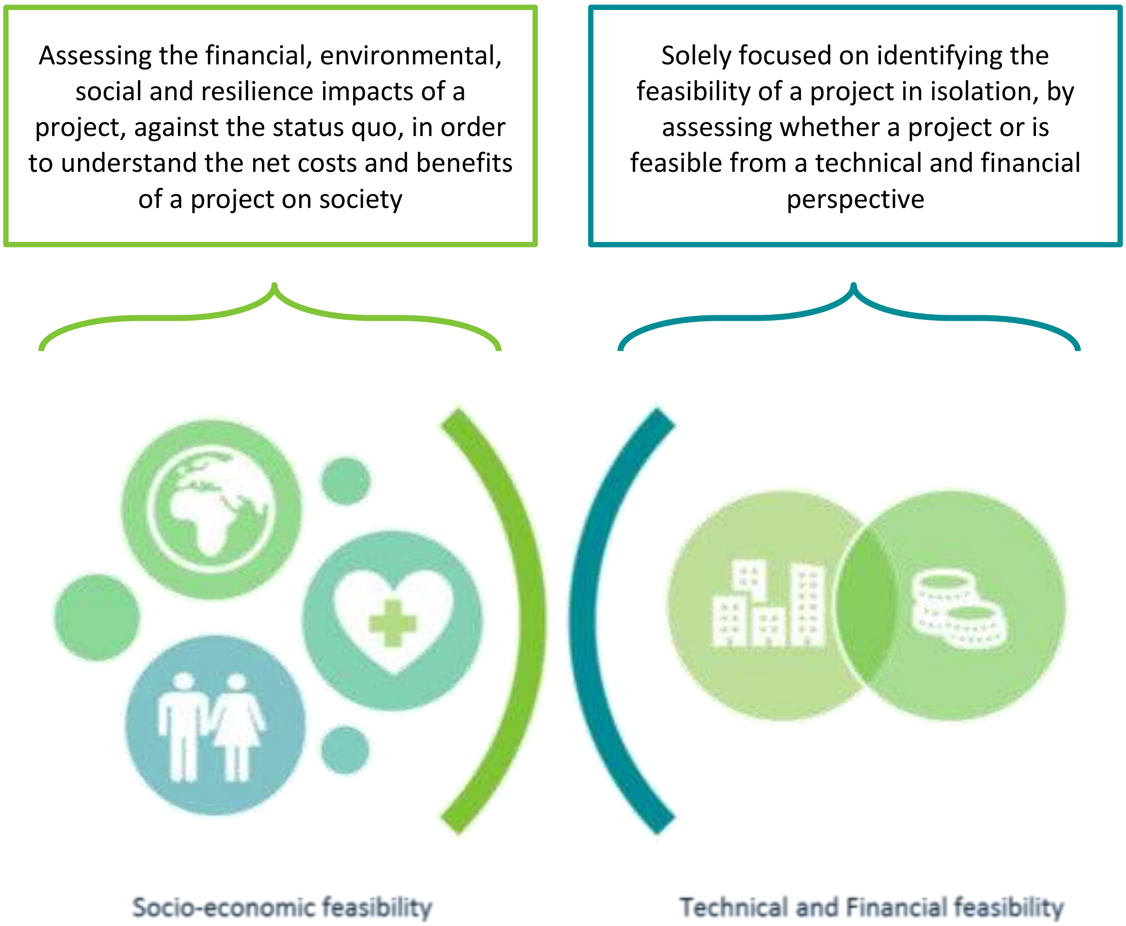
Technical and financial assessments are strictly limited to the direct impacts of a project; that is, they cover the technical and financial viability of a project, including an assessment of any constraints which could prevent the project from going ahead. Such constraints could include road access issues faced by the project developer, or limits to potential building fabric improvements due to a building’s listed status.

Where a technical and financial analysis looks at whether a project or initiative stacks up on its own terms, a socio-economic assessment needs a basis for comparison because socio-economic assessments look at how a proposed intervention affects the status quo for society, across a range of different aspects.

In order to assess accurately all of the impacts of an intervention, it is necessary first to understand where and to what degree a given impact will influence the status quo; for instance, how an intervention in the form of a proposed heat network is likely to affect fuel poverty in a given zone, relative to the status quo of continued reliance on individual heating solutions. To avoid “cherry-picking” of potential impacts, which would bias the assessment one way or another, a socio-economic assessment must follow a robust, structured approach.

The socio-economic assessment methodology detailed within this document is based on best practice guidance from existing literature sources. A key document that has been referred to throughout is HM Treasury’s Green Book (2018). Key elements of the Green Book are shown in Box 1.

Figure 1 Illustration of socio-economic, financial and technical analysis of a project



This document provides guidance on how to conduct socio-economic assessment at the project level. Cost Benefit Analysis (CBA) has been identified as the most appropriate socio-economic assessment methodology for assessing district heating interventions at project level.

CBA assesses the costs and benefits from a proposed project (intervention) against what would happen otherwise (the status quo or baseline, also known as the counterfactual).

Converting as many of the costs and benefits into monetary values, including those that are not usually bought or sold under market conditions, allows the analysis to generate a single value such as a social Net Present Value, which estimates whether the proposed project is better for society than the status quo.

This approach is generally most useful when most of the impacts identified can be monetised.

Box 1: Key elements to note from HM Treasury's Green Book (2018)

HM Treasury's Green Book (2018) provides guidance on appraisal and evaluation of policies, programmes and projects, a key requirement in any undertaking where public resources are used. The key aim of the guidance provided in the Green Book is to support decision making processes across all sectors in which UK public sector policy makers and practitioners are involved.

The following points of guidance from the Green Book have been considered:

> Identifying the correct valuation methods for energy usage and greenhouse gas emissions.

> Applying a suitable baseline methodology to serve as a benchmark from which alternative interventions can be compared.

> Taking into consideration costs and benefits that occur across different periods of time – by implementing a social discount rate of 3.5% in real terms.

> The appraisal of social value should be conducted using prices which are representative of values during the chosen base year (see section 3.3.2).

> Caution should be applied when calculating local employment impacts (termed 'labour demand'), as any deviations from a proposed intervention cannot be reliably measured or observed from a national perspective.

> Amending Cost Benefit Analysis outputs to take into consideration risk and uncertainty.

The methodology described in this guidance has been tailored specifically for the development of project-level district heating interventions. The intention is that this guidance sits as a comprehensive, stand-alone document aligned with existing best-practice guidance available in the UK and consistent with the development of the Green Book Five Case Model in public sector decision-making (which is covered in Table 6 of this guidance document).

2.2 How to use this document

This document is intended for public and private sector practitioners and project managers across Scotland, who, under Energy Efficient Scotland, may be required to develop socio-economic assessments of district heating interventions (i.e. proposed district heating schemes/projects).

This document aims to guide the user through the step-by-step processes that are needed to conduct an effective, robust socio-economic assessment. Concepts are based on best-practice guidance and the approaches outlined are replicable and illustrated with relevant examples.

The structure of this document focuses on:

- communicating the inputs required to conduct assessments;
- detailing how to set an appropriate baseline scenario;
- the process of calculating CBA;
- the key outputs which should be expected from assessments; and
- the importance of conducting uncertainty and sensitivity analysis.

3. Project Level Cost Benefit Analysis- Draft Methodology

3.1 Overview

CBA is an assessment tool used in a variety of applications to inform investment decisions and estimate net benefits to welfare and society[3]. CBA assesses as many of the impacts of a given project or programme as possible in monetary terms, using a single figure that summarises all costs and benefits.

Conducting a CBA supports the identification of interventions that offer the best value for money and positively contribute to social welfare, for example through positive environmental impacts and economic growth[4]. Figure 2 shows a definition of a good CBA.

Figure 2 Institute for Government's report on how to value infrastructure, highlighting what a good CBA looks like (2017)

What does good Cost Benefit Analysis look like?

- ✓ It includes all relevant impacts
- ✓ It is realistic about costs
- ✓ It is consistent
- ✓ It is transparent and well communicated

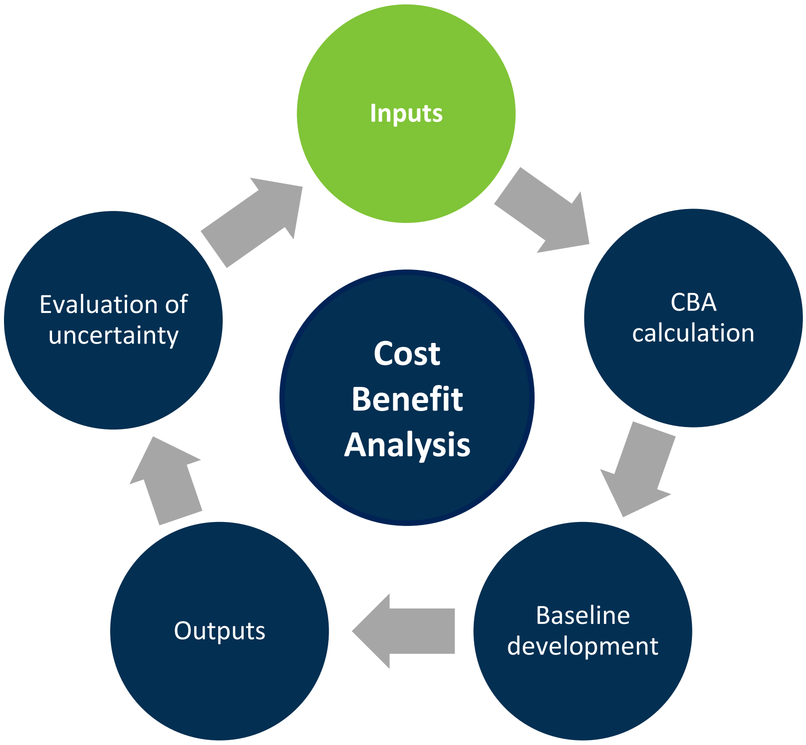
The powerful nature of assessing as many outcomes as possible in monetary terms has resulted in CBA becoming a popular methodology for a number of European Commission schemes, including the European Regional Development Fund, where the feasibility of projects submitted to the fund are scrutinised using CBA frameworks[5].

A limitation to CBA is that impacts which cannot be monetised are not considered in the CBA calculation. This is problematic if non-monetisable impacts are significant in scale. An augmented CBA methodology has therefore been proposed to ensure that non-monetisable impacts are also taken into consideration through quantitative or qualitative assessment. A narrative of the non-monetisable impacts will sit alongside the results of the CBA calculation.

Under the proposed duty, CBA has been identified as the most appropriate methodology for project-level socio-economic assessments. These project level socio-economic assessments are expected to be applicable only to district heating interventions, that is, comparing a potential district heating scheme against a baseline that is in line with existing policy and regulation at the time of development (termed 'do minimum').

[3] Atkinson, G. and S. Mourato (2015), "Cost-Benefit Analysis and the Environment", OECD Environment Working Papers, No. 97, OECD Publishing, Paris
[4] Department of Transport, Transport analysis guidance: WebTAG, updated December 2017. UK
[5] European Commission, Guide to Cost-Benefit Analysis of Investment Projects, 2017. EU

3.2 CBA – Inputs



The value of CBA lies in monetising as many of the impacts from a project as possible. All potential impacts therefore need to be identified, assessed and, where possible, monetised.

This section provides an overview of the potential impacts which are likely to be included in a project-level socio-economic assessment. For each impact, indicators need to be identified which allow assessment of the impact. This section therefore also identifies suitable indicators, how they can be assessed and subsequently where to source data in order to monetise them.

3.2.1 Identifying impacts of district heating projects

The impacts of district heating projects can be organised into four categories:

- **Financial**
- **Environmental**
- **Social**
- **Resilience**

N.B. **Local economic impacts** can also be assessed but these will not be included in the CBA calculation under this methodology. The reasons for this are discussed in the Local economic impacts section below.

The impact categories are discussed below, with an overview of the likely impacts, indicators and methods of assessment and monetisation provided in Table 1. Ahead of conducting a

CBA, however, a brainstorming session should be conducted to understand all potential impacts of the particular proposed district heating scheme which you are considering, given its particular local context.

3.2.1.1 Financial impacts

The financial impacts considered in a socio-economic analysis of a district heating project will principally consist of the:

- **Capital investment costs**
- **Maintenance and operation costs**
- **Fuel costs**

It is important to note that considering the financial impacts of an intervention in a socio-economic analysis is entirely different and separate to the financial appraisal of a project. For example, the financial appraisal will also consider the cost of finance, tax and revenue streams. As previously discussed, the socio-economic appraisal of a project sits alongside the technical and financial appraisals in order to aid decision making; socio-economic analysis aims to quantify the net sum of all impacts on society of a proposed intervention against the status quo.

The technical and financial appraisals of an intervention will, however, be a data source for the socio-economic analysis. For example, the financial impacts noted above (capital investment, maintenance and operation, and fuel costs) should ideally be sourced from the financial appraisal. Where a financial appraisal is yet to be conducted, or where robust local data does not exist for the baseline scenario, a **Cost Database**[6] has been developed to sit alongside this methodology. N.B. This Cost Database should only be used when other more reliable source(s) of data are not available. An example of a reliable alternative source would be a recent feasibility study for a similar district heating scheme elsewhere in the same or a similar local authority area.

Technical Note: The values used for financial impacts will be the market prices. In countries where there are high levels of subsidy and taxation all market prices are converted into shadow prices, since the market prices are not considered to reflect the opportunity cost of the inputs and outputs due to distortion from taxation and subsidy regimes. It will not be necessary to apply this approach in Scotland as the market prices are a fair representation of the opportunity cost, due to low levels of taxation and subsidy for energy/heat in the UK.

Revenues, taxes and subsidies

Note that no revenues, taxes or subsidies should be included in the financial cost estimates for the CBA.

Taxes and subsidies are not included because socio-economic assessments are conducted from the viewpoint of the country as a whole ('Scotland Plc'), which implies that taxes and subsidies are flows of money from one part of the economy to another and therefore cancel each other out.

[6] The Cost Database is available from the Scottish Government website

Revenues are not included because they are not an accurate reflection of the benefits or costs of a project or of the value of heat provision to residents connecting to the network (i.e. they do not necessarily reflect willingness to pay for a benefit or willingness to accept a cost).

For example, a district heating scheme may be designed with a principal aim of reducing fuel poverty in a given zone. The proposed heat network may be so effective at delivering heat that even allowing for an increased heat demand from each resident, the annual costs of heating would still be lower than what they are paying in the business as usual (BAU) scenario. An illustration of this is provided in the table below:

	Proposed low-cost district heating scheme	BAU scenario
Annual total revenues from residents in fuel poverty zone	£350,000	£370,000
Annual total heat demand from residents	3,800 MWh	3,400 MWh

In this example, revenue is lower for the highly efficient district heating scheme than in the BAU, despite a higher heat demand. This is because the per unit cost of heating is significantly lower in the proposed district heating scheme and it is expected that a household currently living in fuel poverty would be likely to increase their annual heat demand to achieve higher levels of household thermal comfort. Residents in the scheme who are not affected by fuel poverty would be more likely to retain their existing level of heat demand and enjoy a cost saving on their annual bill. In total, a district heating scheme may therefore increase the annual heat demand from residents yet still have lower costs.

Revenues in this scenario would not accurately reflect what customers would be willing to pay, which is implied by the higher costs in the BAU; when looked at in isolation, this could therefore understate the benefit of the proposed district heating scheme.

Price year

It is crucial to make a note of the year in which the financial cost estimates are made. For example, the investment cost for a district heating system might be sourced from a feasibility study conducted in 2017. Assuming no other reference year is given, all the costs would then be in 2017 prices; however, the data provided in the Cost Database for the baseline may not be from the same year, so a direct comparison between costs for the proposed district heating plant and the baseline would not be at the same price level, thereby unintentionally introducing bias into the socio-economic assessment. Guidance on how to bring all estimates of impacts to the same price level is provided in Section 3.3.4.

3.2.1.2 Environmental impacts

The environmental costs and benefits of a district heating project range from impacts on air quality and greenhouse gas emissions through to noise from construction and impacts on biodiversity and local heritage.

It is important to ensure that impacts are considered across the construction, in-use and post-use phases, as these can often be different.

The complexity of assessing and monetising environmental impacts is that for many of these impacts, market prices may not exist.

Monetising impacts without a market value

Where impacts do not have market prices, for example with air quality pollutants, it is still possible to monetise them through a variety of techniques, generating what is referred to as a *shadow price*. In the field of socio-economic assessment, there are several techniques available for generating a shadow price, which require varying levels of effort.

The Green Book recommends that the effort used in the socio-economic analysis should be proportionate to the size of the study and impact. In light of this, for the purpose of assessing district heating impacts where market prices are not available, *generic prices* should be sought to calculate a *shadow* price. *Generic* prices provide a unit price that can then be multiplied by the volume of the impact in order to monetise it. For example, generic "damage air quality" cost prices exist per tonne of air pollutant. Where generic prices exist for the indicators of impacts, these are provided in the Cost Database.

Where impacts cannot be monetised

Not all indicators of impacts have generic or market prices, for example the indicators of the impact on biodiversity. This means that some indicators are not able to be monetised for inclusion in the cost benefit analysis calculation. Where this is the case, these indicators should still be considered and assessed either qualitatively or quantitatively, with their assessment sitting alongside the results of the CBA calculation in an appraisal summary table (see Table 1) so that they are still made visible and can be considered at the same time as the results of the CBA.

Table 1 provides an overview of the impacts and indicators that should be assessed in the appraisal of district heating interventions. For those that can be monetised, the indicators and market or generic prices are provided, and for those that can't be monetised, a method of assessment is provided.

Technical Guidance

How to assess and monetise GHG emissions

For both the intervention and the baseline, the annual fuel consumption needs to be calculated, data for which would be available from the technical appraisal. The appropriate carbon emissions factor, available from DEFRA, would then be applied to calculate tonnes of carbon dioxide equivalent (tCO_2e) emitted. The annual emissions would then be multiplied by the unit price per tCO_2e, price data which is available from HM Treasury. Consideration needs to be given to the fact that there are different prices for traded and non-traded emissions sectors: emissions need to be calculated separately for traded and non-traded sectors. Consideration also needs to be given to the grid decarbonisation scenario used; decarbonisation scenarios are published by BEIS. A range of low, central and high unit costs are available. Using the central scenario is recommended by the Green Book, with high and low scenarios used for sensitivity analysis. Please see the Green Book supplementary guidance: V*aluation of energy use and greenhouse gas emissions for appraisal* for more detailed advice. All data and sources mentioned above are provided in the Cost Database.

3.2.1.3 Social impacts

The social impacts to be assessed range from thermal comfort and fuel poverty, through to sense of community and quality of built environment and local heritage. As discussed above under the sub-heading "Where impacts cannot be monetised", the indicators of these impacts cannot be monetised as shadow prices and market prices do not exist; as per the Green Book's guidance, due to the size of the projects it is not worthwhile to pursue other time- and cost-intensive methods to monetise these impacts. As discussed above, a qualitative or quantitative assessment of these impacts can still be conducted and can sit alongside the CBA results in the appraisal summary table. Table 1 provides further advice on methods to appraise the potential societal impacts.

3.2.1.4 Resilience impacts

The resilience impacts to be assessed include energy security and energy demand. As above, these can both be quantitatively appraised though will not be monetised. Table 1 provides further advice on methods to appraise these impacts.

3.2.1.5 Local Economic impacts

In accordance with the Green Book, local economic impacts, notably for employment, are not monetised directly in a cost benefit analysis. This is because most projects are of a size that their impact on employment is small when viewed from a national level.

Jobs supported can be considered separately as part of a local economic analysis. If increased employment is a key part of this local economic impact analysis it is important to distinguish between jobs created and jobs supported by the project.

As with jobs, supply chain impacts are not directly monetised in a CBA. A narrative of the potential local supply chain and employment impacts can sit alongside the CBA calculation results in the appraisal summary table, for example identifying the sectors of the local economy which are likely to gain or lose economic activity and employment as a result of the project.

Table 1: The potential impacts and indicators for district heating projects and baseline scenarios to be assessed. If indicators can be monetised, the unit price data available is provided. For indicators that cannot be monetised (and therefore not included in the cost benefit calculation), their method of assessment is stated.

Impact classification	Impact	Indicator	Unit price data if the impact can be monetised	Method of assessment / Considerations
Financial	Capital costs	Capital costs	Total cost assessed in separate financial appraisal or £/kW or £/MW applied from cost database	Capital costs should be available from the financial feasibility study. Baseline data to be sourced – either from similar feasibility studies or the Cost Database.
	Operation and Maintenance costs	Operation and Maintenance costs	Total cost assessed in separate financial appraisal or £/kW or£/MW applied from cost database	Operation and maintenance costs should be available from the financial feasibility study. Baseline data to be sourced – either from similar feasibility studies or the Cost Database.
	Fuel costs	Fuel costs	£/kWh or £/MWh	Fuel consumption data available from the technical feasibility study. BEIS price projections to be applied- Annex M. If local fuel prices are available these can be used with the growth trend of the BEIS price projections applied to the market prices without VAT & CCL. Baseline data to be calculated.
Environmental	Carbon emissions	GHG emissions (tonnes CO_2e)	Traded and non-traded prices of carbon (£/tCO_2e) – see database	Fuel consumption data available from the technical feasibility study. Emission factors applied to fuel consumption followed by either the traded or non-traded price of Carbon. Baseline to be appraised in the same way. Consideration needs to be given to the decarbonisation scenario applied.

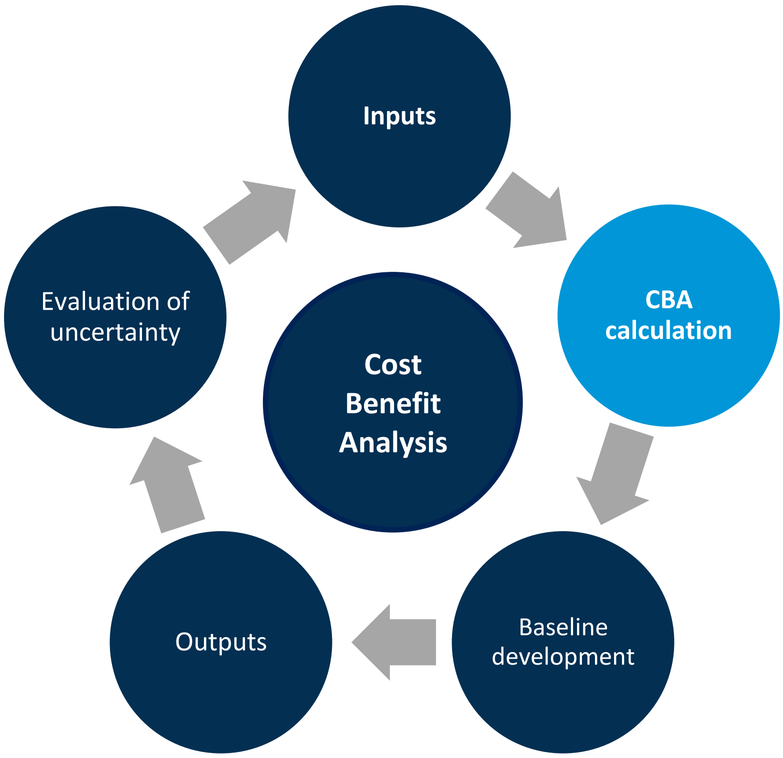
	Air quality	Volume of pollutants (tonnes of nitrous oxide, particulate matter, sulphur oxide and ammonia)	£/t pollutant – see database	Fuel consumption data used to calculate the volume of pollutants. The volume of each pollutant multiplied by the damage cost price per tonne unit data available.
	Noise	Noise levels (dB)	£/dB – see database	Noise levels may be quantified in environmental impact assessment or the technical feasibility study. The price per decibel then multiplied by the annual level of noise generated.
	Built environment & local heritage	Quality of built environment		Consider whether an intervention will influence the quality of the surrounding built environment, and what impact this will have on local heritage.
	Biodiversity and ecosystem services	Proportion of natural habitat		Assess whether there will be an increase or decrease in areas of natural landscape against the baseline. It may be possible to quantify this and provide a narrative on the type(s) of landscape being affected and the possible impacts.
Social	Fuel poverty	Risk of fuel poverty within an area		An appraisal of the overall fuel poverty risk of the area. How many fuel poor households are present? What are the drivers of fuel poverty in the area? Consider whether intervention is likely to have an impact on the drivers and levels of fuel poverty.
		Change in unit cost of heat (£ per kw)		The unit cost of heat of the proposed intervention may have been identified during technical feasibility, allowing the % change from the BAU scenario to be identified. This will allow a scoring scale to be

				developed according to the range of percentage changes. If not, it may be possible to determine which fuel sources
		Change in average EPC rating		What affect will an intervention have on average EPC ratings across the local area? This metric will be strongly correlated with fuel bill savings.
	Physical and mental health and wellbeing	Thermal comfort		An appraisal of whether there is likely to be an improvement of thermal comfort. If the unit cost of heat has fallen, is it likely that residents will use more heat, but spend the same amount on energy overall in order to improve thermal comfort? It may be possible to quantify the number of households impacted.
		Proportion of recreational and community space		It may be possible to quantify a change in the proportion of recreational and community space, and provide a narrative on how this would impact the local area. An example here could be if the energy centre of a district heating system is to be located on land currently used by the community.
Resilience	Energy Security	National vs international sourcing of fuel		An assessment of where the fuel will be sourced from and whether this has a positive or negative impact on fuel security.

3.2.2 Inputs checklist

Good practice checklist for indirect impact inputs		
✓	**Have all impacts been identified?** Table 1 provides a list of impacts to consider. Identify whether there are any others that should be appraised.	
✓	**Monetise impacts where possible** Where there is unit cost data for indicators of impacts these should be monetised. Use data available in the Cost Database (which can be found at the Scottish Government website).	
✓	**Assessing economic impacts** Employment impacts are not monetised directly in a cost benefit analysis but can be considered within a separate local economic assessment which sits alongside the CBA.	
✓	**Assessing non-monetisable impacts** Where impact cannot be monetised, these impacts should still be assessed quantitatively and/or qualitatively and the narrative around them should sit alongside the result of the CBA calculation..	
✓	**Capital investment, operation and maintenance, and fuel costs:** Values should be sourced from the financial feasibility assessment undertaken for the project (recognising that the financial appraisal in a socio-economic analysis is very different). Supplement with data from the database where values are missing and for the baseline scenario.	
✓	**Price levels** All cost estimates should include the year they were estimated, to ensure fair and accurate comparison can be made to values from different years.	
✓	**Taxation and subsidies** No taxes or subsidies should be included in any of the cost data. This includes VAT on equipment and services, and the Climate Change Levy on fuel costs.	
✓	**Revenue** No revenues should be included in the financial impacts.	

3.3 Cost Benefit Analysis – method of calculation



A key prerequisite of any CBA modelling is that the costs and benefits associated with any chosen intervention must be easily identifiable and monetised where possible, in order to maximise the robustness of the analysis undertaken. Before moving on to the method of calculation practitioners should confirm validity by ensuring that costs and benefits have been valued credibly.

3.3.1 Time Horizon

Calculated costs and benefits will need to cover the entire economic/functional lifetime of a project. The number of years adopted for this will largely depend on the nature of the intervention being chosen, with benchmarks often varying depending on the sector in question. The time horizon chosen for CBA will play a large role in determining the overall reliability and outcome of model outputs. This is due to the decline in direct effectiveness of an intervention over time[7].

For a **district heating project** the guideline time horizon appropriate for CBA is set to **40 years** from the start of the operation of the scheme. This may be less than the expected lifetime of some of the capital components of a district heating network, where the energy centre and pipework typically have expected lifetimes of 40-60 years. Extending time-horizons beyond 40 years has been shown to cause significant increases in the uncertainties of associated costs and benefits of the project.

Where projects include capital components with lifetimes exceeding 40 years, straight line depreciation should be used to account for residual values. Calculating residual values will help to

[7] World Health Organisation, Guidelines for conducting cost-benefit analysis of household energy and health interventions, 2006

reflect the opportunity costs associated with projects at the end of the appraisal period. Examples of how to use straight line depreciation are included below:

Straight line depreciation: example for a 20-year CBA:

- A £6 million investment has gone into a new district heating network. This includes £3.5 million of investment into the pipe network and the energy centre, which have expected lifetimes of 50 years.
    - For simplicity, it is assumed that the remainder of the network investment is into components with lifetimes of 20 years.
- Straight-line depreciation over 50 years means that each year a proportion of the value of the network and energy centre are written off the original investment value until Year 50, when there is no value left in the original £3.5 million investment.

	Year 0	Year 1	Year 2	…	Year 50
Original investment	£3.5 million				
Depreciated value		£70 thousand	£70 thousand	£70 thousand	£70 thousand
Remaining value	£3.5 million	£3.43 million	£3.36 million	…	£0

- Note that straight line depreciation is typically only used for accountancy purposes and does not reflect real transfers of money to and from the project.

3.3.2 Base year

Adopting an appropriate base year for discounting, from which the costs and benefits of alternative interventions will be compared, forms an integral part of any CBA approach. The chosen base year for the CBA approach for district heating projects in Scotland is **2018**.

3.3.3 Choice of discount rate

An important point to note at this stage is that all future costs associated with an intervention will need to be appropriately adjusted, to reflect the 'social time preference'. This reflects the fact that a unit of currency will be worth more at present in comparison to any point in the future.

To deal with the differential timing of costs, a social discount rate is often applied. This is applied to calculate what is effectively a present value for future costs (i.e. allows for costs and benefits to be compared across varying time periods).

To ensure Green Book compliance, a social discount rate of **3.5%** in real terms should be adopted for the first 30 years, **reduced to 3.0% after 30 years**[8]. Table 2 details how a present value of £1,000 declines over a 10-year period with a discount rate of 3.5%.

Practitioners should note that taking into account the social time preference should be considered a separate action to accounting for inflation (see next section) and should also be treated in isolation to financial discounting, which reflects the opportunity cost of capital.

Table 2: The decline of present values over a 10-year period with a discount rate of 3.5% (HM Treasury's Green Book, 2018)

Year	0	1	2	3	4	5	6	7	8	9	10
Value	£1,000	£966	£934	£902	£871	£842	£814	£786	£759	£734	£709

3.3.4 Adjusting for inflation

Simply defined, inflation can be described as the *changes in price across different periods, in response to imbalances associated with the supply and demand for goods*[9].

The appraisal of social value should therefore be conducted using prices which are representative of values during the chosen base year. As stated above, the chosen base year for this analysis is 2018, so all calculated costs and benefits should be adjusted for inflation to represent 2018 prices.

To adjust appropriately for inflation a GDP deflator value is required, giving a calculation which will adjust prices from nominal to real terms. The GDP deflator value which is chosen will need to align to the most recent forecasts provided by the Office for Budget Responsibility (OBR), as is recommended in the Green Book, (2018). This calculation will appropriately remove the effects of general inflation, and ensure that all analysis is carried out in real prices (Table 3).

Nominal versus real

Simply put, nominal values include inflation and real values do not include inflation. Real prices include real price changes whereas nominal prices are real prices plus inflation

Why does it matter? A model which includes a combination of nominal and real values will over- or under-state some costs and benefits relative to others. A model which uses solely nominal values and only the social discount rate will overstate the social Net Present Value of the project in real terms.

[8] Interventions being appraised over time periods of greater than 30 years require a different discounting approach and value. A discount rate of 3% should be adopted for interventions that cover 31-75 years (HM Treasury's Green Book, 2018).

[9] World Health Organisation, Guidelines for conducting cost-benefit analysis of household energy and health interventions, 2006

Table 3: The effect of adjusting for inflation using a 2% GDP deflator

Year	0	1	2	3	4	5
Nominal terms	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000
Real terms	£1,000	£980	£961	£942	£924	£906

3.3.5 Incremental from baseline

When conducting a CBA, it is also important to ensure that the costs of the district heating intervention(s) being appraised are compared to the baseline scenario. Specifically, practitioners should calculate the sum of the costs and benefits associated with (a) the baseline and (b) the project scenario(s). Values should then be compared to one another, in order to identify intervention(s) with the greatest margin of benefit. An example of this is provided in Table 4.

Table 4: Comparing the costs and benefits of the chosen baseline scenario against project-level interventions

	Baseline scenario	District Heating Option A minus Baseline	District Heating Option B minus Baseline
Net Benefits	£2 million	£0.6 million	-£0.2 million
Net Costs	£1.6 million	£0.4 million	£0.1 million
NPV	£0.4 million	£0.2 million greater than Baseline	£0.3 million less than Baseline

3.3.6 Adjustments for optimism bias

Uncertainty can also stem from optimism bias, which occurs when practitioners are overly-optimistic regarding project parameters such as capital costs, return periods, and overall project benefits. Considerations regarding optimism bias need to be managed correctly at **three key stages** of the socio-economic assessment[10]:

- During initial feasibility phases;
- Throughout final shortlisting; and
- Before final decisions are made.

[10] BEIS, Heat Network Detailed Project Development Resource: Guidance on Economic and Financial Case – Development of the Financial Model, Heat Pricing and Maximising Opportunities, 2016. UK

If optimism bias is not accounted for during the decision making process there is a risk that undeliverable targets may be generated as a result of over-optimistic estimates.

Approaches towards reducing optimism bias include the adoption of percentage adjustments, which should be applied at the beginning of an appraisal, and should form part of a wider risk analysis. This percentage will represent the level of bias that can be expected throughout a given intervention, and should be based upon the past experiences of Local Authority project teams, taking into consideration recommended adjustments (Table 5).

To apply optimism bias factors, project parameters such as the present value associated with capital costs should be multiplied by the chosen optimism bias value. This result should then be added to the total net present value of the whole project cost.

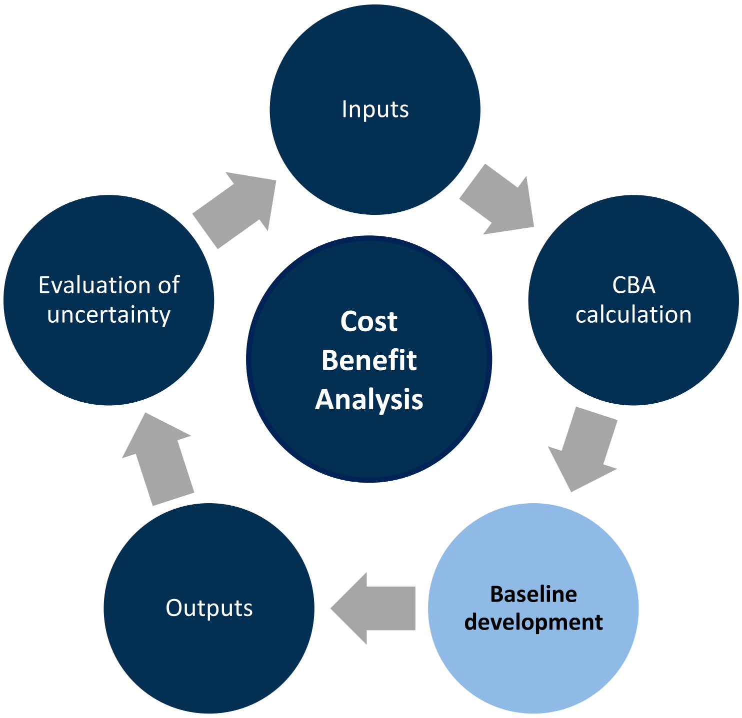
Green Book-recommended percentage adjustments are provided in Table 5, and should be drawn upon for best practice guidance. The use of these ranges should however be done with caution, and factors will need adjusting to meet the specific requirements of individual district heating schemes. Accounting for optimism bias in this way is an effective approach towards managing both expectations and costs relating to chosen interventions.

Table 5: Recommended percentage adjustments to account for optimism bias. Table sourced from HM Treasury's Green Book (2018).

Optimism Bias (%)				
Project Type	**Works Duration**		**Capital Expenditure**	
	Upper	Lower	Upper	Lower
Standard Buildings	4	1	24	2
Non-standard Buildings	39	2	51	4
Standard Civil Engineering	20	1	44	3
Non-standard Civil Engineering	25	3	66	6
Equipment/Development	54	10	200	10
Outsourcing	n/a	n/a	41	0

Calculation checklist		
✓	**Identify suitable impacts where future costs and benefits can be forecasted and monetised**	
✓	**Set appropriate time horizons to suit the chosen intervention** 40 years is recommended, a clear justification should be provided for any deviation	
✓	**Implement correct discount rates to calculate the present value of future costs and benefits** Social Time Preference of 3.5%	
✓	**Appropriately adjust for inflation using best practice deflator values**	
✓	**Accounting for optimism bias** Drawing on local authority experience and Green Book guidance, optimism bias will need to be evaluated during 3 key stages of the appraisal, : • During initial feasibility phases; • Throughout final shortlisting; and • Before final decisions are made.	

3.4 Cost Benefit Analysis – Baseline Development



CBA assesses all direct and indirect costs and benefits from a proposed project (intervention) against what would happen otherwise (the baseline). The choice of baseline therefore has strong implications for the results of the CBA.

The baseline development for this project-level socio-economic assessment will be a '**do minimum**' scenario. The 'do minimum' scenario will be intervention that is compliant with, though does not go beyond, the requirements of current legislation at the time of the assessment. For example, for a socio-economic assessment at the time this draft was published (autumn 2018), the baseline chosen must be reflective of the following legislation/regulation:

1.) **The Scottish Building Standards System**[11]

- e.g. Condensing boilers must have a minimum seasonal energy efficiency of 88%, whilst non-condensing boilers must have a minimum energy efficiency of 80%.

2.) **The Energy Efficiency Standard for Social Housing (EESSH)**[12]

- e.g. Minimum Standard Assessment Procedure (SAP) efficiency ratings will have to be met for each property type in order to pass the EESSH.

[11] https://beta.gov.scot/policies/building-standards/monitoring-improving-building-regulations/
[12] https://beta.gov.scot/policies/home-energy-and-fuel-poverty/energy-efficiency-in-social-housing/

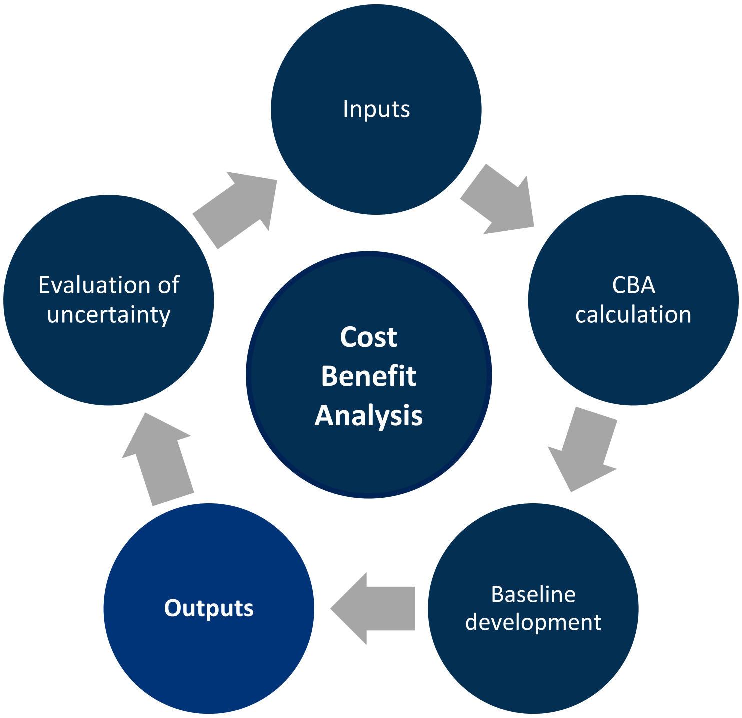
Upcoming changes to legislation

Practitioners should acknowledge that future legislation relating to energy efficiency and low carbon heat across Scotland may develop from proposals and consultations (both those published at time of writing, autumn 2018, and those which will emerge subsequently), notably the **Energy Efficient Scotland Consultation**[13], which took place during summer 2018 and is expected to be implemented over coming years. When adopting a baseline scenario for this socio-economic assessment, practitioners will need to be aware of current and planned changes to legislation across Scotland to ensure scenarios are compliant.

	Good practice checklist for baseline development	
✓	**'Do minimum' baseline** The choice of baseline must be compliant with current legislation.	
✓	**Time horizon** For a district heating project the guideline time horizon appropriate for CBA is set to **40 years** (as explained in section 3.3.1). For projects which include capital components with lifetimes exceeding 20 years straight line depreciation should be applied to account for residual values.	
✓	**Adopt an appropriate base year** As explained in section 3.3.2, this should be 2018.	

[13] https://consult.gov.scot/better-homes-division/energy-efficient-scotland/

3.5 Cost Benefit Analysis – Outputs



The overarching goal of CBA is to identify clearly whether the benefits of an intervention exceed its costs. If CBA is able to demonstrate this to be the case then an intervention will be considered a cost effective measure. To align with guidance provided by the Green Book, when presenting the business case for a proposed intervention (i.e. district heating scheme, in this context) it is vital to ensure that the following factors are met, commonly known as the **Five Case Model** (Table 6).

Key outputs from the CBA will work to support both the **economic and financial** case for a given intervention.

Table 6: The Five Case Model. Adapted from HM Treasury's Green Book (2018)

Cases	Evidence required
Strategic case	✓ The intervention must be supported by an appropriate case for change that aligns to wider government policies and objectives
Economic case	✓ The social value of the intervention must exceed that of the baseline scenario, to certify its net value to society
Commercial case	✓ The proposed intervention must be commercially viable and realistic with relevant risks identified and managed
Financial case	✓ Financial aspects of the intervention must be affordable and sustainable (i.e. capital and revenue costs)
Management case	✓ The intervention must be realistic and achievable in order for pre-defined objectives to be met successfully

3.5.1 Net Present Value

There are a variety of ways in which the cost-effectiveness of an intervention can be calculated and portrayed.

One of the most popular approaches is the **Net Present Value (NPV)** which shows the net monetary or welfare gain that can be expected from a chosen intervention. NPV is simply a sum of all monetised costs and benefits, which are discounted to the chosen base year. NPV acts as a suitable summary tool to determine the payback periods associated with an intervention:

$$NPV = present\ value\ of\ benefits - present\ value\ of\ costs$$

Using the NPV function in Excel

Practitioners should note that the NPV function in Excel **should be used with caution**. This is due to the incorrect assumption in Excel that year 1 should be the base year, not year 0, which causes time period issues across the duration of the appraisal. If the NPV function is used in Excel, practitioners must ensure that the first value (i.e. year 0) is added to the final NPV result to allow for it be considered.

When comparing interventions that have similar upfront costs, those with the highest NPV, and thus the greatest net welfare gain, should be favoured (Table 7). As per guidance from the Green Book, outputs such as NPV should be presented in summary form and backed up in greater detail by additional text and tables. This will allow practitioners to identify clearly and with ease the most cost-effective intervention.

Table 7: An example showcasing the appropriate selection of an intervention based on NPV values

Intervention	Economic Indicator	Values
District Heating Option A against Baseline	Net Present Value (NPV)	***+ £5000***
District Heating Option B against Baseline	Net Present Value (NPV)	**— £5000**

3.5.2 Benefit Cost Ratio

Another primary output of CBA that will help to determine the overall cost-effectiveness of an intervention is the **Benefit Cost Ratio (BCR).** The BCR shows the factor by which economic benefits exceed the economic costs of an intervention. It is calculated by the present value of benefits divided by the present value of costs.

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Present value of benefits}}{\text{Present value of costs}}$$

As with NPV, when calculating the BCR, future costs and benefits should:

- Consider and be adjusted for inflation to base year prices (i.e. the first year of the proposal)
- Be discounted by a social discount rate of 3.5% to provide the present value

The BCR should represent the economic case of the Five Case Model (Table 6), helping to portray the extent to which an intervention has value to society. In simple terms, a BCR below one indicates that the chosen intervention will cost more to implement than what will be achieved in response, indicating that it may not be economically viable to deliver. By contrast, a BCR value that is greater than one suggests positive economic returns from a given intervention, where the higher the BCR, the higher the return per pound invested in the project (see example in Table 8). Having said this, consideration still needs to be given to the impacts that cannot be monetised.

Ascertaining the BCR of interventions therefore forms an intrinsic part of CBA and should be considered a powerful mechanism through which to identify and rank the most feasible and cost-effective interventions towards meeting pre-defined objectives. It is important to consider the BCR of all proposed interventions, to allow practitioners to make an informed judgement on the most appropriate intervention.

Table 8: An example of the appropriate selection of an intervention based on Benefit Cost Ratio (BCR) values

Intervention	Economic Indicator	Values
District Heating Option A against baseline	Benefit Cost Ratio (BCR)	***1.8***
District Heating Option B against baseline	Benefit Cost Ratio (BCR)	***0.8***

A succinct way in which to present CBA outputs such as NPV and BCR is through the use of an Appraisal Summary Table (AST), which can be used as an effective summary tool. This will provide practitioners with all the key information required to make informed decisions with regards to the adoption and comparison of proposed interventions. This is where the assessment of the non-monetisable impacts can be presented, so that they can be considered alongside the outputs of the CBA calculations. A template which can be used to appraise project level interventions is provided in Table 9.

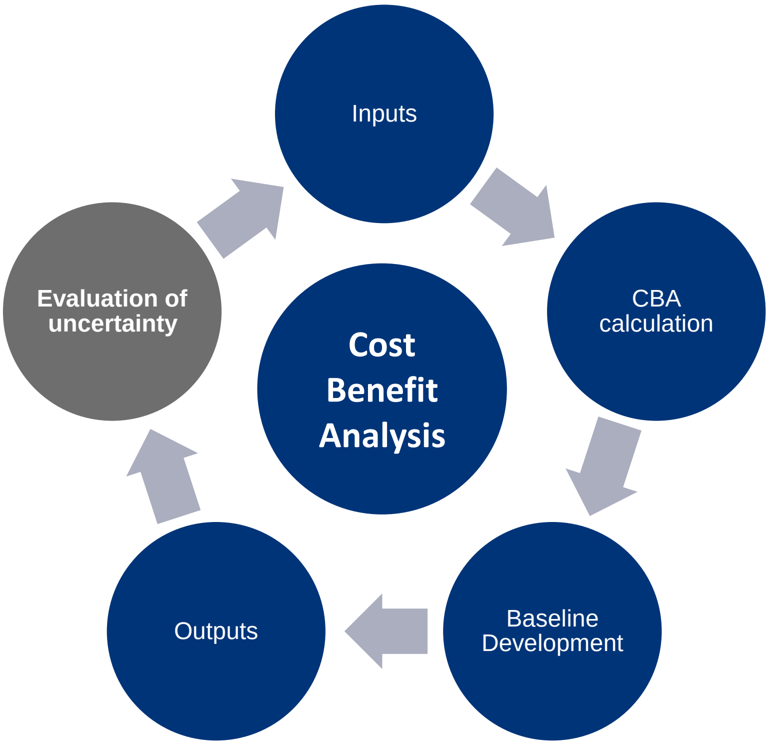
Table 9: Example template of an Appraisal Summary Table. Adapted from HM Treasury's Green Book (2018)

		District Heating Option A against baseline	District Heating Option B against baseline
A)	**Social Net Present Value**		
B)	**Social Benefit Cost Ratio**		
C)	**Non-monetised impacts**		
D)	**Social impacts**		
E)	**Environmental impacts**		
F)	**Resilience impacts**		
G)	**Local economic impacts**		

It is important to highlight at this stage that all outputs generated from CBA should be viewed with caution, due to the inherent uncertainties that are associated with the methodologies adopted to conduct CBA. As with all socio-economic approaches, CBA has uncertainties that will need to be appropriately addressed and accounted for (see section 3.6 for further guidance on this). It should be stated therefore within finalised documentation, that CBA results may be subject to later change as a result of sensitivity analysis.

Good practice checklist for meaningful CBA outputs		
✓	**The Five Case Model** Practitioners should refer to the Five Case Model when appraising interventions	
✓	**Clear communication of CBA results** Both NPV and BCR outputs, alongside a narrative on the non-monetisable impacts, should be compared to one another across all interventions through the use of an Appraisal Summary Table	
✓	**Justifying results** CBA outputs should be used to justify any decisions made by practitioners. Are results clear and concise?	
✓	**Revisiting results** CBA results should be re-considered after uncertainty has been accounted for, i.e. through sensitivity analysis, to identify any meaningful changes in results. This is covered in section 3.6.	

3.6 Evaluating uncertainty



Another crucial aspect of socio-economic assessments that needs to be carried out appropriately is the communication and explanation of project uncertainties. It is important that practitioners account for differing levels of uncertainty, to increase the strength and validity of CBA results. Key sources of uncertainty during the appraisal process can include a lack of understanding in regards to proposed interventions, alongside insufficient data being used as supporting evidence.[14]

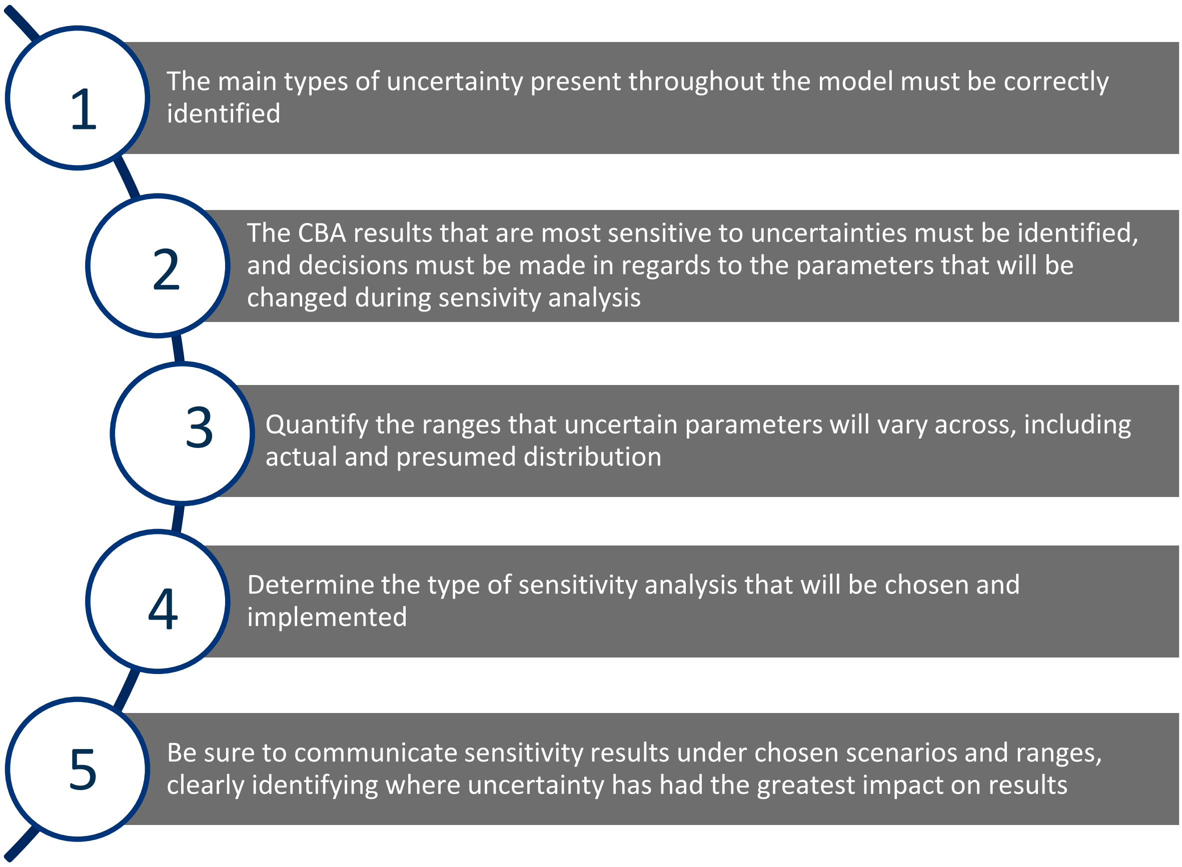
A methodology which does not account for such levels of uncertainty therefore runs the risk of identifying inappropriate interventions which will not work towards solving pre-defined goals and objectives.

The broader framework for identifying related uncertainties can be referred to as **sensitivity analysis**. Sensitivity analysis should be carried out to ascertain the overall effect that changing input data and model assumptions has on CBA outputs. An example approach towards this involves adjusting chosen input data to represent greater or lesser values to determine the overall impact data will have on the appraisal results (i.e. influence on NPV and BCR).

It should be noted that there are five key stages that must be adhered to in order to quantify uncertainties through sensitivity analysis (Figure 3).

[14] HM Treasury, The Green Book: appraisal and evaluation in central government, updated March 2018. UK

Figure 3: The five key stages towards quantifying uncertainty using sensitivity analysis. Adapted from 'Guidelines for conducting cost-benefit analysis of household energy and health interventions', WHO (2006).



A number of approaches towards sensitivity analysis do exist (Figure 4), and it is important that practitioners clearly highlight and justify the approaches taken.

Figure 4: The three main types of sensitivity analysis that should be adopted when applying this CBA methodology.

Varying data inputs over plausible ranges	Threshold analysis	Changing model assumptions
• This approach involves changing the CBA input values • Will reflect uncertainties associated with inaccurate data • Conducted using one-way analysis of values, multi-way analysis of values, and through probabilistic sensitivity analysis	• This approach focuses on developing input values that would be needed to allow for certain CBA results to be achieved • For example, what fuel prices would deliver a net loss instead of a net benefit to a District Heating scheme?	• Involves analysing the impact that changing model assumptions will have on CBA outputs • Most common technique is to vary the inclusion or exclusion of chosen costs or impacts • Can also involve altering the time preference and discount rate used for future costs and benefits

Sensitivity analysis is a powerful tool that can be used to inform practitioners on the robustness of socio-economic analysis outputs and should be carried out after a whole review of the model has been completed to isolate all independent variables.

The sensitivity analysis should also consider how the proposed intervention performs against the long term standards included in the Energy Efficiency Scotland Route Map which state that (a) all homes in Scotland should meet an EPC rating of C by 2040 (where technically feasible and cost effective); and (b) that all homes in Scotland with households in fuel poverty should reach EPC rating C by 2030 and EPC B by 2040 (where technically feasible and cost effective).

Good practice checklist for evaluating model uncertainty

✓	**Five key stages** The five key stages process must be followed to in order to identify and quantify uncertainties through sensitivity analysis
✓	**Justify approach** The approach taken towards carrying out a sensitivity analysis should be clearly justified by practitioners. Results should be clearly communicated and adjusted where necessary (Figure 4)

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