Committee on Climate Change

A consistent set of socioeconomic dimensions for the CCRA3 Evidence Report research projects

Final Report

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Contents

1 Introduction

1.1 Background to the study

Mitigating and adapting to climate change is a priority for the UK government, and it aims to address these issues through a combination of policies aimed at reducing harmful greenhouse gas (GHG) emissions and preparing for current and future impacts from climate change.

The 2008 Climate Change Act was established in 2008 to set out the pathway for achieving an 80% reduction in GHG emissions by 2050 (below 1990 levels), and to assess the risks and opportunities to the UK presented by climate change. As stipulated by the Climate Change Act, the UK government must publish a Climate Change Risk Assessment (CCRA) every five years, with the third CCRA (CCRA3) due to be published in January 2022.

To inform the CCRA3, the Committee on Climate Change (CCC) will produce an Evidence Report, which is due to be finalised by the summer 2021. Five research projects, commissioned by the CCC, will feed in to the Evidence Report and address evidence gaps that existed in the CCRA2. This report is part of the sixth research stream, to establish shared socioeconomic baselines for the other research projects. It is important to develop a consistent set of socioeconomic projections to be used across all the research projects, as well as other chapters and analysis of the CCRA3, to ensure that the analysis presented throughout the CCRA3 Evidence Report is also consistent. Through scoping, shortlisting and data collection and manipulation tasks, the present study produces the consistent set of social and economic data projections required by the five research projects, such as projections of population, GDP, employment and land use.

1.2 Aims and objectives

The aims of this study were to:

- Develop an understanding of a proposed ‘optimum’ dataset of socioeconomic dimensions that would meet the needs of the CCRA3 Evidence Report initiative.
- Understand the needs of the five research projects as well as the overall aims of the CCRA3 Evidence Report, to determine the social and economic variables (and their dimensions) that will be required.
- Collate and justify the dataset of socioeconomic dimensions that can be used by the other projects and analyses within the CCRA3 Evidence Report.
- Once the optimum dataset of socioeconomic dimensions was determined, the project aimed to collate the most transparent and robust data, and justify the data sources used, outlining their key attributes and merits. Within this justification, other requirements of the data were considered, such as the differences (or similarities) with data used in previous CCRAs, the need for a spatial element to the current data, the possibilities for creating new scenario data, and the ability for the data to be used in scenarios out to 2100.

1.3 Report structure

In the remainder of this report we present the methodological approach applied across Chapters 2 – 4. In Chapter 5 comparisons are made between the projections produced by this study, and the set of projections used in the previous CCRA, CCRA2. Chapter 5 also provides further detail to the scenarios used, in the form of more detailed narratives that provide a richer context for the data. Finally, Appendix A provides details of the Quality Assurance checks carried out on the dataset, while Appendix B provides some user guidance for navigating and understanding the dataset.

2 Scoping of research project indicator needs

The initial work was to ensure that the needs of the other CCRA3 research projects and analysis were well understood. On this basis, a full specification of the variables required for the CCRA3 research projects was developed, including an indication of the specific dimensions required (in terms of spatial and sectoral levels of detail), the specific research project that requested the data and our view of whether such data could be collected within the scope of this study.

In this Chapter the requests provided by each of the research project leads are presented through a cross-comparison of requirements in Table 2.1[1].

[1] The lead of the 'Interacting Risks' project indicated that they will not be a direct user of the socioeconomic dimensions dataset, hence Table 2.1 does not include any requests from this project. However, the team leading the project are interested in understanding how the other research projects will use the socioeconomic dimensions. They are keen to ensure that the other projects use the projections in a consistent and coherent way so that the results generated by the other projects can be mapped onto the overall interacting risks model.

Table 2.1: Matrix of indicator requests across all research projects

Indicator	Project: Behaviour change	Flooding	Water availability	Thresholds
Population	✓	✓	✓	✓
Temporal dimension	Annual	Annual	Annual	Annual
Age dimensions	0-15, 16-24, 25-34, 35-44, 45-59, 60-64, 65+ And if possible further disaggregation 16 – 18, 19 – 24, 25 – 29, 30 – 34	0-5, 75+		0-15, 16-24, 25-34, 35-44, 45-59, 60-64, 65+
By gender?	✓			
Spatial dimensions	• Local authority • And if possible by habitat – coastal, rural, urban etc.[2]	Local authority	• Local authority • If possible, 1km grid or Water Resource Zone	• Region • Local authority
Other dimensions	• Race/Ethnic background (at local authority level) • Physical disabilities • Education level (at local authority level)	• Recent arrivals to UK (% people with <1-year residency coming from outside UK) • Private renters (% Households) • Social renters (% households renting from social landlords) • High levels of disability (% disabled) • People living in medical and care establishments (%) • Single-pensioner households (%)		

[2] Research lead may be able to do this themselves with the local authority level data, but worth checking whether the data can be downloaded in these dimensions.

Indicator	Project: Behaviour change	Flooding	Water availability	Thresholds
		• Lone-parent households with dependent children (%) • Children of primary school age (4-11) in the population (%)		
GDP & GVA	✓	✓	✓	✓
Temporal dimension	Annual	Annual	Annual	Annual
Sectoral dimensions (for GVA)	SIC 2-digit code		SIC 2-digit code	
Spatial dimensions	Local authority	• Local authority • If possible, by neighbourhood – LSOA (England & Wales), Data zones (Scotland), SA? (NI)	• Region • Local authority	• Region • Local authority (for GDP)
Land use	✓	✓ (Ecosystem/habitat protection enlargement: might then be able to link to the NFM measures)	✓	✓
Temporal dimension	Annual	Annual	Annual	Annual
Habitat classifications	• Industry & commerce • Residential • Agriculture • Transport and utilities • Forest • Open land and water • Undeveloped land			Minimum level of detail is rural/urban Additional detail could include • Agricultural • Residential property • Industry
Spatial dimensions	Local authority		• Regional • If possible, river catchment	

Indicator	Project: Behaviour change	Flooding	Water availability	Thresholds
Expenditure on R&D	✓		✓	
Temporal dimension	Annual		Annual	
Purpose dimensions	• Government • Business • Non-Profit			
Spatial dimensions	Regional		National	
Employment	✓	✓	✓	✓
Temporal dimension	Annual	Annual	Annual	Annual
Spatial dimensions	• Local authority • Regional	• Local authority • If possible, by neighbourhood – LSOA (England & Wales), Data zones (Scotland), SA? (NI)	National	Regional
Sectoral dimensions	SIC 2-digit code			SIC 2-digit code
Age dimensions	0-15, 16-24, 25-34, 35-44, 45-59, 60-64, 65+			
Other employment-related data		• Disability / people in ill-health (% people whose day- to-day activities are limited) • Households with at least one person with long-term limiting illness (%) • Unemployed (% unemployed) • Long-term unemployed (% who are long-term unemployed or who have never worked)		

Indicator	Project			
	Behaviour change	Flooding	Water availability	Thresholds
		• Low income occupations (% in routine or semi-routine occupations) • Households with dependent children and no adults in employment (%)		
Technological change	✓		✓ (narratives around technological advances)	
Technologies of interest	• Expected advances in warning systems • Irrigation • Flood control measures • Flood protection devices • Potential expected advances/impact on housing stock (retrofitting - insulation and renewable energy technology)			
Labour productivity	✓		✓	✓ (no dimensions stated)
Temporal dimension	Quarterly		Annual	
Spatial dimension	National		• National • If possible, regional	
Sectoral dimension	SIC 2-digit code (per worker)			
Gross and net capital stock	✓			
Temporal dimension	Annual			
Spatial dimension	• National			

Indicator	Project Behaviour change	Flooding	Water availability	Thresholds
	• If possible, by habitat (coastal, rural, urban etc)			
Sectoral dimension	SIC 2-digit code			
Other dimensions	By asset			
Energy sector (demand, generation and capacity, fuel prices, carbon intensity energy efficiency)	✓		✓	
Temporal dimension	Annual		Annual	
Spatial dimension	National		• National • If possible, regional or by river basin	
Sectoral dimension	SIC 2-digit code			
Other dimensions	By technology (e.g. wind, solar PV etc.)		• Energy mix • Location of new and closed power stations	
Residential property price				✓
Temporal dimension				Annual
Spatial dimension				Regional
Fuel prices				✓ (no dimensions stated)
Household occupancy rate		✓	✓	
Temporal dimension		Annual	Not specified	
Spatial dimension		Neighbourhood – LSOA (England & Wales), Data zones (Scotland), SA? (NI)	Not specified	
Household income		✓		
Temporal dimension		Annual		

Indicator	Behaviour change	Project Flooding	Water availability	Thresholds
Spatial dimension		• Local authority • If possible, by neighbourhood – LSOA (England & Wales), Data zones (Scotland), SA? (NI)		
Other dimensions		Split by income percentile (if at LA level), lowest 10%, 25%, 50%, 90% and average (if at neighbourhood level)		
Infrastructure		✓		
Temporal dimension		Annual		
Spatial dimension		Local authority		
Other dimensions		Absolute numbers or change values		
Types of infrastructure		• Wastewater and cleanwater treatment sites • Railway stations • Major roads • Railway lines • Power stations and transmission substations • Care homes • GP surgeries • Schools • Police, ambulance and fire stations • Hospitals • Landfill sites		

Indicator	Project: Behaviour change	Flooding	Water availability	Thresholds
Development type		✓		
Temporal dimension		Annual		
Spatial dimension		Local authority		
Other dimensions		By pre-defined settlement type (England & Wales – ONS, Scotland – Scottish Government, NI – NISRA)		

2.1 Prioritising indicators

The indicators detailed in Table 2.1 were then grouped in to lists according to their overall importance to the research projects (see Figure 2.1). The groupings of indicators can be broadly defined as follows:

- Priority indicators – indicators that were requested by more than two of the research project leads and for which projections are likely to exist
- Further indicators – indicators that were requested by two or fewer of the research project leads (so not priorities), but for which it is expected projections will readily exist
- Beyond scope – projections requested by only one research project and considered to be beyond the scope of this project, because the work to construct them would be extremely time-consuming and therefore not represent a good balance of cost vs reward

Figure 2.1: Prioritisation of indicators

Priority indicators	Further indicators	Beyond scope
• Population • GDP • GVA • Employment • Labour productivity (calculated from GVA and employment projections) • Land use • Households occupancy rate	• Expenditure on R&D • Energy generation by technology	• Technological change • Gross & net capital stock • Residential property prices • Fuel prices • Household income • Infrastructure • Development types

The indicators listed as 'Priority indicators' and 'Further Indicators' were taken forward to Task 2, to investigate sources of existing data projections.

2.2 Data format

Two of the five research projects requested the constructed dataset to be in a geodatabase format, while other research projects did not specify a format. The outputs of Task 3 (Data Collection and Manipulation) therefore included all data presented in a standard spreadsheet format.

3 Shortlisting potential projections

The next phase of the work was to establish a shortlist of suitable projections that met the needs of the requests identified in Table 2.1.

Table 3.1 lists all the identified sources of projections for each indicator, the attributes of the projections, and their limitations.

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Table 3.1: Potential sources of projections

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
Indicator:							
Population	Office for National Statistics (ONS), StatsWales, National Records of Scotland (NRS), Northern Ireland Statistics and Research Agency (NISRA)	Up to 2116	Annual	National + England, Scotland, Wales and Northern Ireland	Age cohort (0-15, 15-29, 30-44, 45-59, 60-74, 75 & over), gender, migration, births & deaths	No	No detailed spatial dimension (Local Authority)
	Office for National Statistics (ONS), StatsWales, National Records of Scotland (NRS), Northern Ireland Statistics and Research Agency (NISRA))	Up to 2041	Annual	Local Authority in England	Age cohort (every single year of age), gender, migration, births & deaths	Only one scenario for 2016-based projections at local authority level. Variants by migration, fertility and life expectancy are available for GB countries. 2014-based projections variants by migration, fertility and life expectancy	Other dimensions are missing

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
						available for local authorities.	
GDP	Organisation for Economic Co-operation and Development (OECD)	Up to 2060	Annual	National	None	No	Only at national level, no clear specification of the underlying assumptions
	Office for Budget Responsibility (OBR): Economic and Fiscal Outlook 2018	Up to 2023	Annual	National	None	No	Limited timescale
	Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018	Up to 2067	Annual	National	Fiscal Sustainability Report 2018	6 separate scenarios: Baseline, Old age structure, Young age structure, High migration, Low migration, 50% lower EU migration	Only one % annual GDP growth rate per decade
	HM Treasury	Up to 2022	Annual	National		Comparison across projections from various companies and institutes	Limited time scale

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
GVA	Ernst & Young (EY): UK Regional Economic Forecast	Up to 2020	Annual	Regional	CAGR growth rate over 2017-2020	No	Limited time scale, no precise numbers available (only a chart)
	Greater London Authority (GLA): London's Economic Outlook - Spring 2018	Up to 2020	Annual	London	Also including output and employment annual growth in 2020 by sector	Yes (average, low and medium)	Limited spatial coverage
Land use	Centre for Ecology & Hydrology (CEH): Projections of emissions and removals from the LULUCF sector to 2050	Up to 2050	Annual	National	Area covered by Forest, Cropland, Grassland, Wetland, Settlement and Other; also GHGs emission data	5 separate scenarios: Central, Baseline (1&2), Low and Stretch	Only national data, no differentiation of the "Settlement" category. Linked to climate change projections – the scenarios are specific to an end goal of GHG emissions reduction.
	UK National Ecosystem Assessment (2011)	Up to 2060	None	National	Land cover classifications: coast, freshwater, grasslands, mountains &	12 different scenarios, a high and low projection for each of the following: Go	Only national data. Annual data not available. High and low relates to emissions

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
					heathlands, other marine, urban, conifer wood, broadland wood, enclosed farmland	with the Flow, Green & Pleasant Land, Local Stewardship, National Security, Nature@work, World Markets[3]	levels and therefore the variant cases relate to land use response to climate change (therefore linked to climate change projections)
Expenditure on R&D	Campaign for Science and Engineering (CaSE)	Up to 2027	Annual	National	Public and private investment in R&D	No; target of 2.4% of GDP on R&D by 2027	No differentiation across government / businesses / non-profit
Employment	Office for Budget Responsibility (OBR): Economic and Fiscal Outlook 2023	Up to 2023	Annual	National	Projections for employment, unemployment, productivity, wages and participation rate	No	Limited timescale and spatial differentiation
	Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018	Up to 2067	Annual	National	Projections for employment, unemployment, productivity,	6 separate scenarios: Baseline, Old age structure,	No differentiation by sector or

[3] For more detail on scenarios, please refer to pp 1196-97 http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=xVZhyZUdslM%3d&tabid=82

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
					wages and participation rate	Young age structure, High migration, Low migration, 50% lower EU migration	geographical area
	UK Commission for Employment and Skills (UKCES): Working Futures 2014 - 2024	Up to 2024	Annual	National	6 broad sectors, by gender and occupational category; also including GVA	No	Limited time scale, and spatial differentiation
	Greater London Authority (GLA): London Labour Market Projections 2017	Up to 2050	Annual	London Boroughs (central scenario), London (low and high scenarios)	16 sectors in the central scenario	Yes: low, central and high	Detailed data only for the central scenario; limited spatial coverage
Labour productivity	Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018	Up to 2067	Annual	National	Annual productivity growth rate	No	No differentiation across sectors and regions/local authorities
Gross and net capital stock	Office for National Statistics (ONS)	Only historical data	Annual	National	SIC 2-digit sectors	No	No differentiation across regions/local authorities

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
Energy sector - generation by technology	National Grid: Future Energy Scenarios (FES)	Up to 2050	Annual	National	Lots of data covering fuel prices, CO_2, gas and electricity demand, heating, energy supply	4 separate scenarios: Consumer Evolution, Community Renewables, Steady Progression, Two Degrees	Only at national level
	World Resources Institute: Global Power Plant Database	Only today's data		All countries	Power plants by technology and by country, with generation and detailed geographical data	No	No projections
	International Energy Agency (IEA): World Energy Outlook 2018 (WEO)	Up to 2040	Annual	International	Fuel and CO_2 prices	Yes	
	European Commission (EC): PRIMES Reference Scenario 2016	Up to 2050	Annual	EU28	Generation and capacity data by technology	No	
Household occupancy rates/ Average household size/	ONS household projections National Records of	Up to 2041	Annual	Local authorities	n/a	No	

	Projection data source	Timescale	Standard temporal dimension	Standard spatial dimension	Standard sectoral (or other) dimension	Different scenarios available?	Limitations
Number of households	Scotland household projections Welsh Government household projections NISRA household projections						

In Table 3.2 the list of identified sources are further refined in to a final shortlist of projections, which best meet the requirements of the research projects, and which were subsequently delivered. Data starts in the first available year upon which the projections are based (either 2016 or 2018), and in all cases extends to 2100.

Table 3.2: Final shortlist of projections

	Projection data source	–Scenarios to be provided	Dimensions to be provided	Metric
Indicator:				
Population	Office for National Statistics (ONS), StatsWales, National Records of Scotland (NRS), Northern Ireland Statistics and Research Agency (NISRA)	• Central projection, based on ONS principal projection scenario • High projection based on 'young age structure' ONS scenario • Low projection based on 'old age structure' ONS scenario	• Annual, from 2016 to 2100 • Age bands 0-14,15-64,65+ • Local authority level • Persons/Male/female	000s of people
GDP	Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018	• Central projection, based on OBR baseline projection scenario • High projection based on 'young age structure' OBR scenario • Low projection based on 'old age structure' OBR scenario	• Annual, from 2016 to 2100 • National level	£m

GVA	To be calculated via GDP and population projections (as described below) using historical data for GVA	• Central projection based on calculation using the 'central' GDP and 'central' population scenarios • Low projection based on calculation using the 'low' GDP and 'low' population scenarios • High projection based on calculation using the 'high' GDP and 'high' population scenarios	• Annual, from 2016 to 2100 • Local authority level • Aggregates of SIC 1-digit sectoral level (10 sectors)	£m
Land use	Centre for Ecology & Hydrology (CEH): Projections of emissions and removals from the LULUCF sector to 2050	• Central projection is based on the 'Central' emission scenario • Low projection is based on the 'Low' scenario • High projection is based on the 'Stretch' scenario	• Annual, from 2016 to 2100 • National level • For land use categories: Forest, Cropland, Grassland, Wetland, Settlement, Other	Kha, % land
Expenditure on R&D	Campaign for Science and Engineering (CaSE)	• Central projection based on calculation using 'central' GDP scenario and constant, long-term ratio between GDP and R&D expenditure • Low projection based on calculation using 'low' GDP scenario and constant, long-term ratio between GDP and R&D expenditure • High projection based on calculation using 'high' GDP scenario and higher R&D expenditure ratio of 2.4% of GDP by 2027 (higher ratio kept constant after 2027)	• Annual, from 2016 to 2100 • National • Public and private sectors	£m
Employment	Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018	• Central projection, based on OBR baseline projection scenario	• Annual, from 2010 to 2100 • Local authority level	000s of jobs

		• High projection based on 'young age structure' OBR scenario • Low projection based on 'old age structure' OBR scenario	• Aggregates of SIC 1-digit sectoral level (10 sectors)	
Labour productivity	Calculated from GVA and employment projections	• Central projection based on calculation using 'central' GVA projection and 'central' employment projection • Low projection based on calculation using 'low' GVA projection and 'low' employment projection • High projection based on calculation using 'high' GVA projection and 'high' employment projection	• Annual, from 2010 to 2100 • Local authority level • Aggregates of SIC 1-digit sectoral level (10 sectors)	£ value added per job
Energy capacity by technology	National Grid: Future Energy Scenarios (FES)	• Central projection based on 'Two Degrees' Scenario (rapid decarbonisation, low levels of decentralisation) • High projection (reflecting high demands on infrastructure) is 'Steady Progression' scenario • Low projection (low demands on infrastructure) is 'Community Renewables' scenario	• Annual, from 2017 to 2050 (held constant out to 2100) • National • By 14 energy technologies (plus storage and vehicle to grid)	MW
Electricity generation by technology	National Grid: Future Energy Scenarios (FES)	• Central projection based on 'Two Degrees' Scenario (rapid decarbonisation, low levels of decentralisation) • High projection (reflecting high demands on infrastructure) is 'Steady Progression' scenario	• Annual, from 2017 to 2050 (held constant out to 2100) • National • By 14 energy technologies (plus storage and vehicle to grid)	TWh

		• Low projection (low demands on infrastructure) is 'Community Renewables' scenario		
Gas and electricity demand by final user	National Grid: Future Energy Scenarios (FES)	• Central projection based on 'Two Degrees' Scenario (rapid decarbonisation, low levels of decentralisation) • High projection (reflecting high demands on infrastructure) is 'Steady Progression' scenario • Low projection (low demands on infrastructure) is 'Community Renewables' scenario	• Annual, from 2017 to 2050 (held constant out to 2100) • National • By 5 users	TWh
Household occupancy rate/ average household size/ number of households	ONS household projections National Records of Scotland household projections Welsh Government household projections NISRA household projections	• Central projection based on single published scenario	• Annual, from 2016 to 2100 • Local authority level • Average household size and total number of households per LA	Average household size – no. of persons, households per LA – no. of households

4 Data collection and manipulation

As identified in Table 3.1 and Table 3.2, all projections required some form of manipulation to ensure that they met the dimensions and timescales required. Additional dimensions were required, such as expanding projections to sub-national level, or furthering the disaggregation where insufficient detail is currently available. The methodologies for manipulating the projections of each indicator are outlined below in Sections 4.1-4.9.

A key challenge to this work was ensuring consistency with any published figures; however it was relatively straightforward to do this by using such series (typically available only at an aggregate level, e.g. for national or regional totals) as a constraint against which all series are scaled.

More difficulty is presented where disaggregated series need to be constructed, based upon historical links with other data series, and particularly where this process covers a number of dimensions – for example gross value added (GVA) by local authority, sector and time. Our approach to estimating these values in a robust way, and ensuring internal and external consistency, was built upon our experience of constructing these detailed economic datasets in previous workstreams, both for our own internal use and for provision to external clients (CE maintains a database of population, GVA and employment at local authority level by 40 sectors out to 2050, which informs our work for local government, and until recently also maintained an equivalent database, in less sectoral detail, for the NUTS3 regions of Europe).

The approach that we took to this task was to create a 'hierarchy' of series, based upon the robustness of the underpinning data. In practice, this means first estimating series at higher levels of geographical and sectoral aggregation, and then using these as constraints in the estimation of more detailed series. In the context of this work, it means creating an additional level of geographical detail at the NUTS1 region level (equivalent to the 9 former government office regions of England plus the other three nations, giving 12 regions in total). The hierarchy used in our construction of projections for this project was broadly the following;

- UK national level total
    - (if appropriate) UK level sectorally or age-band disaggregated series, constrained to the UK national projections
    - Regional totals, constrained to the UK total
        - Regional disaggregated series, constrained to both the UK disaggregated series and the regional totals
        - Local authority totals, constrained to the regional totals
            - Local authority disaggregated series, constrained to both the regional disaggregated series and the local authority totals

Such an approach limits the extent to which rapid changes in historical series at a very detailed level (for example in a single sector in a single local

authority) can lead to unrealistic outcomes in the projections. However, all data was checked for such substantial growth rates, and other economic sense-checks (such as checking ratios between different variables) were also applied to ensure that the series is as internally and externally consistent as possible (see Appendix A for further details of the Quality Assurance checks carried out).

4.1 Population

The principal and variant population projections from the ONS provide a useful starting point for the construction of these series. The principal projections from the ONS (available from a 2016 base for England, Scotland and Northern Ireland and a 2014 base for Wales) include projections by age band out to 2116. The variant projections go out only to 2041. Our approach to estimate all out to 2100 is set out below;

- From the principal official projections, take data by age band (0-14,15-64,65+) for the four nations of the UK
- Take consistent local authority data (available to 2041 for local authorities in England, Wales and Scotland, to 2039 for local authorities in Wales) by the same age bands, and apply 20-year average growth rates to extend each age band individually out to 2100
- Scale these extended local authority estimates to the nation-level series, to construct a consistent central set of projections
- Using data from the 'young age structure' and the 'old age structure' variant projections (available to 2041 for local authorities in England, Scotland, and Northern Ireland and to 2039 for local authorities in Wales), identify the former as the 'high' and the latter as the 'low' scenario
- At the UK level, apply long-term (20-year) growth rates to trend out i) total population and ii) population by age band, to 2100, and scale the latter to match the former
- Scale the local authority-level central estimates to be consistent with the UK projections (i.e. assumes no change in the geographical distribution of each age band between the scenarios).

4.2 GDP

The Office for Budget Responsibility (OBR) publishes forecasts of UK GDP out to 2067, showing annual growth rates at 10-year intervals. These provide the starting point for the series to be constructed. The OBR provides a central projection, plus five variants; low migration, high migration, young age structure, old age structure, and 50% reduction in migration. We used the 'young age structure' scenario for the high case (as it has the highest average rate of GDP growth, and is based upon a similar hypothesis as the equivalent population projections) and the 'old age structure' for the low case (as it has the lowest average growth rate and a similar unpinning narrative). The manipulations required for each scenario are then as follows;

- Use different annual growth rate for every decade during 2017-2067
- Hold long-term growth rates constant after 2067, to estimate GDP out to 2100.

4.3 GVA

There are no freely-available projections of gross value added (GVA) that are published in the UK. Instead, the key data source is the central, high and low GDP and population projections that have been developed above, plus historical data for GVA and GDP. The detailed steps required to construct these estimates are set out below. Note that in each scenario, the same process is followed, although different input data (in this case, the different scenarios for GDP and population) is used at the start of the process.

- From historical data, calculate (at a UK level) the ratio between GDP and GVA
- Hold constant the ratio between GDP and GVA in future years, and apply to the GDP projections to produce UK total GVA estimates to 2100
- Assume that the sectoral breakdown of UK GVA is unchanged from the last year of history
- Calculate GVA at local authority level by growing historical data in line with working age population (taken from population projections)
- Scale local authority estimates to the UK
- Calculate local authority sectoral breakdown by assuming that sectoral breakdown (i.e. shares) are unchanged from last year of history
- Carry out a two-dimensional scale (known as a RAS) to scale the local authority GVA by sector estimates to the local authority total GVA and the UK-level sectoral data.
- For constructing the high and low scenarios, the high and low scenario growth rates of population and GDP were used and the same methodology adopted.

4.4 Employment

The employment projections are based upon OBR UK employment projections (available from 2018 to 2068). As with GVA, input data from the different scenarios, namely the baseline, ‘young age structure’ and ‘old age structure’, is used to shape the employment projections for the equivalent central, high or low scenario. The specific steps are;

- Start with OBR employment projections at UK level out to 2067
- Apply long-term (20-year) average growth rates to extend national employment projections in each scenario out to 2100
- Take historical employment data by sector for the UK from the Business Register and Employment Survey (BRES), and project forward historical data in line with working age population (taken from population projections)
- Assume that the sectoral breakdown of UK employment is unchanged from the last year of history
- Scale the UK sectoral estimates to UK total employment
- Project forward total employment in the regions and local authorities based upon growth in working age population, to 2100
- Scale the local authority totals to the UK total employment

- Estimate local authority sectoral breakdown by assuming that sectoral breakdown (i.e. shares) are unchanged from last year of history
- Apply a RAS (two-dimensional scale) to ensure that the estimates match the local authority total employment and UK sectoral data series.

4.5 Labour productivity

Projections of labour productivity can be calculated from the GVA and employment projections detailed above. By dividing local area sectoral GVA by local area sectoral employment in each of the three scenarios, a central, high and low projection of labour productivity can be calculated i.e. a central, high and low labour productivity scenario using data from the corresponding central, high and low projections for GVA and employment.

4.6 Land use

The land use data is based primarily on the high-level CEH projections. These exist out to 2050, and the land-use shares from the different scenarios are extended out to 2100 by applying the 2049-50 growth rate in shares to all subsequent years (which shows only minor changes in land use shares after 2050). Following this step, projections of all land use categories were scaled, to ensure the shares of land use always sum to 100%. The central, low and high scenarios used in the database are based on the 'central' (current policy), 'low' and 'stretch' CEH scenarios, respectively.

4.7 Expenditure on R&D

There are no official published projections of economy-wide R&D that are available at a UK or subnational level. Instead the scenarios are based around stated government aims (to raise R&D expenditure in the UK to 2.4% of GDP by 2027) and the GDP projections calculated previously.

The starting point for these estimations was to calculate the current ratio between R&D expenditure and GDP at the national level – in recent years, R&D has consistently been around 0.8% of UK GDP. In the central and low cases, we held this value, calculated based upon the last year of historical data, constant through to 2100, and applied it to the relevant GDP projections. In the high scenario, R&D as a share of GDP is steadily increased to meet the UK government target of 2.4% of GDP by 2027, and held constant thereafter. This was applied to the high scenario GDP series.

Note that this presents something of an asymmetry between the scenarios; rather than being at the midpoint between the high and low cases, the central scenario is substantially closer to the low case, as they both use the same ratio between R&D and GDP, while in the high case, a higher rate of R&D expenditure is applied to a GDP figure which is growing more rapidly, leading to substantial divergence from the other scenarios.

4.8 Energy generation by technology

The National Grid FES scenarios are the key source for the energy projections. The National Grid FES scenarios present alternative future deployments for electricity generation in the UK out to 2050. Given the challenge in extending these out beyond 2050 (it would require a dedicated energy technology diffusion model, and ideally that used in the original FES

scenarios, to ensure consistency), a detailed extension of these scenarios is not possible. Instead, energy generation by technology is held constant after 2050 out to 2100. The implicit assumption here is that any increase in demand for energy from increased economic activity is cancelled out by improvements in energy efficiency, and that any investment in capacity is done only to replace existing capacity which reaches the end of its operating lifetime. From the FES scenarios which are based on the level of resource and infrastructure use, the following scenarios were used:

- 'Two Degrees' as the Central scenario; with rapid decarbonisation and low levels of decentralisation
- 'Steady Progression' as the High scenario; with high demands on infrastructure and the highest resource use
- 'Community Renewables' as the Low scenario; with low demands on infrastructure through taking load away from the grid.

4.9 Average household size

The Office for National Statistics publishes a single set of projections (a 'central' case) for number of households at the local authority level, out to 2041. One of the (published) underlying assumptions supporting these projections are projections (also by local authority) of the evolution of average household size. These form the primary source for the construction of a single set of consistent projections to 2100, where the following methodology is applied;

- The average household size projections out to 2041 are extended to 2100 using a 20-year average growth rate, at both the UK and local authority level
- These projections are multiplied by the central population projections to create projections of number of households
- The household projections for the local authorities are scaled to the UK projections to ensure consistency
- A revised set of consistent average household size projections are calculated by dividing the central population projections by number of households.

5 Final scenarios

The data manipulations detailed in Chapter 4 led to a final set of detailed projections to be used by the research projects and any other analysis feeding in to the Evidence Report for the CCRA3. The final dataset is presented in a workbook 'Socioeconomic dimensions dataset', and user guidance for navigating this database is provided in Appendix B of this Final Report.

Uncertainty

It is important to note that the projections provided in the dataset are based upon key assumptions which are subject to inherent uncertainty; for example in the case of population, the projections are based on assumptions of future levels of fertility, mortality and migration, but these assumptions are influenced by numerous factors and future outturns are likely to be different from the assumptions made. Furthermore, the uncertainty of projections increases the further in to the future they are estimated, particularly when disaggregated by various dimensions such as region, sector, age bands or gender.

Changes in the political and economic climate can have a large impact on the indicators we produce projections for in this study. However, it is difficult, if not impossible, to determine what impact these factors will have in the future. For this reason, our projections do not acknowledge any specific impacts of the UK leaving the EU, or the impacts of any potential negotiated settlements with the European Union. Instead, the projections seek to reflect broader socio-economic and demographic change.

In the remainder of this Chapter, we make comparisons with the projections used in the CCRA2 Evidence Report and also provide narratives to accompany the data projections, putting the data in to real-world perspective.

5.1 Comparisons with CCRA2 population projections

The CCRA2 Evidence Report did not use a consistent set of socioeconomic dimensions to inform the research projects or any other analysis feeding in to the Report.

However, the CCRA2 Evidence Report research projects did use a consistent set of population projections for the UK, its regions and local authorities, including one central estimate along with an upper and a lower bound estimate. This approach is similar the one adopted in this study, and in both cases the population projections from the Office for National Statistics were used as base reference, representing plausible futures on population growth.

There are however key differences between the two sets of projections. This study relies on an updated set of population projections published by the ONS based upon historical data to 2016, with local authority area projections provided to 2041 and national projections to 2100. In contrast, the CCRA2 made use of the 2012-based projections providing local authority area projections to 2037 and national projections to 2100. In addition, different variants were selected to represent the Low and High population scenarios, with the CCRA2 relying on the ONS High and Low Fertility variants. The more recent Young Age and Old Age Structure scenarios were instead considered to represent the High and Low projections in this study.

5.2 Scenario narratives

For each of the indicators included in the socioeconomic dimensions database, narratives are provided for each of the central projections and the high and low variant cases.

Population

The population projections used in our database are based on official projections published by the Office for National Statistics (ONS), StatsWales, National Records of Scotland (NRS) and the Northern Ireland Statistics and Research Agency (NISRA). The population projections published by these sources "provide an indication of the future size and age structure of the population" and are based on the latest mid-year population estimates together with assumptions of future levels of fertility, mortality and migration, which vary according to each variant of the central projection[4].

Central scenario

Our central population projection is based on the ONS 'principal projection scenario', which assumes demographic patterns in future such as fertility, mortality and migration trends remain the same as current trends. The central scenario assumes that the UK population grows at a steady pace, increasing by over 17 million (compared to 2016), to reach a total population of almost 83 million in 2100. In this scenario, in the short term (i.e. up to 2026), just under half of the UK population growth is expected to result from more births than deaths, with the remainder of the increased population resulting from net migration. Our approach assumes these trends continue up to 2100. In the central scenario the UK population is ageing, with older people accounting for an increasing share of the total population. Up to 2050 the ageing population is partly caused by the 1960s baby boom generation reaching retirement age and then moving in to old age. By 2100, those aged over 65 are expected to account for around 30% of the total population, compared to 18% in 2016. This is caused by numerous factors, such as increased life expectancy due to improvements in health, medicines and health care technology, and lower birth rates leading to a smaller share of people in the 0-15 age bracket. The working age population represents a smaller share of the total population (55% in 2100 compared to 63% in 2018), meaning there is a high dependency ratio.

High scenario

Our high scenario is based on the ONS 'young age structure' variant of its principal population projection. This variant projection is based on alternative assumptions of future fertility, mortality and migration. In this scenario, fertility rates are assumed to be higher than in the central case while life expectancy is lower. Furthermore, net migration is higher than in the central case. All these factors lead to a younger age structure of the population. In the high scenario, total population reaches around 92 million in 2100, an increase of almost 27 million from 2016, compared to the central scenario in which the population reaches 83 million in 2100. 59% of the population are of working age (aged between 16 and 64), compared to the central scenario in which 55% of the population is of working age. The proportion of dependents aged between 0-15 is also slightly higher in the high scenario, reflecting higher birth rates, with this group accounting for 19% of the population compared to 17% in the central scenario.

Low scenario

[4] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections

Our low scenario is based on the ONS 'old age structure' variant of its principal population projection. In this scenario, fertility rates are assumed to be lower than in the central case while life expectancy is higher. Furthermore, net migration is lower than in the central case. All these factors lead to an older age structure of the population. In the low scenario, total population reaches 66 million in 2100, an increase of just 1 million since 2016, compared to the central scenario in which the population reaches 83 million in 2100. In 2100, individuals aged over 65 account for 36% of the population, compared to 29% in the central scenario.

GDP

Our GDP projections are based on the Office for Budget Responsibility (OBR): Fiscal Sustainability Report 2018 real GDP growth projections.

- Central projection, based on OBR baseline projection scenario
- High projection, based on 'young age structure' OBR scenario
- Low projection, based on 'old age structure' OBR scenario.

Central scenario

The Central scenario envisages a GDP annual growth rate for the UK of about 1.6% from 2018 to 2028 and an acceleration with GDP expected to grow by2.2% per annum from 2029 onwards.

High scenario

While GDP growth is predicted to be positive in all of the projections, the High scenario is the most optimistic one, achieving growth of 1.7% per year to 2028, and 2.4% pa from 2029.

Low scenario

The Low scenario projects an annual increase in GDP of 1.6% per year to 2028, increasing to 2.2% in the following decade but reducing to 1.9% per annum thereafter.

GVA

The Gross Value Added (GVA) projections produced for this study are calculated from the historical sectoral GVA data published by the ONS and from the GDP and working-age population (16-65) projections presented above. The ONS provides annual estimates for GVA at the national, regional and local authority area level by broad industrial group according to the SIC 2007 classification. From the historical data, GVA projections are estimated in line with the expected GDP and population growth in each scenario. The sectors considered are the following:

- ABDE – Agriculture, mining, electricity, gas, water and waste
- C – Manufacturing
- F – Construction
- GHI – Distribution, transport, accommodation and food
- J – Information and communication
- K – Financial and insurance activities
- L – Real estate activities
- MN – Professional and administrative services
- OPQ – Public administration, education, health
- RST – Recreation, other services and household activities.

Central scenario

In the Central scenario all sectors experience a similar growth pattern based on the Central GDP growth rates, in line with the methodology developed.

Distribution, transport, accommodation & food and Public administration, education & health are the major contributors to growth.. The average annual GVA growth over the entire projected series is about 2.1%.

High scenario In the High scenario GVA is influenced by more rapid GDP growth but also working-age population growth. On average, GVA is projected to increase by 2.3% annually. In the same way as in the other scenarios, relative shares across sectors do not change over time.

Low scenario In the Low scenario a more pessimistic GDP projection and reduced population lead to the slowest GVA growth across the three scenarios, with an average annual growth of 1.9%.

Employment

The employment projections used in our database are based on the OBR UK employment projections (available from 2018 to 2068) and on the historical employment data at the regional and local authority area from the Business Register and Employment Survey (BRES). The sectors considered are the same as those presented for GVA.

Central scenario In the Central scenario employment at the UK level increases by 0.5% annually in 2019, followed by a slower increase in the successive decades, continuing to decelerate and reaching a minimum of 0.1% by 2050. On average, employment grows by 0.2% over the entire projected period. The sectors with the highest employment levels are Distribution, transport, accommodation & food, Public administration, education & health and Professional & administrative services. Overall, the total number of jobs in the UK increases from 32 million to almost 39 million in 2100.

High scenario In the High scenario total employment in the UK expands by 0.6% per annum to 2027, but the growth rate slows thereafter to a minimum of 0.3% in 2054. The average growth rate equals 0.4% between 2018 and 2100, leading to an expansion in the number of jobs of about 11.5 million over the entire period.

Low scenario In the Low scenario employment levels do increase in the UK and across its regions up to 2039, with a maximum growth rate of 0.5% in 2019. However, employment starts to fall from 2040, leading to an overall contraction of more than 2 million jobs by 2100. This is due to the expected decrease in the working-age population, particularly in the second part of the century.

Labour productivity

Labour productivity is presented in terms of thousands of pounds sterling per job and it is estimated by dividing the GVA projections by the employment projections produced in this study in each of the three scenarios considered. Sectoral estimates are provided according to the same sectoral classification used for GVA and employment.

Central scenario In the Central scenario productivity levels are expected to grow across all sectors. Real estate activities is the most productive sector, with around £446,000 per job in 2018 increasing to more than £2.1m per job in 2100. The highest productivity levels are achieved in 2100, with an average annual growth rate of approximately 1.9% across the entire period.

High scenario In the High scenario the expansion in productivity is not as pronounced as in the Central scenario due to a larger increase in the number of jobs created within the UK economy. Nevertheless, the sectoral productivity levels achieved in 2100 are only slightly lower than in the Central case, and the average annual growth rate remains around 1.9%.

Low scenario

The Low scenario is characterised by productivity levels which are in line with the other two scenarios. This is due, on one hand, to the reduced number of jobs expected by 2100 and, on the other hand, to the expansion in sectoral GVA. The highest productivity levels are achieved in 2100 and do not significantly differ from the previous projections, with the Real estate sector remaining the most productive one. The average annual growth rate is again approximately 1.9%.

Land use

The land use scenarios we use in our dataset are based on the Centre for Ecology & Hydrology (CEH): Projections of emissions and removals from the LULUCF sector to 2050 (2017). The scenarios are developed to predict land use, land use change and forestry activities in the future, "taking into account current land use policies and/or aspirations (e.g. achieving a certain percentage of forest cover by 2050)"[5]. One assumption that remains constant across the various projections is total UK land area, meaning land lost to sea level rises is not taken in to account.

Central scenario

Our central projection is based on the 'central' CEH scenario. This scenario assumes current policies and funding, non-forest rates and 2014 afforestation planting rates continue at the same rate into the future. In 2050, the percentage of land attributed to each of the land use classifications; forest, cropland, grassland, wetland, settlement and other, remains the same or very similar to 2014 levels.

High scenario

Our high projection for land use is based on the 'Stretch' scenario from the CEH projections, and represents the scenario with the largest changes in land use. In this scenario we assume climate change mitigation is ambitious and policy aspirations or funding exceed those currently in place. For example, the high scenario assumes ambitious levels for afforestation, with a planting programme exceeding current policy, while peatlands are fully restored by 2030 with an end to peat extraction. The high levels of afforestation lead to loss of grasslands in this scenario, while shares of other land use classifications remain fairly similar to 2014 levels.

Low scenario

Our low projection for land use is based on the 'Low' scenario from the CEH projections. In this scenario current climate change mitigation policy for each of the devolved administrations are assumed up to 2021, after which mitigation policy aspirations are projected forward. For example, the low scenario uses forest planting rates to 2021 determined by available grants for woodland creation within each devolved administration, supplemented by additional planting activity to meet policy aspirations after 2021. In the low scenario 50% of peatlands are assumed to be restored by 2050 in Scotland and Northern Ireland, and 100% restoration in England, with an end to peat extraction across the UK in the same timeframe.

Expenditure on R&D

There are no official published projections of economy-wide R&D that are available at a UK or subnational level. Instead the scenarios are based around current R&D expenditure to GDP ratios, or stated government aims (to raise R&D expenditure in the UK to 2.4% of GDP by 2027), combined with the GDP projections calculated in this study.

[5] https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1703161052_LULUCF_Projections_to_2050_Published_2017_03_15.pdf

Central scenario

In our central scenario, the central projection for GDP is used along with the continuation of the long-term ratio between GDP and R&D expenditure; currently 0.8%. In this scenario we assume government policy aimed at encouraging innovation and public-sector support for R&D projects remains similar to today. Firms are faced with the same barriers and opportunities for R&D, such as access to finance, and so it is likely that R&D intensity (proportion of turnover spent on R&D activities) remains similar to today.

Low scenario

Similarly, in the low scenario, we also assume the long-term ratio between GDP and R&D expenditure of 0.8% holds up to 2100, and this rate of R&D expenditure is applied to the low projections of GDP. Again, similar policy, economic and firm-specific conditions as those faced by forms today exist.

High scenario

The high scenario differs from the previous two projections in that it combines the high GDP projection with a higher ratio R&D expenditure ratio. In this scenario, up to 2027 it is assumed that baseline private sector investment in R&D increases in line with increases in GDP, while baseline public sector investment remains steady. However, with additional investment and intervention from the Government, both public and private sector investment increases in a joint effort to meet the 2.4% R&D expenditure target.

Energy generation by technology

The National Grid FES scenarios are the key source for the energy projections. The National Grid FES scenarios present alternative future deployments for electricity generation in the UK out to 2050. The scenarios sit within a matrix in which the level of decarbonisation is on one axis, and the speed of decarbonisation is on the other axis. In our selection of scenarios to represent our central, high and low cases, we have considered which FES scenarios best represent central, high and low resource and infrastructure use. This is because scenarios of higher population, GDP and employment place greater demand on resources, including energy.

Central scenario

Our central scenario is based on the National Grid FES 'Two Degrees' scenario, in which there is rapid decarbonisation and low levels of decentralisation.

In this scenario electricity demand is very low. While demand for electricity is fairly high for EV charging, this is more than offset by improvements in energy efficiency and low electricity demand for heating. By 2033 most cars are electric, while commercial vehicles use a high level of gas. However by 2040 hydrogen is the main source of fuel for commercial vehicles. In the heat sector hydrogen from steam methane and district heat have key roles to play in heat generation and high levels of thermal efficiency are assumed. Electricity is generated mainly through offshore wind, nuclear, large scale storage and interconnectors. Gas supply includes some green gas such as biomethane and BioSNG, and in this scenario the UK has a high gas import dependency. In this scenario, 2050 carbon reduction targets are met.

High scenario

For our high scenario we have used the FES 'Steady Progression' scenario, since of all the FES scenarios, demand for infrastructure and resource use are highest in this scenario. In this scenario electricity demand is moderate to high, with high demand for electricity for EVs and only moderate efficiency gains. By 2040 most cars are EVs and some gas is used in commercial vehicles. For heat, gas boilers still dominate and there are only moderate levels of thermal efficiency. Electricity is generated mainly through offshore wind, nuclear and gas, and there is some carbon capture utilisation and

storage (CCUS) gas generation from the late 2030s onwards. In 2050 the UK is still producing gas, and some shale gas is used. In this scenario, 2050 carbon reduction targets are not met.

Low scenario

For our low scenario we have used the FES 'Community Renewables' scenario, since of all the FES scenarios, demand for infrastructure are lowest in this scenario, since load is taken away from the grid. Electricity demand is high, driven by high demand for EV charging and heating, but there are good efficiency gains. Most cars are EVs by 2033, while in this scenario there is the greatest use of gas in commercial vehicles. However, this is replaced in the mid 2040s by hydrogen. In the heat sector, heat pumps replace gas boilers as the dominant technology and there are high levels of thermal efficiency. Electricity is mainly generated by solar and onshore wind, while in the gas supply sector, green gas development is high from 2030 onwards. In this scenario, 2050 carbon reduction targets are met.

Average household numbers and size

For the average household number and size projections we produce a single scenario, a central case. This central scenario is based on the ONS central projection of number of households. The number of households in this scenario is projected to increase by 4 million between 2016 and 2041, and by 14 million to 2100 (compared to 2016). The majority of growth in the number of households is expected to be caused by the ageing population, as the number of households headed by someone aged over 65 increases, and likelihood of single occupants increases. This also partly explains why the average UK household size decreases over the time period, from 2.35 persons per household in 2016 to 1.96 in 2100. Other factors such as lower birth rates and higher divorce rates may also play a part in reducing the average household size.

Appendix A Quality Assurance

This appendix outlines the quality assurance checks carried out on the socioeconomic dataset provided to the Committee on Climate Change under the contract 'A consistent set of socioeconomic dimensions for the CCRA3 Evidence Report research projects'.

The following sections detail the checks carried out on the data and provide a declaration from the appointed Quality Assurance Director, Richard Lewney, whose role is to independently ensure the quality of all the project outputs.

Checks carried out

	How check will be carried out
Ensuring no anomalies in the data (negative values, very high or very low values)	Automated checks (e.g. conditional formatting, min, max, range calculations), charting data
Check for smooth trajectories in projections, i.e. no drastic or unexpected changes in growth rates that change the course of the projection.	Charting data, automated checks on growth rates
Ensure results are realistic/plausible within the timeframe, and that they make sense within our scenario narratives	Spot checks on data points at specific time intervals, e.g. 2030, 2050, 2100, charting data. Average growth rates over the projection period will be calculated at a national level and spot checked at regional and local authority level. The plausibility of these growth rates will be considered. Compare shares of each region/local authority in start year and end year to check whether results seem plausible.
Ensure disaggregated data shares sum to 100	Automated checks, e.g. compare sum of LAs to regions, sectors to totals.
Ensure projections of related indicators move in the same direction/ follow similar patterns	Chart data, random spot checks, calculation and checking of implied intermediate data. Ratios to calculate and check include: • GDP per capita • R&D expenditure per capita • GDP / GVA • GVA per capita • Ratio between population and land used for 'settlement' • Total energy generation per capita • Employment to population ratio (number of people employed/ working age population)

	• R&D expenditure intensity (R&D/ GDP) • Energy intensity (total energy demand/ GDP) • Total residential energy demand per household
Ensure data is well structured	Quality Assurance Director to consider workbook usability (as a team member external to the day-to-day activities of the project).

Declaration

As the appointed Quality Assurance Director for this project, I can confirm that the above checks were carried out on the dataset provided.

Richard Lewney

Chairman, Cambridge Econometrics

Appendix B Dataset user guidance

This appendix is dedicated to helping the user navigate through the Socioeconomic baselines database that Cambridge Econometrics developed for the CCRA3 Evidence Report research projects.

When opening the file, the user is introduced to an 'Information' tab which shows key file's elements such as the author, client, version, last date of revision and release date. This section also lists the sheets included in the file (with a hyperlink on each of them) together with a short description of contents.

The second spreadsheet, named 'ID numbers', provides the user with a table matching the UK Local Authority Districts (LAD) names with their respective codes as defined by the Office for National Statistics.

The remaining part of the Socioeconomic baselines database is organised into a series of spreadsheets named according to the considered indicator by geographical region and scenario. The projections for each indicator, covering the period up to the year 2100, are presented in the following order:

1. **Population** (Thousands) at the national, regional and local authority level by gender and age band, three scenarios are presented (Central, Low and High);
2. **Gross Domestic Product** (£ million, real 2016) for the UK in the Central, Low and High scenarios;
3. **R&D expenditure** (£ million, real 2016) by sector (Government, Higher Education, Business and Private/Non-Profit) at the national and regional level in the Central, Low and High scenarios;
4. **Gross Value Added** (£ million, real 2016) by sector (ABDE, C, F, GHI, J, K, L, MN, OPQ, RST) at the national, regional and local authority level in the Central, Low and High scenarios;
5. **Land use** (kha) by land use category (Forest, Cropland, Grassland, Wetland, Settlement, Other) at the national and regional level in the Central, Low and High scenarios;
6. **Energy generation** (TWh) and **capacity** (MW) per technology in the UK, **Gas** and **electricity demand** (TWh) by sector (Industrial, Commercial, Residential, Transport, Transformation, Power Generation) in the UK in the Central, Low and High scenarios;
7. **Employment** (Thousand jobs) by sector (ABDE, C, F, GHI, J, K, L, MN, OPQ, RST) at the national, regional and local authority level in the Central, Low and High scenarios;
8. **Productivity** (£ thousand per job) by sector (ABDE, C, F, GHI, J, K, L, MN, OPQ, RST) at the national, regional and local authority level in the Central, Low and High scenarios;
9. **Households number** (Thousands) and **average household size** (Persons per household) at the national, regional and local authority level in the Central scenario.