CARBON NEUTRAL COMMUNITIES

Centre for Design, RMIT University and University of South Australia

TITLE: CARBON ASSESSMENT METHODS AND METHODOLOGIES FOR CARBON ASSESSMENT AT LGA SCALE

Working Paper –Final draft subject to acceptance

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ABSTRACT

The prospect of state government driven carbon emission reduction targets brings with it the prospect of targets being set at local government level. Such targets will need to be based on reliable estimates of energy demand and greenhouse gas emissions at the local government level. In Australia greenhouse gas inventories are established at federal and state levels. However, more locally it becomes difficult to establish emissions profiles. Cities for Climate Protection has produced emissions profiles for a large number of local council areas in Australia, but this analysis often does not reflect local characteristics and conditions since it is derived from higher level data sets.

This paper examines three alternative methods, including the CCP method, to estimate energy use and GHG emissions for the residential, commercial, industrial, transport and waste sectors at the local government level, using the City of Playford in South Australia and Manningham City Council in Victoria as examples. The aim is to test each of these approaches and compare the results in order to arrive at reliable emissions profiles which reflect local conditions and can be used to reliably set targets for GHG emission reductions.

The results of the assessment indicate that while the two hybrid bottom up methods, including the CCP method, are more reliable than the top down method using state based per capita data solely, there is a lack of energy consumption data available at the local government level for most sectors. This lack of data will make it difficult for local government to reliably determine baseline energy use and GHG emission profiles required to set targets to reduce energy consumption and GHG emissions across its community. It is recommended that further studies be undertaken at local government level to obtain a more reliable profile of energy consumption and GHG emissions for each sector.

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Glossary of Terms and Acronyms

ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
ARC	Australian Research Council
CCP	Cities for Climate Protection
CNC	Carbon Neutral Community
Climate Change	A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods
GHG	Greenhouse Gases - those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation
GWP	Global Warming Potential - An index representing the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION

1.1 Context and Definitions

Greenhouse gas (GHG) emissions have been linked directly to climate change and are a focus of international agreements such as the Kyoto Protocol and government policy at national and state level in most countries (UNFCCC undated).

While Australia has been a laggard in committing to targets for GHG reductions at the national level, the States are variously developing their own targets and in some instances implementing legislation which commits to reductions in GHG emissions. As part of the Local Agenda 21 program which was initiated in the 1990's, regional and metropolitan local government agencies have variously adopted targets for GHG emissions and promote initiatives for energy and water conservation within their area of control and influence. Initiatives have generally been implemented as part of the nationally funded Cities for Climate Protection (CCP) program under the auspices of the International Council for Local Environmental Initiatives (ICLEI).

Locally relevant baseline emissions data is essential to enable the identification of appropriate emissions reductions mechanisms for adoption at a local level. This knowledge also informs the development of locally relevant targets and provides the base for measuring the effectiveness of mechanisms adopted at the local level to address emission reduction targets and report on achievements. While baselines have been variously determined and reported at the national and state levels, there is little baseline data available at the regional or local government level other than that provided by the CCP program which is developed from state level data.

Definition of Greenhouse Gases

The greenhouse effect is a natural effect and has been described as one of the most important physical processes operating in the climate system (Zillman et al, 2005) as it maintains the earth's temperature at the surface at a level suitable for human existence. The effect is due to radiation from the earth's surface being absorbed by trace gases in the atmosphere and re-emitted. These trace gases known as GHGes (GHGs) consist of water vapour, carbon dioxide, methane, ozone, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride.

Meaning of the term 'carbon' in carbon assessment

The use of the term 'carbon' relates to the natural and human influenced carbon cycle as explained by the Intergovernmental Panel on Climate Change (IPCC, 2001) and reproduced here as Figure 1. This gives rise to terms such as the 'carbon economy' and 'carbon neutrality'. As the basis of reporting emissions is linked to carbon dioxide in the atmosphere, the term 'carbon assessment' is used to refer to the assessment of GHGs emitted.

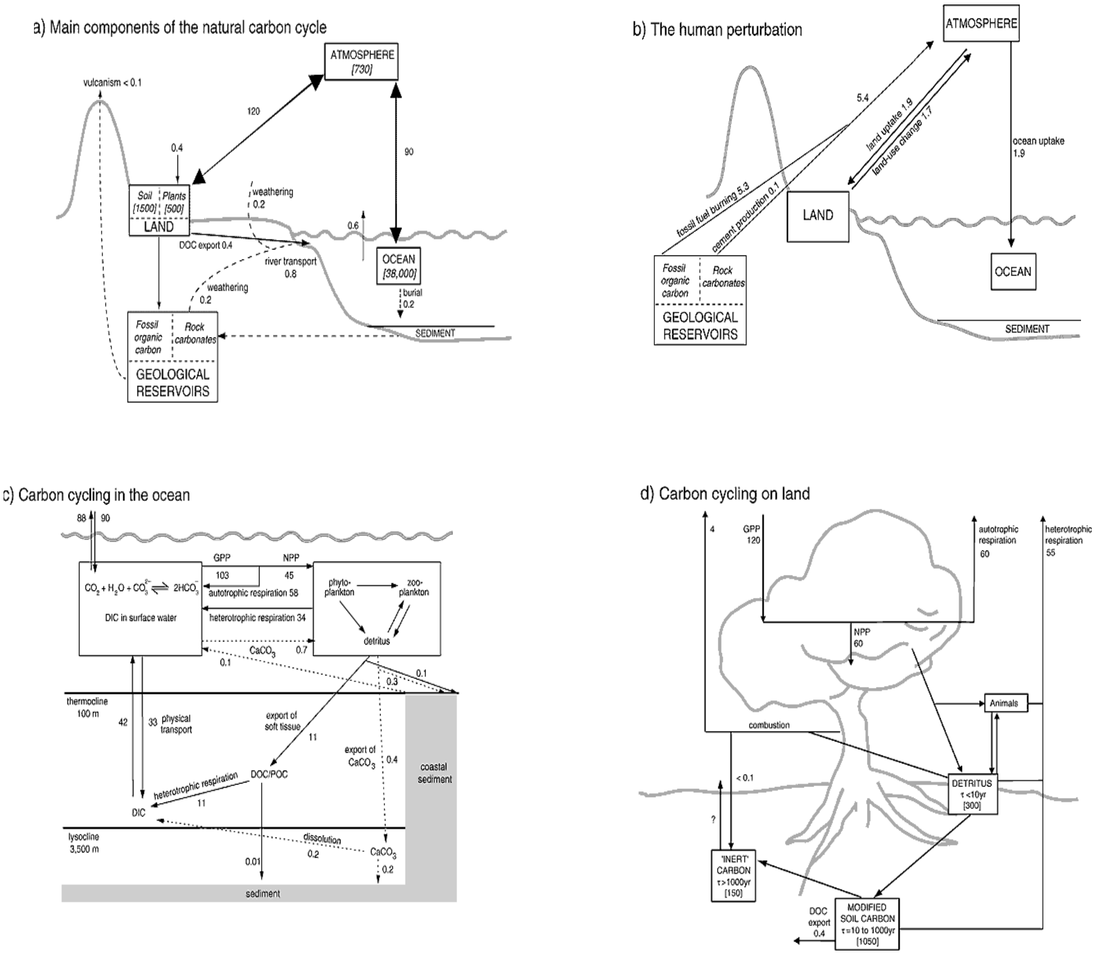

Figure 1. Parts a), b), c) and d) depict the carbon cycle and human influences (Source: IPCC (2001))

1.2 Aims and Objectives

The aims and objectives of this paper are to:

- provide a summary of the literature related to methods being adopted internationally and in Australia for the assessment of GHGes,
- determine methods that can be applied at the local government level,
- trial the carbon assessment methods for the City of Playford in South Australia and the Manningham City Council in Victoria,
- discuss the results of this trial, and
- recommend a carbon assessment method for the Carbon Neutral Communities: Making the Transition ARC Linkage project.

1.3 Layout and Approach

Section 2 provides a background to the carbon assessment methodologies used internationally, nationally and at state level. It then proceeds to discuss in more detail the approaches that have been adopted in the literature for studies of GHG emissions at local government level. It outlines the method used by the ICLEI CCP program and the method adopted in studies in the United Kingdom, both of which inform the approach adopted for this study.

Section 3 summarises the results of the trials of methods for assessing GHGs that were undertaken for the City of Playford in South Australia and for the Manningham City Council in Victoria.

Section 4 discusses the findings of the trials conducted and Section 5 makes recommendations for further study and use of the approaches to carbon assessment for the Carbon Neutral Communities: Making the Transition project.

2. Method and Approach: Carbon Assessment Methodologies

This section comprises a review of literature about methodologies used internationally and in Australia for the assessment of GHG emissions at the national and state level. It then describes methodologies which have been used in previous studies of GHG emissions for local government areas, and concludes by describing the method proposed to be used for assessing GHG emissions for the Carbon Neutral Communities (CNC) project. The general approach is to review and compare the existing methods for carbon assessment based on the availability of data and the differences and similarities between the results and the methods used.

2.1 Relevant literature relating to Carbon Assessment Methodologies at the national and state level

This section commences with a discussion of GHGs and identifies those that are commonly assessed and reported internationally. It then summarises methodologies adopted by international agencies and by Australia in its reporting of GHG emissions nationally and at the state level.

Which GHGs should we assess?

According to Cotton and Pielke (1995:161) the basic greenhouse concept was first described by Fourier in 1827 and further developed and explained by Arrhenius in 1896. As stated previously the GHGs comprise of water vapour, carbon dioxide, methane, ozone, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride.

While water vapour is a major GHG it varies naturally both in space and time mainly due to the hydrological cycle of the earth (Cotton and Pielke, 1995:161) and is not directly influenced by anthropogenic action. Ozone concentration is affected by the presence of other gases such as carbon monoxide and the nitrogen oxides and as it has a relatively short lifetime its relative contribution to human influenced global warming is considered to be less important than other GHGs (Cotton and Pielke 1995:165). The United Nations Framework Convention on Climate Change (UNFCCC) do not require signatory countries to measure or report emissions of water vapour or ozone but do require that countries report on their emissions of carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride (IPCC, 2006).

These GHGs are emitted directly to the atmosphere during the combustion of fuels for generating energy for various activities in the residential, commercial, industrial and transport sectors, from agricultural activities, landfill activities, wastewater treatment processes, some industrial processes and from land use changes where land is cleared of natural vegetation or forests.

The GHGs differ in their ability to re-emit radiation and in the time that they remain in the atmosphere. Consequently the Global Warming Potential (GWP) of GHGs differs (UNFCCC, 2007). When considering a 100 year time horizon, methane has 21 times and nitrous oxide has 310 times the GWP of carbon dioxide.

To enable a standard way of measuring the emissions of GHGs, all GHGs are converted to an equivalent amount of carbon dioxide based on their GWP. Hence reports of GHGs emitted are in terms of the equivalent carbon dioxide emission as kilograms (kg) CO_2-e or tonnes (t) CO_2-e.

International Carbon Assessment Methods

The lead international carbon assessment method was developed by the IPCC and a panel of over 800 climate scientists. This section will describe the methods that are endorsed by the IPCC for use by countries in preparing their inventory reports for GHG emissions.

The inventory reports include GHG emissions for the energy sector, industrial processes, solvent and other product use, agriculture, land use, land use change and forestry and any other sources.

Methods for the assessment of GHG emissions have been developed internationally by the IPCC. In discussing the methodological approaches for the combustion of fossil fuels, the IPCC describe three Tiers of assessment based on the level of information which is available and provide a decision tree to determine which Tier should be used (IPCC, 2006). This has been reproduced and included as Figure 2. Tier 1 uses fuel combustion from national energy statistics and default emission factors. Tier 2 uses fuel combustion from national energy statistics, together with country-specific emission factors, where possible, derived from national fuel characteristics. Tier 3 uses fuel statistics and data on combustion technologies applied together with technology-specific emission factors. Tier 3 includes the use of models and facility level emission data where available.

Countries that are signatories to the UNFCCC report their GHG emissions annually and are required to outline their methodology for undertaking their assessments and developing their GHG emissions inventories, particularly if they do not comply with the standard IPCC method.

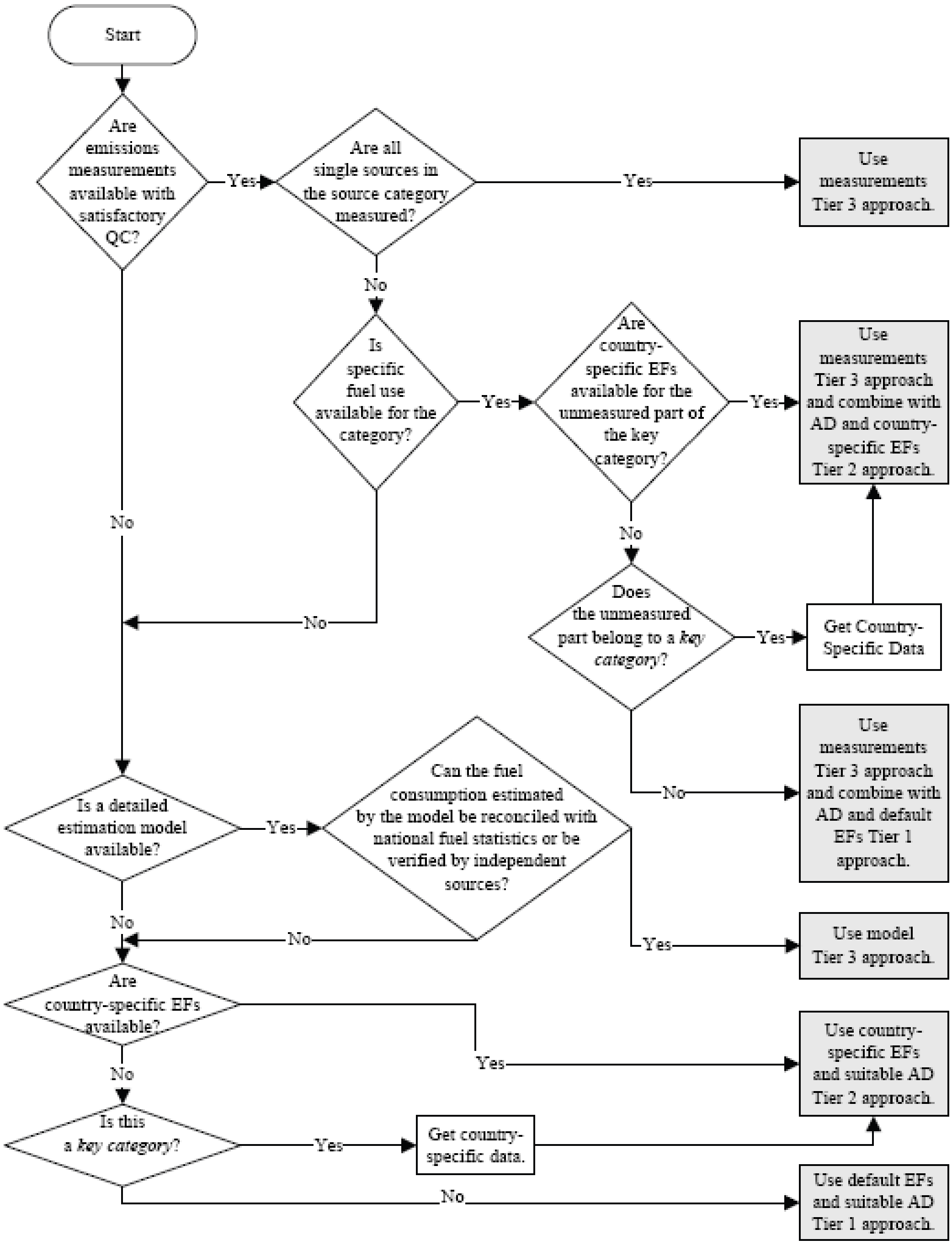

Figure 2. Generalised decision tree for estimating the emissions from fuel combustion (Source: IPCC, 2006)

Australia's Carbon Assessment Methods

Since 2004, GHG emissions for Australia have been calculated by the Australian Greenhouse Office (AGO) according to methods outlined in the *AGO Factors and Methods Workbook* (AGO, 2006a) and the *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks: States and Territories* (AGO, 2006b). In 2005, the UNFCCC released its report of the review of Australia's National Communications from 2003 including the inventory report and methods (UNFCCC, 2005). They concluded that the combination of country-specific and IPCC methods, together with both national and IPCC default emission factors, were applied to key sources identified in accordance with IPCC good practice guidance.

The GHGs that are emitted by communities depend on the type of fuels that a community uses to provide energy for its activities, the type of wastes a community produces, the types of processes used to handle wastes and the types of industrial and commercial activities which are undertaken. Communities use energy for their day to day activities and consume products which have been manufactured or produced using processes that either emit GHGs directly or use energy that has been produced by processes that generate GHGs. Communities also produce wastes which require treatment and disposal.

GHG emissions are calculated as a product of an activity level (eg fuel consumed) and an emission factor. In order to calculate GHGs the actual fuel consumption data should be obtained or estimated and the appropriate emission factor applied for each fuel.

In Australia, emission factors have been developed for each type of fuel consumed for transport and other purposes eg home heating or commercial /industrial use and for each State emission factors have been developed for electricity consumption and natural gas consumption (AGO, 2006b). The Australian Bureau of Agriculture and Resource Economics (ABARE) have compiled data relating to fuel consumption by sector for Australia and for each State and Territory. These include categories of agriculture, mining, manufacturing, construction, electricity generation, transport, commercial and services, residential and a category of 'other' sectors. Using the ABARE data and State based emission factors the GHG emissions for each sector can be calculated at a State level for each type of fuel consumed.

The *Australian Greenhouse Inventory* (AGO, 2007) provides a summary of emissions from the energy sector which comprises stationary energy facilities, transportation (mobile combustion) and fugitive emissions from the handling of fuels. These emissions together accounted for 70% of Australia's GHG emissions (AGO 2007) with the stationary energy component alone comprising 50% of Australia's emissions. Of the remaining 30% of Australia's GHG emissions, agriculture contributed 16%, land use, land use change and forestry contributed 6%, industrial processes contributed 5% and waste contributed 3%.

Other Surveys of Household Energy Use

In addition to the reports produced by the AGO, the Australian Bureau of Statistics (ABS) undertakes surveys to ascertain attitudes to environmental issues and monitor trends that are taking place across states. The method they adopt is to conduct face to face interviews with a sample of Australian households using a standard questionnaire for each survey. A responsible adult from each sample household provides answers to questions about various environmental practices. Energy consumption practices, household and dwelling characteristics and the use of appliances and energy efficiency initiatives have been obtained and reported using this method. It should be noted that while surveys of environmental issues and trends are undertaken by the ABS each year, the focus is not always on energy.

2.2 Carbon Assessment Methods applicable for use at Local Government level

This section summarises the methodologies documented in the literature for assessing GHG emissions at a local government level. The methodologies included are from programs used in Australia and studies from the United Kingdom.

ICLEI Cities for Climate Protection Method

While inventories of GHG emissions have been developed for the whole of Australia and for States and Territories, compiling fuel consumption and emissions within each sector and below the State level is more problematic (AGO, 2006b). Obtaining reliable and relevant data at this level is difficult due to confidentiality. A method has been developed by the ICLEI CCP program (CCP, undated) to enable local government agencies undertaking GHG reduction initiatives within their own council operations to estimate the emissions arising within their community and thereby provide a baseline for their community to assess itself against while implementing initiatives to reduce GHG emissions across its area of responsibility and influence.

The community GHG emissions calculated by CCP cover four sectors – residential, industrial, transportation and waste. The methods used to calculate these emissions are summarised as:

- Residential - A Base Year population figure for each local government authority area is combined with state-based per capita consumption for each of electricity, natural gas, LPG and fuel oil. The consumption data is sourced from ABARE for the Base Year.

- Industrial – State-based ABARE figures for energy used within each ANZSIC is expressed in terms of GJ per employee. Employee numbers for each business by ANZSIC is obtained from ABS for the state and for each local government area.

- Transportation – State based per capita VKT figures used multiplied by population residing in the LG area. Emissions from road based public transport (ie buses) are the only public transport included. (Note emissions from other public transport are in the Industrial sector – Transport and Storage).

- Waste - For the waste sector, CCP advises local government to obtain data from local waste management authority – eg for Playford the Northern Adelaide Waste Management Authority (NAWMA) is the source of local data.

The CCP database also has ability to calculate projections for energy use and GHG emissions for each sector. These are based on ABARE state based projections for population and businesses. Future employment numbers are not projected but use the base year numbers.

Carbon Assessment Methodologies used in the United Kingdom

Bennett and Newborough (2001) observed that in the United Kingdom (UK), energy consumption data tended to be available at either a macro (international or national) level or a micro (individual establishment or residence) level with very little reliable data collected at the community level. The usefulness of macro level consumption data in bringing about behaviour change was considered to be low and it was considered that an individual business or household would respond more favourably when they could see consumption levels at the community level. The collective response of a city, town or urban district was considered to promote the greatest ownership of energy-saving emissions reduction initiatives.

Bennett and Newborough (2001) developed a method that involved the following:

- Divide the area into a series of key sectors – ie residential, industrial, retail, government agency.
- Divide each sector into sub-sectors and continue to subdivide until the data is no longer available.
- Collect data.
- Identify gaps where data is missing and undertake specific studies (data collection) from local sources to fill gaps.
- Aggregate the data for the whole area.

Grant and Kellett (2001) described a method for undertaking the baseline assessment of energy use for the Conisbrough and Denaby areas of the UK. Their method included the following:

- Obtain land use data for each area.
- Obtain census data on population, income and employment.
- Obtain the overall energy demand for the following sectors – domestic, commercial, industry, public sector buildings and services and transport.
    - For the domestic sector energy consumption data by fuel type was obtained for 95% of the public housing and 5% of the private stock. Information about dwelling type, size, build date and construction materials was also obtained.
    - Actual energy consumption data was obtained for locally owned public sectors buildings.
    - The Industry sector was disaggregated by Standard Industry Classification. National energy consumption figures for each class were used to estimate business and industry consumption of energy. The estimates obtained were checked by surveying a sample of industry/businesses in the area.
- Convert energy used for each sector into carbon emissions for each type of fuel. The Digest of United Kingdom Energy Statistics (DUKES) provided these conversion factors.
- Compare the energy consumption and emissions figures with national figures for similarities and differences.

While the method used by Grant and Kellett (2001) follows the approach of Bennett and Newborough (2001) it does not undertake empirical research to fill the gaps identified but uses a pro rata of national statistics to fill these gaps.

Shaw (2004) outlined a method for undertaking a baseline energy and GHG emissions assessment for Sheffield in the UK. It followed a review of methods used by both Bennett and Newborough (2001) and Grant and Kellett (2001) and was a hybrid of two approaches:

- The first approach was to-
    - Obtain national statistics on energy consumption, population and employment levels
    - Obtain local statistics for population and employment for the area under assessment.

    - Using national statistics and local statistics, calculate a pro-rata energy consumption
- The second approach was to –
    - Undertake a comprehensive assessment using information gathered from local sources such as end users and energy suppliers.

The hybrid approach adopted used the following method–

- Conduct an indicative energy assessment based on both national data for an area and local data for each sector where available.
- Produce energy consumption ratios based on numbers of households, numbers of people employed, the floor area of buildings and number of vehicles and journeys.
- Produce estimates of final energy consumption per sector and fuel type.
- Calculate greenhouse emissions using emission factors for each fuel consumed.

Carbon Assessment Methods for Smaller (Neighbourhood) Scale

This section describes the methods used to estimate energy use and GHG emissions in a selection of studies undertaken at the neighbourhood scale in Australia.

Perkins (2002) undertook a study of life cycle energy used for housing and transport for samples of households in metropolitan Adelaide. As the purpose was to contrast the energy used, samples were drawn from two case study areas chosen for fringe and infill development (Perkins 2002:178). Household energy use and GHG emissions were calculated for components of “travel”, “vehicles”, “roads”, “appliances” and “dwellings” (Perkins 2002:179). Operational energy consumption was obtained from the 212 households in the case study areas in the form of electricity and gas bills, wood and oil use data. Travel diaries were used to record actual trips undertaken and mode of transport used. Perkins calculated embodied energy in addition to operational energy and used actual house plans and construction materials information for this.

Troy et al (2003) undertook a study of embodied and operational energy consumption across the metropolitan area of Adelaide. Electricity and gas consumption of households was obtained directly from the utilities for a sample of 30 houses in each of six case study areas. The case study areas were chosen to be representative of different stages of development in the spatial layout of Adelaide’s metropolitan area. The study also estimated the energy consumed in the transport task for each study area. For private vehicles this was estimated from the private vehicle ownership statistics for each case study area (ABS Census data) multiplied by the average distance travelled by vehicles each year. For public transport (buses only) the energy consumed was estimated from average journey to work statistics collected by the ABS and estimates of occupancy rates of public transport. Rail use was not estimated. The total distance per household was then multiplied by the average fuel consumption of buses. Business travel and freight travel were not estimated in the study (Troy et al 2003: 29).

Oliphant (2004) conducted a study of a small inner-city ecologically sustainable development in Adelaide, South Australia and compared this to studies undertaken by the University of South Australia at the Mawson Lakes subdivision in the northern suburbs of metropolitan Adelaide (Saman and Mudge 2003). The studies obtained energy use (gas and electricity) at the household level directly from the household meters and reported GHG emissions related to these levels of consumption. The emissions were reported for six homes in Mawson Lakes, a number of homes in the inner city development and the energy used for a network of homes at Mawson Lakes. It was not specified how these emissions were calculated and what emission factors were used in the calculations. Transport energy use was not studied in these cases.

Pullen et al (2006) conducted a study of operational and embodied energy in twelve case study areas of metropolitan Sydney during 2004. The case study areas were a mix of outer suburb and inner suburb areas constructed since the late 1970s and varied in dwelling type, housing density and number of storeys. Annual operational energy data for gas and electricity use was collected directly from the energy retailers. Transport energy use was not studied in these cases.

Perkins et al (2007) conducted a study of operational energy consumption, embodied energy and travel related energy in three case study areas of metropolitan Adelaide. The case study areas were chosen to represent three different residential urban forms – the outer metropolitan area, inner metropolitan area and apartments within the City of Adelaide central area. Similar to the Perkins (2002) study discussed earlier, operational energy consumption, the appliances that were used and details of motor vehicles used were obtained from the households in each case study area through the completion of a household survey and provision of electricity and gas bills. Travel diaries were used to record actual trips undertaken and mode of transport used. As embodied energy was also a focus of the study information about the dwellings was obtained from actual dwelling plans as well as from site inspections and the household survey.

'Ideal' Carbon Assessment Method for Local Government

Ideally the assessment of GHG emissions for a community would collect actual energy use and waste generation data for all sectors of the community within a local government area. While this can and has been undertaken on a small scale generally using a sample of the population, undertaking this on a local government scale is problematic due to confidentiality of energy consumption information and the considerable time required to collect and validate the data.

2.3 Carbon Assessment Methods trialled for use by the CNC project

This section describes three methods to determine the baseline carbon emissions. These methods are being trialled in the City of Playford in South Australia and at Manningham City Council in Victoria as part of the CNC project.

The methodology adopted builds on the approach developed in the United Kingdom by Bennett and Newborough (2001) and Grant and Kellett (2003) and further developed by Shaw (2004). This approach was described in Section 2.2.

Three approaches were developed and trialled. The first was a top-down approach, the second a hybrid bottom-up approach and the third used existing information and projections provided by the Cities for Climate Protection (CCP) program.

Approach 1 – top down.

In this method the GHG emissions related to energy consumption for residential, industrial/commercial and transport sectors for each of the City of Playford in South Australia and the Manningham City Council in Victoria were calculated as a pro rata of State level statistics based on the population. The energy consumed and GHG emissions for each of these local government areas was determined on a pro rata basis from the state figures for each sector and reported as per capita energy use, annual total energy use and annual greenhouse emissions. The assessment of the emissions from waste was determined on a pro rata basis from the state emissions for waste.

Approach 2 – hybrid bottom-up.

A hybrid approach similar to that described by Shaw (2004) was used and is described as follows:

- Define the boundary of the area
- Divide the area into sectors including residential, commercial, industrial, agricultural and transport
- For each sector determine the level of information available to calculate fuel consumption
- Obtain energy consumption, dwelling numbers, size of dwellings (number of rooms and floor area), population, vehicle numbers, vehicle type, fuel used at sectoral or local government level or if available at a lower level such as suburb or postcode
- Obtain emission factors (EFs) for each of the fuels consumed - relevant to the jurisdiction
- Obtain information about the area of land used for agriculture, type of crop, number of animals
- Obtain data on waste volumes/weight produced by type of waste, volumes/weight of waste recycled, waste disposed and how disposed
- Obtain emission factors for waste disposed to land fill

In Australia, the Australian Bureau of Statistics (ABS) collects and publishes data for some of these. However for other information such as the area of dwellings and business establishments this data is not readily available for local government areas. Similarly the disaggregated fuel consumption figures at the local government level are also not readily available.

The Australian Greenhouse Office (AGO) provides information on emission factors for fuels at the State level. The ABS reports waste management at the state level. However the local government agency is more likely to hold figures on annual waste produced by type and how it is disposed of or recycled as the provision of waste management to a community is generally a responsibility of local government in Australia.

For the residential sector it was resolved to use the average per capita energy consumption as recommended by Oliphant (2003) who observed that the number of people in a dwelling was of greater significance to overall energy consumption than the size of the dwelling (floor-space) or number of rooms.

For commercial and industrial premises there was an attempt to calculate energy use by area of floor-space using intensity from studies undertaken in the United States and reported by the AGO. However the information available for the City of Playford through the SA Government Land Services Group valuation database was unreliable and it was resolved to use employee numbers rather than area of floor-space.

Approach 3 – projection from CCP data.

This method took the 1995 energy consumption and GHG emissions results for each of the Residential, Commercial, Industrial, Transport and Waste sectors for the City of Playford determined by CCP and the projected increases or decreases sector by sector predicted by CCP for the Year 2010. It was then assumed that the changes over time were linear. Based on this straight line relationship the emissions at 2006 for each sector were calculated.

3. Results of the Trial for Carbon Neutral Communities project

This section summarises the results of the trial of the three approaches on data for the City of Playford in South Australia and the Manningham City Council in Victoria. The results are further discussed in Section 4.

Data for 2006 has been obtained wherever possible to coincide with the 2006 ABS Census date (8 August 2006).

3.1 City of Playford

The City of Playford is a local government area located approximately 30 km north of Adelaide and forms part of the northern metropolitan area of Adelaide in South Australia. It is approximately 346 sq km in area and consists of 35 suburbs. It contains the Munno Para area first established in 1853 and the city of Elizabeth, designed and built in the 1950s to provide housing and industry for an influx of immigrants from Europe after the Second World War. The City of Playford contains 19,000 ha of prime horticultural areas on the Northern Adelaide Plains and 7,150 ha of the Mount Lofty Ranges within its boundaries. There are 2 district retail centres, 9 neighbourhood retail centres, 12 local retail centres and 3 rural townships also within its boundaries. Industry is located mainly in the Elizabeth South suburb where the General Motors Holden automobile manufacturing plant is located and in the Elizabeth West suburb.

Demographic data for the City of Playford was obtained from the ABS 2006 Census of Population and Housing conducted in August 2006.

Approach 1 – top down.

The population usually resident in South Australia was 1,514,337 at 8 August 2006 (ABS, 2007a). The population of Playford usually resident at that time was 70,011 which equated to 4.62% of the state's population.

The annual per capita energy use, total energy use and associated GHG emissions for the City of Playford using Approach 1 were calculated on a per capita pro rata basis from data for the whole of South Australia (ABARE, 2006) and (ABS, 2007b) and are summarised in Table 1. It can be seen that according to this approach the industrial and transport sectors used the most energy (43% and 34% respectively) while the residential sector used 13%.

The GHG emissions likewise were dominated by the industrial sector with 38% of emissions followed by the transport sector (25%) and the residential sector (19%). Emissions from agriculture were included as agricultural activity (mainly horticulture) is undertaken in the City of Playford area.

Table 1. Energy use and GHG emissions for City of Playford – Approach 1 (based on pro rata state energy consumption by sector)

LG area and sector	**Population** (Place of usual residence)	**Annual per capita energy use GJ**	**Annual Total Energy Use PJ**	**Annual GHG emissions Mt CO2-e**
Playford	70,011		12.23	1.19
Residential		23.3	1.63 (13%)	0.23 (19%)
Commercial		11.7	0.82 (7%)	0.14 (12%)
Industrial (includes Manufacturing, Construction, Mining, Gas & Water Supply)		75.0	5.25 (43%)	0.45 (38%)
Transportation		58.8	4.12 (34%)	0.3 (25%)
Waste			NC	0.04 (3%)
Agriculture, Forestry & Fishing		5.9	0.41 (3%)	0.03 (3%)

Note: NC= not calculated (Sources: Energy Use - ABARE, 2006; 2006 Census Quickstats - ABS, 2007; State and Territory GHG Inventory - AGO, 2005; End Use Allocation of Emissions - AGO, 2002).

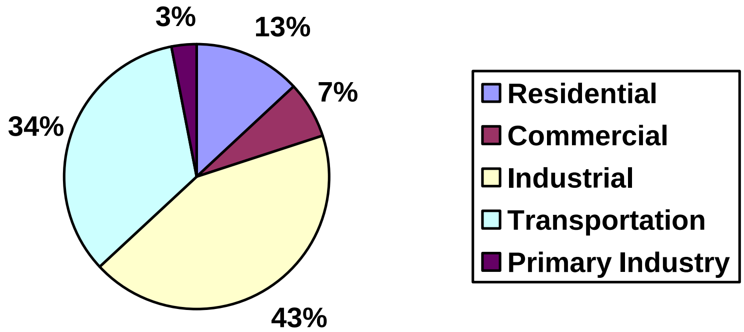

Figure 3 Energy Use for City of Playford – Approach 1

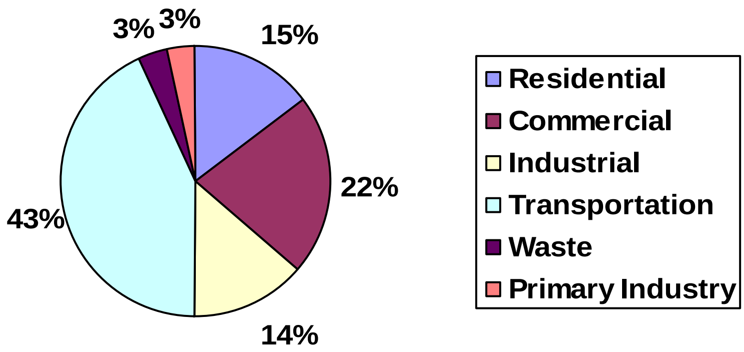

Figure 4 GHG emissions for City of Playford – Approach 1

Approach 2 – hybrid bottom up.

This method used the following data:

- The 2006 Census statistics (ABS, 2007a) were used to provide information on the number of usual residents, the number of dwellings and those dwellings which were occupied at the time of the Census.
- The average consumption of gas and electricity per household was obtained from the South Australian study undertaken by Oliphant (2003) and used for calculating energy used and emissions for Method 2a.
- The energy use reported by Oliphant (2003) for households of varying size based on the number of people usually resident was used for calculating electricity and gas consumption and emissions and is recorded as Method 2b.
- The average consumption of wood per household was obtained from the study of Driscoll et al (2000) and used for both Method 2a and 2b
- The data for the number and type of vehicles, average kilometres travelled and fuel used was obtained from the *Motor Vehicle Census* conducted by the ABS (ABS, 2006b) and *Transport Facts* (Apelbaum, 2006)
- Appropriate emission factors relevant to each fuel used were obtained from the *Factors and Methods Workbook* (AGO, 2006a)
- The counts and types of businesses in the commercial and industrial sectors as at June 2006 was obtained by postcode from the ABS (ABS, 2006)
- Employee numbers working in businesses in each sector within Playford were obtained from the Community Profile for Playford which used the ABS 2001 Census figures as up to date local information was not available.
- Waste production and disposal data was obtained from NAWMA and emission factors for waste were obtained from the *AGO Factors and Methods Workbook* (AGO, 2006a)

The results are summarised in Table 2 and the percentages are depicted graphically in Figures 5 and 6.

This approach resulted in approximately 50% of all of the energy used and 45% of the carbon emissions for Playford being due to industry with the manufacturing industry alone contributing 95% of the energy used by this sector. The next highest energy user is the transportation sector at 32% of energy used and 26% carbon emissions and the residential sector with 11% of energy used and approximately 18% of carbon emitted.

These results are discussed further in Section 4.

Table 2. Energy use and GHG emissions for City of Playford – Approach 2

LG area and sector	**Population** Place of usual residence In 2006	**Annual energy use GJ per capita** In 2003	**Businesses Registered in Playford #** In 2006	**Employees working in Playford** (*) # In 2001	**Annual energy use GJ per employee**	**Annual Total Energy Use PJ**	**Annual GHG emissions Mt CO2-e**
Playford	70,011					9.3	0.96
Residential (25,678 Dwellings)	Method 2a 2b	13.9 – 18.6 Ave 15.5 14.84			na	0.9 – 1.2 Ave 1.0 1.04 (11%)	0.13 – 0.17 0.17 (18%)
Commercial			1315 (524 employ staff)	10987	34.9	0.38 (4%)	0.07 (7%)
Industrial (Manufacturing, Construction, Mining, Gas & Water Supply)			762 (252 employ staff)	7026 (manufacturing 6413)	Range 41 – 3115 690 from manufacturing	4.66 4.42 from manufacturing (50%)	0.43 (45%)
Transport -vehicles (not rail) Transport & storage industry			309 (66 employ staff)	433	1044	2.53 0.45 (32%)	0.22 0.03 (26%)
Waste							0.02 (2%)
Agriculture, Forestry & Fishing			434 (81 employ staff)	965	246	0.24 (3%)	0.02 (2%)

na=not applicable; nc=not calculated
* employees may live outside of Playford area
(Sources: ABS, 2007b; Oliphant, 2003; ABARE, 2006; City of Playford Community Profile; Apelbaum, 2006; NAWMA, 2006)

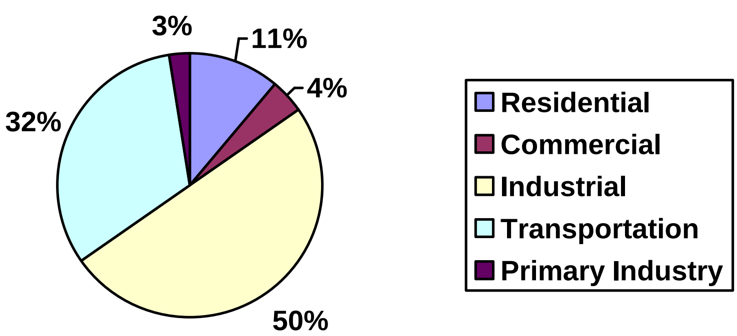

Figure 5 Energy use for City of Playford – Approach 2

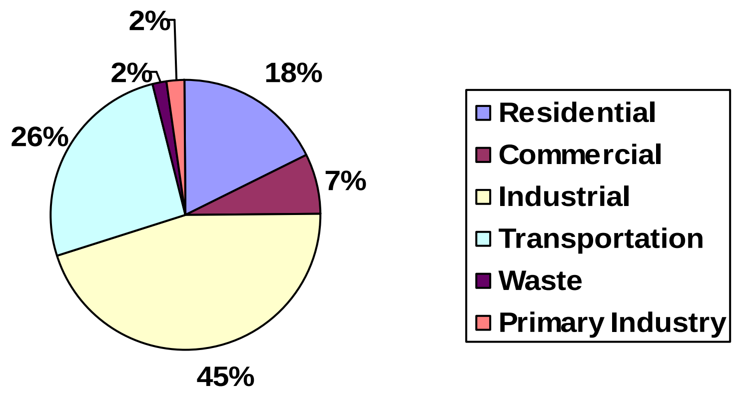

Figure 6 GHG emissions for City of Playford – Approach 2

Approach 3 – projection of CCP data.

This approach took the 1995 baseline energy use and GHG emission assessment together with the 2001 reassessment for the residential, commercial and industrial sectors and sector by sector projections to 2010 from the City of Playford and applied a linear pro-rata back to 2006. The City of Playford, a CNC project Partner, provided the information from their CCP program assessment and projections. These have been reproduced here in Table 3 together with the calculated figures for the Year 2006. Not all sectors were reassessed for 2001 by the CCP program and updated GHG emissions for projections to 2010 were available. It was assumed that the fuel mix was the same in 2006 and 2010 as was used to calculate GHG emissions for 2001.

Figures 7 and 8 depict graphically the percentage contribution to energy and GHG emissions for each sector. Using this approach the transportation sector used 36% of energy but contributed only 20% of carbon emissions while industry accounted for 45% of energy used and 40% of carbon emissions. The residential sector accounted for 13% of energy but contributed 24% of carbon emissions.

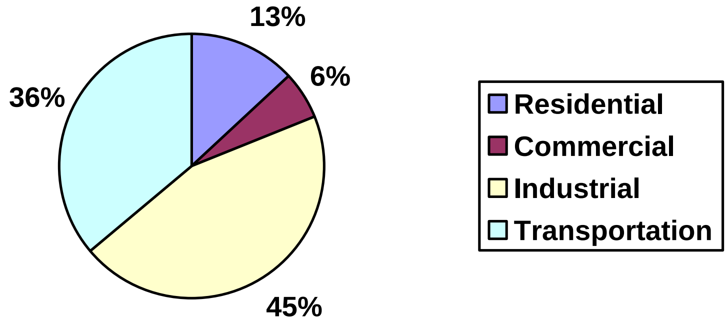

Figure 7 Energy use for City of Playford – Approach 3

Table 3. Energy use and GHG emissions for City of Playford – Approach 3

Sector	Year of Assessment	Annual Energy Use PJ	GHG Emissions Mt CO2-e
Residential	1995a	0.891	0.16
	2001a	1.09	0.25
	2010a	1.12	0.26
	2006b	1.10 (13%)	0.25 (24%)
Commercial	1995a	0.42	0.08
	2001a	0.45	0.10
	2010a	0.55	0.12
	2006b	0.50 (6%)	0.11 (10%)
Industrial	1995a	2.42	0.26
	2001a	3.69	0.40
	2010a	4.04	0.44
	2006b	3.85 (45%)	0.42 (40%)
Transportation	1995a	2.98	0.20
	2001a	na	na
	2010a	3.04	0.21
	2006b	3.03 (36%)	0.21 (20%)
Waste	1995a		0.05
	2001a		na
	2010a		0.06
	2006b		0.06 (6%)
Total	2006	8.48 (100%)	1.05 (100%)

Notes:
a - 1995 and 2010 figures are generated by CCP program (Source: City of Playford CCP data).
b - 2006 figures calculated by assuming straight line projections between 1995 and 2010 data.

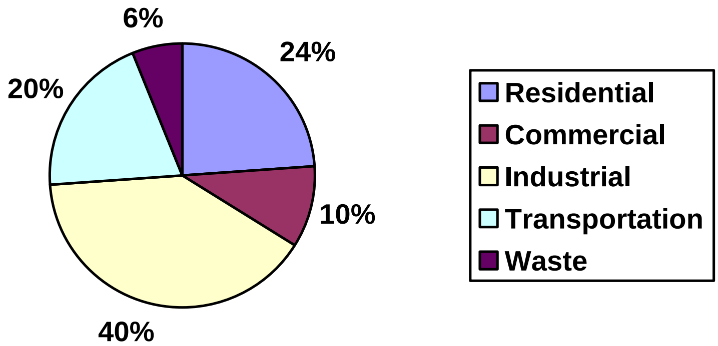

Figure 8 GHG emissions for City of Playford – Approach 3

3.2 Manningham City Council

Manningham City Council is located 12 km east of the Melbourne Central Business District and is bounded on the north and west by the Yarra River and the Koonung Creek to the south. It contains 1200 ha of parks, gardens and reserves within its total area of 114 sq km. Land use is mainly residential with all or part of 11 suburbs within its boundaries. It contains 1 regional and 1 sub-regional retail centre and 30 local retail centres. Its businesses are mainly small commercial enterprises with one third home-based (Manningham City Council, 2007).

Approach 1 – top down.

The population of Victoria was 4,932,422 at 8 August 2006 (ABS, 2007b). At the same time the population of Manningham was 109,915 which was 2.23% of the state's population.

The ABARE figures for energy use by sector for Manningham were calculated as a pro rata of state figures for 2004-05 for Victoria (ABARE 2006). GHG emissions were calculated using the *AGO Factors and Methods Workbook* (AGO, 2006a). The GHG emissions for waste were calculated using the 2005 GHG inventory report for Victoria (VGGI, undated).

The per capita energy use, total energy use for Manningham and associated GHG emissions for various sectors are summarised in Table 4 and depicted graphically in Figures 9 and 10.

Using this approach it can be seen that the transport sector used 39% of the energy followed by industry which used 34% and the residential sector 19%. The commercial sector used 8% of the energy according to this approach.

The resultant GHG emissions based on the per capita approach showed that the greatest contribution was made by the industrial sector which generated 38% of the GHG emissions followed by the transport sector with 23%. The residential sector generated approximately 20% of GHG emissions and the commercial sector 15%.

Table 4. Energy use and GHG emissions for Manningham City Council – Approach 1
(based on pro rata state energy consumption and GHG emissions by sector)

LG area	**Population** (Place of usual residence)	**Annual per capita energy use GJ**	**Annual Total Energy Use PJ and (% of total)**	**Annual GHG emissions Mt CO2-e**
Manningham	109915		19.28 (100%)	2.34 (100%)
Residential		33.2	3.65 (19%)	0.48 (20%)
Commercial		14.4	1.58 (8%)	0.35 (15%)
Industrial (included manufacturing, construction, gas & water, mining, agriculture, forestry & fishing)		59.5	6.54 (34%)	0.89 (38%)
Transport (included road, rail, water, air transport & other transport & storage services)		68.3	7.51 (39%)	0.53 (23%)
Waste				0.09 (4%)

Note: NC= not calculated (Sources: ABARE, 2006; ABS, 2007a, VGGI 2005, undated).

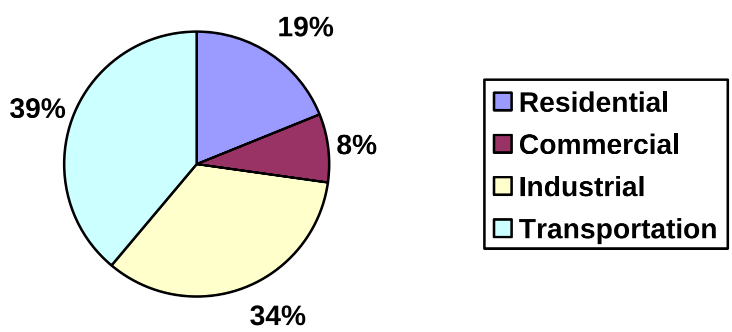

Figure 9 Energy use for Manningham City Council – Approach 1

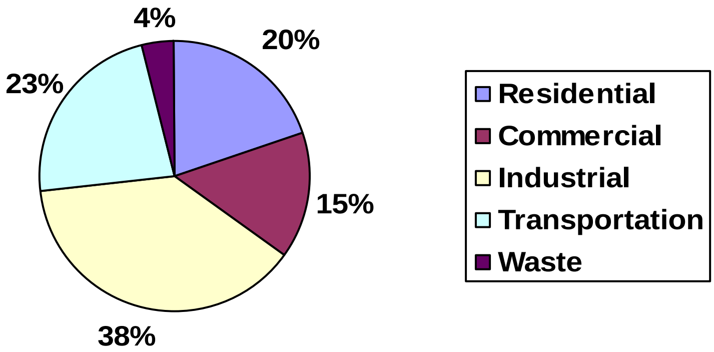

Figure 10 GHG emissions use for Manningham City Council – Approach 1

Approach 2 – hybrid bottom up.

This method used the following data:

- The 2006 Census statistics (ABS, 2007b) were used to provide information on the number of usual residents, the number of dwellings and those dwellings which were occupied at the time of the Census.
- The energy use of households in Manningham was calculated using two methods
  - The first method (2a) used household and per capita electricity consumption data from meters for some of the suburbs within Manningham during 2003 and reported by AIUS (AIUS, 2005). The amounts of other fuels used were calculated assuming that the proportion of all fuels was the same as the state figures for 2004/05 (ABARE 2006). The energy consumed per household was calculated to be 34 GJ electricity, 67 GJ gas and 18 GJ other fuels including wood and LPG. Electricity is 29%, gas is 56% and other fuels make up the remaining 15% of total household energy used according to this method.
  - The second method (2b) used the average household energy use for 2001 from the *Energy for Victoria* publication (DOI, 2002). This was 20 GJ electricity, 55 GJ gas and 10 GJ of other fuel including wood & LPG. Electricity is 24%, gas is 65% and other fuels are 12% of total household energy used according to this method.
- The energy used for Transport (road vehicles) was calculated from the number and type of road vehicles registered in Manningham, the average kilometres travelled and fuel used. This information was obtained from the *Motor Vehicle Census* conducted in 2006 by the ABS (ABS, 2006b) and the ABS motor vehicle usage tables for 2005 (ABS, 2006). The Transport sector also included the energy used by the Transport & Storage industry comprising road, rail, air and sea transport and other transport storage enterprises. Employee numbers working in the Transport & Storage industrial classification in Manningham were obtained from the Community Profile for Manningham (id.com, undated). The average energy use per employee for this sector for Victoria was based on employee numbers for 2001 and energy usage data from 2004-05 (ABARE, 2006).

- Appropriate emission factors relevant to each fuel used were obtained from the AGO *Factors and Methods Workbook* (AGO, 2006).
- The number of each type of business in the commercial and industrial sectors as at June 2006 was obtained by postcode from the ABS (ABS, 2006). Only those businesses that were registered in the postcodes within Manningham City Council boundaries were included. This may under-estimate the actual number of businesses operating in Manningham and the number of employees. The energy usage for each industrial sector was 2004-05 ABARE data (ABARE, 2006).
- To calculate the energy used by Commercial and Industrial sectors, the employee numbers working in businesses in each sector within Manningham were obtained from the *Community Profile* for Manningham (id.com, undated) which used the ABS 2001 Census figures as up to date local information was not available. The average energy use per employee for these sectors for Victoria was based on employee numbers for 2001 and energy usage data from 2004-05 (ABARE, 2006).
- The weight of municipal solid waste disposed to landfill for 2005-06 was provided by the Manningham City Council directly. The conversion factor for GHG emissions associated with domestic waste disposed to landfill was obtained from the AGO *Factors and Methods Workbook* (AGO 2006).

The results are summarised in Table 5 and graphically depicted in Figures 11-14. The transport sector comprising the vehicles registered in Manningham together with the transport & storage industry used the most energy (almost 55%) according to this approach, followed by the residential sector which used 33%. The industrial and commercial sectors used 7% and 6% respectively. The GHG emissions however were produced mainly by the residential sector (44%) and the transport sector (30%). According to this approach the commercial sector generated 13% of the GHG emissions for Manningham despite its lower energy use.

Figure 5. Energy use and GHG emissions for Manningham City Council – Approach 2

LG area and sector	**Population** Place of usual residence In 2006	**Annual energy use GJ per capita**	**Businesses Registered in Manningham #** In 2006	**Employees working in Manningham** (*) # In 2001	**Annual energy use GJ per employee**	**Annual Total Energy Use PJ**	**Annual GHG emissions Mt CO2-e**
Manningham	109915					11.76(2a) (100% (2a)) 11.16 (2b) (100% (2b))	1.16 (2a) (100% (2a)) 1.03 (2b) (100% (2b))
Residential (38492 Occupied Dwellings)		35.3 (2a) 29.8 (2b)				3.87 (2a) (33% (2a)) 3.27 (2b) (29% (2b))	0.51 (44%) 0.38 (2a) (37%)
Commercial			8859	16796	40	0.67 (6%) (6% (2b))	0.15 (13%) (15% (2b))
Industrial (Manufacturing, Construction, Mining, Gas & Water Supply Ag, Forest, Fishing)			2547	2754	Ave 293 (range from 32- 3053)	0.81 (7%) (7% (2b))	0.12 (10%) (12% (2b))
Transport –road vehicles (not rail) + Transport & storage industry			504	502	3127	4.84 (41%) (43% (2b)) 1.57 (13%) (14% (2b))	0.34 (29%) (33% (2b)) 0.01 (1%) (1% (2b))
Waste							0.03 (3%) (3% (2b))

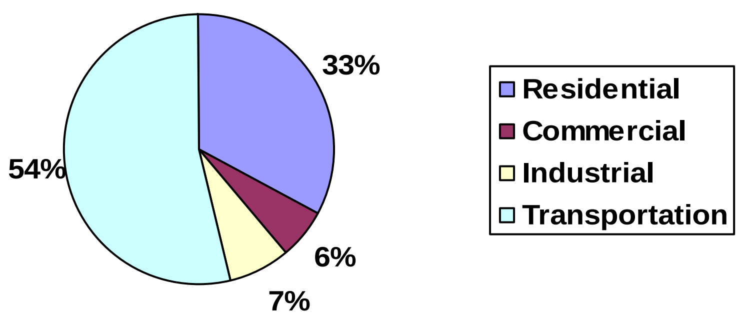

Figure 11 Energy use for Manningham City Council – Approach 2a

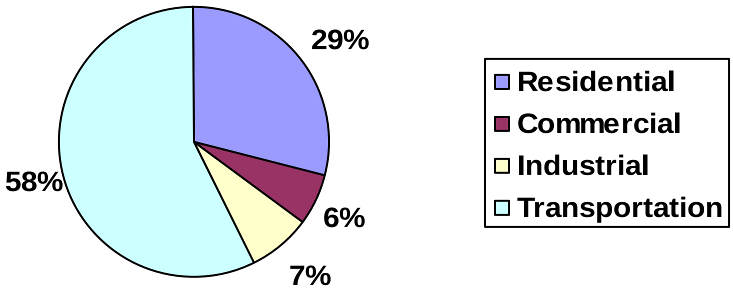

Figure 12 Energy use for Manningham City Council – Approach 2b

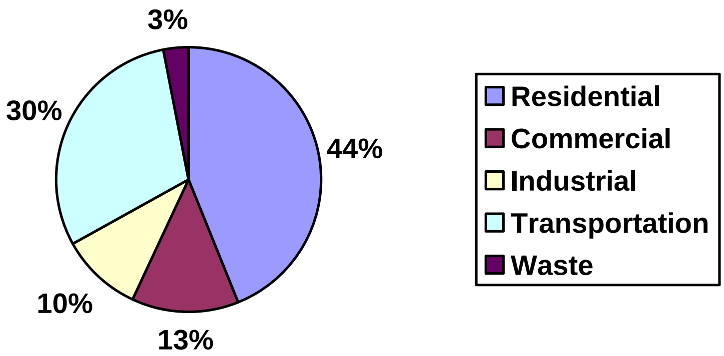

Figure 13 GHG emissions for Manningham City Council – Approach 2a

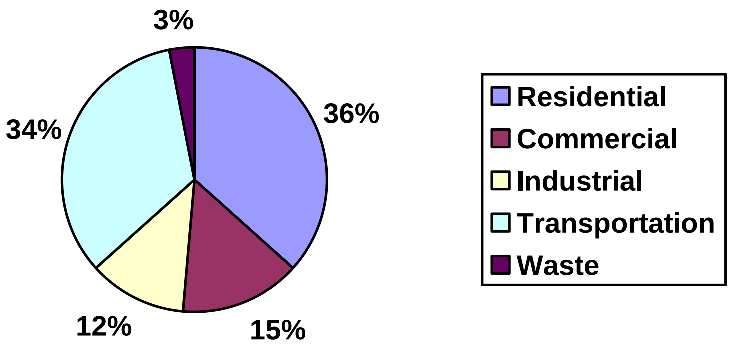

Figure 14 GHG emissions for Manningham City Council – Approach 2b

Approach 3 – projection of CCP data.

This method took the results for Manningham determined by the CCP program then applied projected increases or decreases sector by sector. For the Manningham City Council the CCP program has made predictions for the energy use in 2010.

Using a graphical approach a straight line was drawn through data for 1996, 2001 and 2010. Values for energy use and GHG emissions for 2006 were estimated from the straight line. This is presented in tabular form in Table 6 and in Figures 15 and 16.

Table 6. Energy use and GHG emissions for Manningham City Council – Approach 3

Sector	Year of Assessment	Annual Energy Use PJ	GHG Emissions Mt CO2-e
Residential	1996a	2.84	0.417
	2001a	2.93	0.465
	2006b	2.95 (30%)	0.45 (40%)
	2010a	2.99	0.457
Commercial	1996a	0.83	0.194
	2001a	0.82	0.206
	2006b	1.0 (10%)	0.2 (18%)
	2010a	1.12	0.254
Industrial	1996a	0.60	0.065
	2001a	0.69	0.087
	2006b	0.75 (8%)	0.092 (8%)
	2010a	0.81	0.097
Transportation	1996a	4.07	0.277
	2001a	4.61	0.314
	2006b	5.1 (52%)	0.35 (31%)
	2010a	5.58	0.38
Waste	1996a		0.064
	2001a		0.033
	2006b		0.03est (3%)
	2010a		na
Total	2006	9.8	1.12

Notes: ne = not estimated; na = not available
a – 1996, 2001 and 2010 figures are generated by CCP program (Source :Manningham City Council CCP data).
b - 2006 figures estimated from trend lines.
est – not available from CCP - used 2001.

Using this approach 52% of the energy used was attributed to the Transport sector, followed by the Residential sector with 30%. The Residential sector however contributed 40% of the GHG emissions followed by the Transport sector with 31%. Although the Commercial sector used only 10% of the energy for the Manningham area it contributed 18% of the GHG emissions. The Industrial sector contributed only 8% to both energy use and GHG emissions.

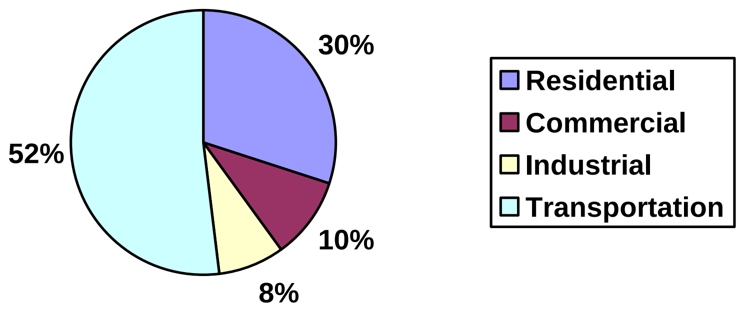

Figure 15 Energy use for Manningham City Council – Approach 3

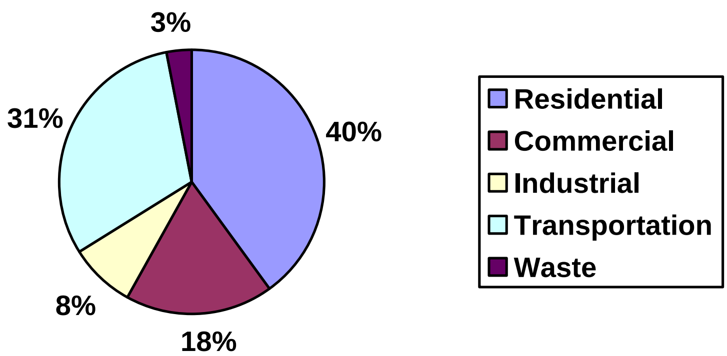

Figure 16 GHG emissions for Manningham City Council – Approach 3

4. DISCUSSION

This section compares the results obtained using the three different approaches, discusses any similarities or differences observed between these and the results from the two different local government areas, and seeks to explain these findings.

The overall results for energy consumed and carbon emitted are presented in Table 7. These results are presented graphically in Figures 17 to 22. The analysis of Playford and Manningham demonstrates a number of key aspects which serve to inform future studies. The hybrid methods (Approaches 2 and 3) resulted in significantly lower energy consumption and carbon emissions than the top down method based solely on pro rata population (Approach 1). These hybrid methods better reflect the actual number of households and employees and the type of business being conducted as well as data from studies conducted locally about energy use. The key differences relate to energy consumed in the industrial sector and are most clearly noted in the case of Manningham. Here, the energy consumed according to the top down method, was 34% of the total for the area with GHG emissions amounting to 38% of total emissions. According to the hybrid methods the industrial sector used only 7-8% of energy and contributed 8-10% of GHG emissions. In the case of Playford the top down method resulted in 43% of the energy use being attributed to the industrial sector with 38% of the GHG emissions. The bottom up-hybrid method resulted in 50% of energy used and 45% of the GHG emissions while the CCP method resulted in 45% of energy used by this sector and 40% of GHG emissions. Since Manningham represents a situation where the proportion of industry is lower than the State average and Playford represents the reverse, these results are entirely consistent with expectations. They nevertheless do not provide us with reliable actual quantities of either energy demand or GHG emissions across each local government area.

The hybrid methods (Approaches 2 and 3) differ in how they calculate residential energy use and in how the energy used by the transport sector is calculated. Approach 2 used the study by Oliphant (2003) to determine the electricity and gas use for households of varying size in Playford. For Manningham two different bases for calculating total energy used by households were employed, one based on a sample of actual data for electricity, the second on pro rata Victorian data. Different proportions of fuel use were applied. There was a broad agreement between approaches 2 and 3 for residential energy demand in Playford, but less so between these methods as applied in Manningham, suggesting that the attempt to disaggregate domestic fuel use here had complicated the picture. Not surprisingly the GHG outcomes differed more significantly. The assumptions made about consumption of fuels other than electricity for Method 2a need further assessment. Again the conclusion must be that none of these methods provides us with an accurate quantified explanation of energy use and GHG emissions in the residential sector.

After Industry, transport proves to be the next most significant sector in all cases. There is broad agreement between methods 2 and 3. The higher estimates derived from method 1 probably reflect a critical problem in the allocation of transport energy on a spatial basis, namely that many, especially long distance trips are difficult to assign to specific locations. Thus much long distance transport, especially in the freight sector, which is included in state wide statistics, is lost when we try to allocate transportation energy to specific locations. Furthermore, the Transport & Storage Industry consumption figures used comprised energy used per employee for all of the road, rail, air and sea transport industry sectors. This may lead to an overestimation of energy used in this sector even using methods 2 and 3. Approach 3 used the state based per capita transport energy used but included the Transport & Storage Industry sector in the Industrial sector.

When we consider the total energy and GHG profile for the Local Government areas in question we can immediately observe a large variation in the overall totals deriving from the three methods. For Playford the total energy ranges from 12.23 PJ to 8.48 PJ. For Manningham the range is 19.8 PJ to 9.8PJ. The evidence suggests that the lower estimates are a more accurate reflection of reality since they are built from the bottom up using actual data wherever possible. However the large discrepancies between methods warrant further exploration. This will be particularly important when considering future target setting under legislation such as the *SA Climate Change and Emissions Reduction Act.*

Table 7. Summary of energy consumed and carbon emitted from the application of three different carbon assessment methods across two different local government areas

	Total	Residential	Commercial	Industrial	Transportation	Waste	Agricultural
Playford South Australia							
Method 1							
Energy PJ	12.23	1.63	0.82	5.25	4.12		0.41
%	100	13	7	43	34		3
Carbon emissions Mt CO2-e	1.19	0.23	0.14	0.45	0.3	0.04	0.03
%	100	19	12	38	25	3	3
Method 2							
Energy PJ	9.3	1.0	0.38	4.66	2.98		0.24
%	100	11	4	50	32		3
Carbon emissions Mt CO2-e	0.96	0.17	0.07	0.43	0.25	0.02	0.02
%	100	18	7	45	26	2	2
Method 3							
Energy PJ	8.48	1.10	0.50	3.85	3.03		nc
%	100	13	6	45	36		
Carbon emissions Mt CO2-e	1.05	0.25	0.11	0.42	0.21	0.06	nc
%	100	24	10	40	20	6	
Manningham Victoria							
Method 1							
Energy PJ	19.28	3.65	1.587	6.54	7.51		nc
%	100	19	8	34	39		
Carbon emissions Mt CO2-e	2.34	0.48	0.35	0.89	0.53	0.09	nc
%	100	21	15	38	22	4	
Method 2a							
Energy PJ	11.76	3.87	0.67	0.81	6.41		nc
%	100	33	6	7	54		
Carbon emissions Mt CO2-e	1.16	0.51	0.15	0.12	0.35	0.03	nc
%	100	44	13	10	31	2	
Method 2b							
Energy PJ	11.16	3.27	0.67	0.81	6.41		nc
%	100	29	6	7	57		
Carbon emissions Mt CO2-e	1.03	0.38	0.15	0.12	0.35	0.03	nc
%	101	37	15	12	34	3	
Method 3							
Energy PJ	9.8	2.95	1.0	0.75	5.1		nc
%	100	30	10	8	52		
Carbon emissions Mt CO2-e	1.12	0.45	0.2	0.092	0.35	0.03	nc
%	100	40	18	8	31	3	

Note that some percentages may not add up to 100% due to rounding

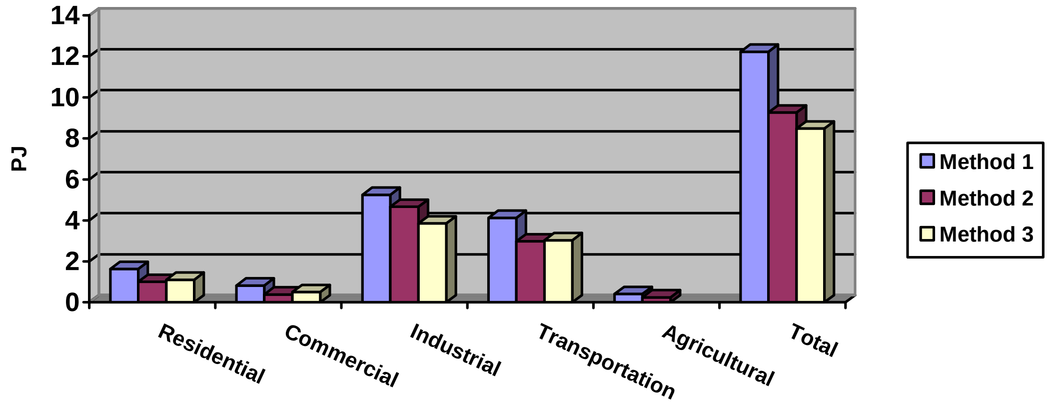

Figure 17 Summary of energy consumed from the application of three different carbon assessment methods for City of Playford

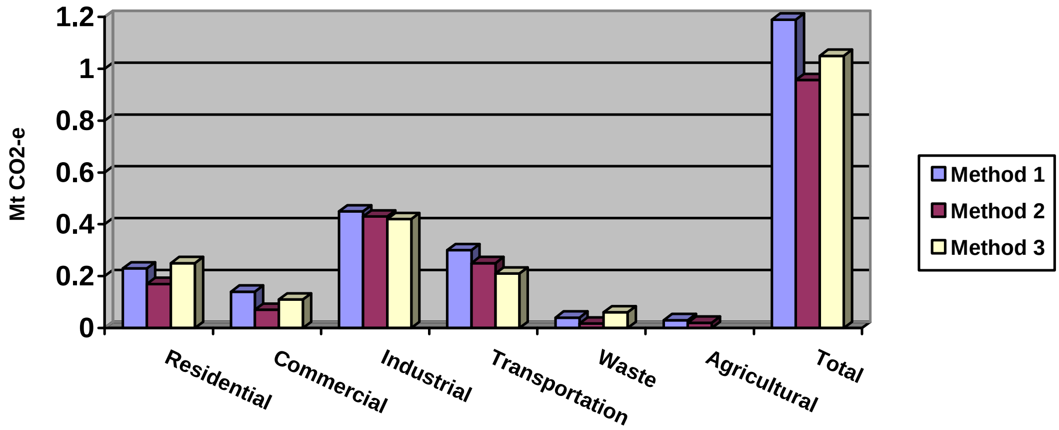

Figure 18 Summary of GHG emissions from the application of three different carbon assessment methods for City of Playford

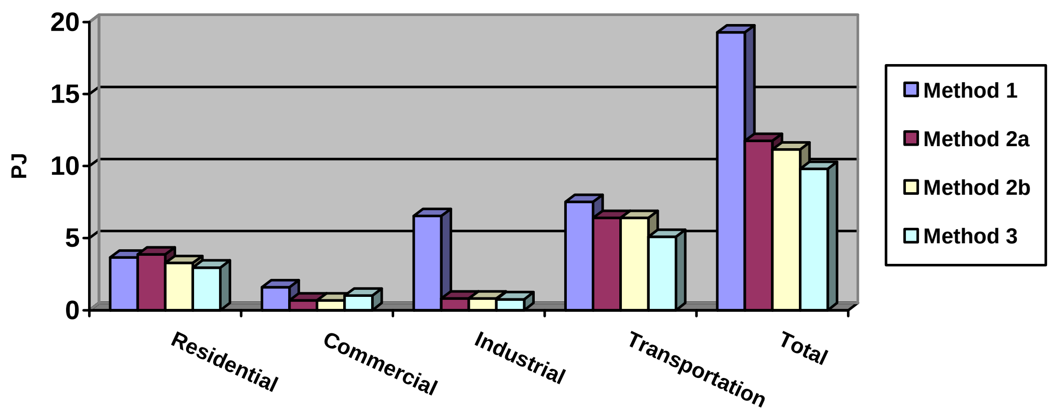

Figure 19 Summary of energy consumed from the application of three different carbon assessment methods for Manningham City Council

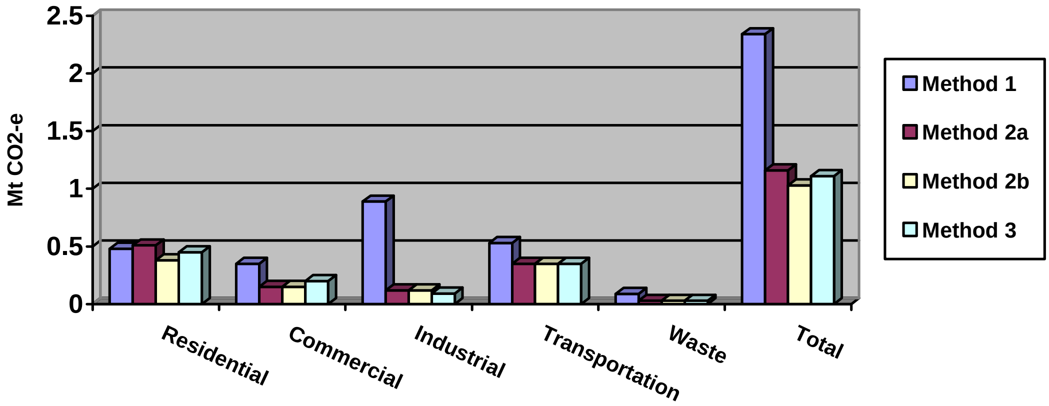

Figure 20 Summary of GHG emissions from the application of three different carbon assessment methods for Manningham City Council

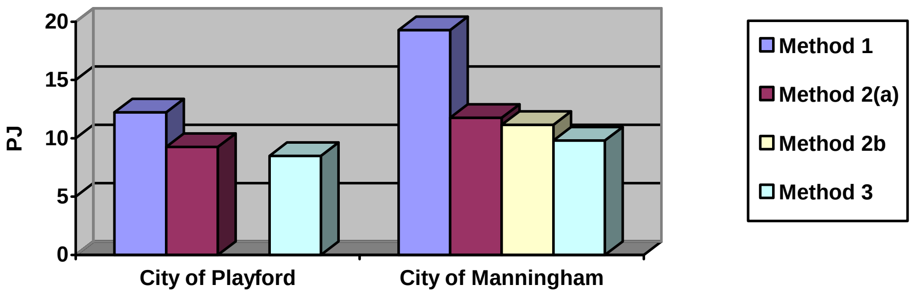

Figure 21 Comparision of Total Energy Use for City of Playford and Manningham City Council from the application of three different carbon assessment methods

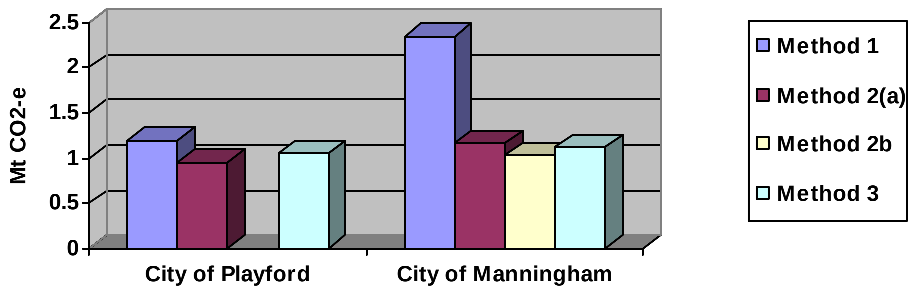

Figure 22 Comparision of Total GHG emissions for City of Playford and Manningham City Council from the application of three different carbon assessment methods

5. CONCLUSIONS

The relative proportions of energy use and GHG emissions produced by all the methods broadly match the national sectoral energy breakdown, suggesting a degree of confidence can be drawn from all approaches. However when we consider the estimated amounts of energy or GHG for each sector then the major discrepancies found across the various methods suggest that there is substantial work needed before estimates that are acceptable to all prospective parties can be achieved.

This study demonstrated the difficulties and traps that local government can experience when attempting to develop a profile of energy consumption and greenhouse gas emissions across their communities. Understanding the characteristics of the sectors within a community is important in developing a carbon profile and identifying those sectors which local government can work with to reduce energy consumption and improve energy efficiency. Developing this understanding of their community will become increasingly important as local government commits its communities to reduce GHG emissions and sets targets for these.

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