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# Carbon Dioxide Emissions in West Norfolk: Analysis and Recommendations

**West Norfolk Partnership**

**August 2007**

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## Executive Summary

Climate change has been identified as one of the most important challenges we face as a global community and will also have severe repercussions on a local level in West Norfolk. As such, it is important local strategic partnerships contribute to national and regional targets for mitigating and adapting to climate change. In order to produce plans to mitigate and adapt to climate change, the causes of carbon dioxide ($CO_2$) emissions in West Norfolk must first be better understood and this is the focus of this report.

Defra's emissions of $CO_2$ for local authority areas for 2004 shows King's Lynn and West Norfolk as having the highest $CO_2$ emissions in Norfolk per captia. In 2004, King's Lynn and West Norfolk were responsible for 1,736 kt of $CO_2$, equivalent to 12.8 tonnes per capita.

Comparative analysis of $CO_2$ emissions reveals that King's Lynn and West Norfolk have the highest per captia emissions in Norfolk, which are 37% higher than national, 45% higher than regional and 33% higher than the county levels.

In total, King's Lynn and West Norfolk account for 23% of all emissions in Norfolk, but only 17% of the population. The main cause of this discrepancy, as well as the disproportionately high per captia emissions, is the substantial land use, Land Use Change and Forestry (LULUCF) and Road Transport emissions.

The most major source of Road Transport emissions in King's Lynn and West Norfolk is by diesel vehicles on major roads, which accounts for 10% of the total $CO_2$ emissions in King's Lynn and West Norfolk. This is most likely due to the rural nature of the area and the wide dispersion of population and services. Additionally, this area forms the western county border, with the only trunk road into and out of Norfolk and also includes a number major roads.

The largest source of LULUCF emissions is from the "other" sub-sector, which accounts for 19% of all emissions in West Norfolk. Within this sub-category and 83% of these emissions are sourced from "Cropland remaining Cropland (lowland drainage)". Further investigation into this issue revealed that lowland wetlands in West Norfolk were drained many years ago for agricultural purposes and continue to emit carbon from the soil.

The most effective way for reducing $CO_2$ emissions and limiting their growth in integrated manner is through the development of a climate change strategy for West Norfolk. As the overarching plan for the Borough Council of King's Lynn and West Norfolk and other key agencies in an area, the sustainable community strategy can provide the necessary policy impetus to influence other plans and strategies throughout West Norfolk on climate change.

Due to the high level of vulnerability to the effects of climate change, it is recommended that a holistic climate change mitigation and adaptation strategy is developed for West Norfolk. This would provide a strategic framework through which to reduce $CO_2$ emissions across sectors and limit increases from growth, whilst adequately preparing the area for adapting to climate change and reducing vulnerability to climate change impacts.

# 1. Introduction

Climate change refers to the variation in the Earth's global climate or in regional climates over time. Presently, climate change, particularly in reference to environmental policy, is used only in reference to changes in modern climate, including the rise in average surface temperature known as “global warming”. The United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change is “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”. In this case, the term is used with a presumption of human causation. The UNFCCC uses the term "climate variability" for non-human caused variations.

Whilst climate change has been identified as one of the most important challenges we face as a global community, it will also have severe repercussions on a local level in West Norfolk. Rises in sea level from partial melting of large ice masses could lead to widespread flooding in West Norfolk, where most of the land is currently categorised as an area of high flood risk.

Climate change could also lead to higher local temperatures, stronger winds, significant changes in rainfall, and increases in coastal and soil erosion, all of which will have impacts on the economy, environment and population. Without substantial reductions in greenhouse gas emissions both locally and worldwide, local and global climates may continue to change.

The UK Government is committed to addressing both the causes and consequences of climate change and to that end is bringing forward proposals for a Climate Change Bill. The Bill will introduce a clear, credible, long-term framework for the UK to achieve its goals of reducing carbon dioxide emissions and ensure steps are taken towards adapting to the impacts of climate change. Additionally, proposed changes to the East of England Plan include a new climate change objective to reduce the region’s impact on, and exposure to, the effects of climate change.

In light of the Climate Change Bill and the proposed changes to the East of England Plan, it is important local strategic partnerships and planning authorities contribute to national and regional targets for mitigating and adapting to climate change.

Emissions of greenhouse gases have been identified as a worldwide problem, as it is commonly recognised that these emissions lead to climate change. The most abundant greenhouse gas is carbon dioxide ($CO_2$), which is therefore the focus of this report.

Defra's emissions of $CO_2$ for local authority areas for 2004 shows King's Lynn and West Norfolk as having the highest $CO_2$ emissions in Norfolk per captia. In order to produce plans to mitigate and adapt to climate change, the causes of $CO_2$ emissions must first be better understood. To that end, the West Norfolk Partnership has commissioned Small Fish to undertake a detailed and comparative analysis of the sources of $CO_2$ in King's Lynn and West Norfolk.

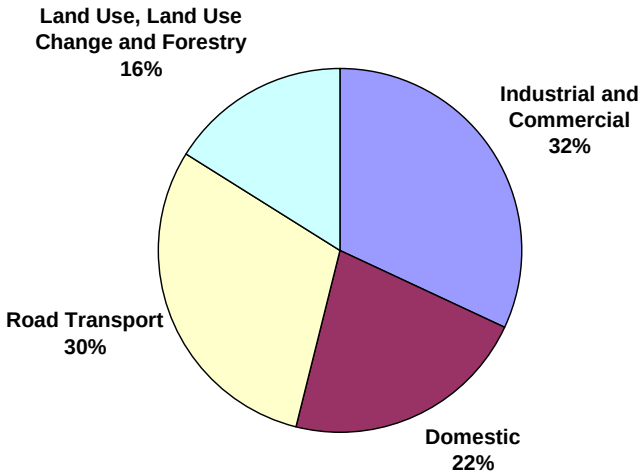
## 2. Carbon Dioxide Emissions Profile – West Norfolk

In November 2006, Defra released data and a report estimating emissions of $CO_2$ for local authority areas. This data set provides nationally consistent $CO_2$ emission estimates at local authority and regional levels for the year 2004 and represents the primary emissions from the consumption of fuel or other process activities that emit $CO_2$. This is the data that has been used for this analysis.

In 2004, King's Lynn and West Norfolk were responsible for 1,736 kilo tonnes (kt) of $CO_2$, equivalent to 12.8 tonnes per capita. **Figure 2.1** below outlines the 2004 $CO_2$ emissions profile for King's Lynn and West Norfolk, broken down by sector. Emissions in West Norfolk by sector, ranked from highest to lowest are:

1. Industrial and Commercial – 551 kt
2. Road Transport – 524 kt
3. Domestic – 381 kt
4. Land Use, Land Use Change and Forestry (LULUCF) – 280 kt

**Figure 2.1: $CO_2$ Emissions in King's Lynn and West Norfolk by sector, 2004**



Additionally, Defra estimates by end user provide a more detailed breakdown within each sector. This detail end user profile can be seen in **Figure 2.2**. Analysis of the split within each sub-sector shows that the five sub-sectors responsible for the most emissions within King's Lynn and West Norfolk are, from highest to lowest:

1) LULUCF emissions "other"
2) Industrial and Commercial gas
3) Domestic electricity
4) Industrial and Commercial electricity
5) Road Transport major roads diesel

**Figure 2.2: Detailed emissions profile by end user**

| Sector | Detailed Sector Split | kt $CO_2$ | % of total |
|---|---|---|---|
| **Industrial and Commercial Emissions** | Electricity | 204 | 12% |
| | Gas | 242 | 14% |
| | Gas (Large Users) | | |
| | Oil (not including energy supply) | 45 | 3% |
| | Solid fuel (not including energy supply) | 12 | 1% |
| | Wastes and Biomass (not including energy supply) | 1 | 0% |
| | Process Gases (not including energy supply) | 1 | 0% |
| | Non fuel (not including energy supply) | 7 | 0% |
| | Industrial off road machinery | 21 | 1% |
| | Agriculture Oil | 16 | 1% |
| | Agriculture Solid fuel | 0 | 0% |
| | Agriculture Non Fuel | 1 | 0% |
| | Diesel Railways | 1 | 0% |
| **Domestic Emissions** | Electricity | 205 | 12% |
| | Gas | 117 | 7% |
| | Oil | 49 | 3% |
| | Solid fuel | 7 | 0% |
| | Home and Garden | 1 | 0% |
| | Products | 3 | 0% |
| **Road Transport Emissions** | Major Roads Petrol | 150 | 9% |
| | Minor Roads Petrol | 123 | 7% |
| | Major Roads Diesel | 166 | 10% |
| | Minor Roads Diesel | 83 | 5% |
| | Other | 2 | 0% |
| **Land Use, Land Use Change and Forestry Emissions** | LULUCF Emissions: Agricultural Soils And Deforestation | 11 | 1% |
| | LULUCF Emissions: Other | 338 | 19% |
| | LULUCF Removals | -69 | -4% |
| **Total Emissions – King's Lynn and West Norfolk** | | **1,736** | |

*Data Source: DEFRA, Emissions of $CO_2$ for local authority areas, 2004*

## 3. Comparative Analysis

Comparative analysis of $CO_2$ emissions in West Norfolk reveals some noteworthy trends. Spatially, King's Lynn and West Norfolk have the highest per captia emissions in Norfolk, which are 37% higher than national, 45% higher than regional and 33% higher than the county levels. It is important when looking at comparisons to consider not only the sector that produces the greatest amount of emissions, but where these emissions are disproportionately high in comparison with national levels. **Figure 3.1** provides a comparison between all Norfolk districts and county, regional and national levels.

**Figure 3.1: Local, county, regional and national $CO_2$ emissions sector split**

| | Industry and Commercial | Domestic | Road Transport | LULUCF | Total (kt) | Per capita (t) |
|---|---|---|---|---|---|---|
| Breckland | 38% | 25% | 40% | -4% | 1,209 | 10.0 |
| Broadland | 39% | 32% | 30% | -1% | 945 | 8.0 |
| Great Yarmouth | 30% | 40% | 29% | 0% | 549 | 6.0 |
| King's Lynn and West Norfolk | 32% | 22% | 30% | 16% | 1,736 | 12.8 |
| North Norfolk | 52% | 25% | 24% | -1% | 1,149 | 11.7 |
| Norwich | 55% | 31% | 14% | 0% | 942 | 7.7 |
| South Norfolk | 32% | 27% | 41% | -1% | 1112 | 10.0 |
| **NORFOLK** | 40% | 27% | 30% | 3% | 7,643 | 9.6 |
| **EAST OF ENGLAND** | 35% | 30% | 33% | 2% | 47,284 | 8.8 |
| **UK** | 45% | 28% | 27% | 0% | 548,777 | 9.3 |

*Data Source: DEFRA, Emissions of $CO_2$ for local authority areas, 2004*

When compared with other local authorities in Norfolk, King's Lynn and West Norfolk have the highest per capita emissions and the highest LULUCF emissions in the county. Conversely, the proportion of Domestic $CO_2$ emissions proportions is lowest in the county and Road Transport and Industrial and Commercial proportions also compare favourably against other local authorities. However, actual tonnage of Road Transport emissions in Norfolk is highest in King's Lynn and West Norfolk and this single district accounts for 22% of all Road Transport and 132% of LULUCF emissions in the county.

Overall, King's Lynn and West Norfolk account for 23% of all emissions in Norfolk, but only 17% of the population. The main cause of this discrepancy, as well as the disproportionately high per captia emissions, is the substantial LULUCF and Road Transport emissions.

When compared with similar districts, Breckland and Fenland, similar trends are revealed. One of the best ways of comparing $CO_2$ emissions across sectors and between local authorities in by considering per capita emissions by sector. **Figure 3.2** outlines the comparison between Fenland, Breckland, West Norfolk and how they relate to national per capita emissions by sector.

**Figure 3.2: Comparison of per captia emissions by sector with similar local authorities**

| | Industry and Commercial | Domestic | Road Transport | LULUCF | Total Per Captia |
|---|---|---|---|---|---|
| Fenland | 5.2 | 2.5 | 2.5 | 1.5 | 11.9 |
| Breckland | 3.8 | 2.5 | 4.0 | -0.4 | 10.0 |
| King's Lynn and West Norfolk | 4.1 | 2.8 | 3.9 | 2.1 | 12.8 |
| **UK** | **4.2** | **2.6** | **2.6** | **-0.03** | **9.3** |

Industrial and Commercial emissions are 2% lower than national levels in King's Lynn and West Norfolk and 9% lower in Breckland, whilst these emissions are 25% higher than national levels in Fenland.

Domestic emissions are 6% higher than national levels in King's Lynn and West Norfolk, as opposed to Breckland and Fenland, where these emissions are 5% below national levels.

Road Transport emissions are substantially higher in both King's Lynn and West Norfolk and Breckland, at 52% and 56% above national levels respectively, whilst Fenland Road Transport emissions are 2% lower than national levels.

LULUCF emissions are 7100% higher than national levels in West Norfolk, 5000% higher in Fenland than national levels. However, in Breckland LULUCF emissions are 13% lower than national levels.

Overall, per capita emissions in King's Lynn and West Norfolk are 37% higher than UK per capita emissions, whilst Fenland is 27% and Breckland only 7% higher. Again, evidence points to high levels of Road Transport and LULUCF emissions in accounting for this discrepancy. Breckland's high per capita emissions levels are most likely a result of higher than average Road Transport emissions, whilst in Fenland this discrepancy is most likely due to a combination of increased Industrial and Commercial emissions as well as higher than average LULUCF emissions.

# 4. Detailed Analysis

Comparative analysis with similar authorities and national averages highlights that $CO_2$ emissions in King's Lynn and West Norfolk are particularly high in relation to Road Transport and LULUCF emissions. Industrial and Commercial and Domestic emissions are within proportional expectations, although that is not to say that efforts for reducing emissions from these sectors should not be pursued.

## *4.1 Road Transport*

Emissions on major roads are estimated using detailed vehicle specific traffic census data (annual average daily flows) for 2004 from the Department for Transport. This census data is mapped on to Ordnance Survey detailed road maps.

Fuel use is calculated for each vehicle type on a road link basis using fleet weighted emission factors for each vehicle type and assumptions about speeds on each road type and in various different parts of the country. Emissions on minor roads are calculated in a similar way, but the traffic flow data is more generalised, with average flows applied to all roads of a particular type across each Government Office Region or Devolved Administration.

### 4.1.1 Major Roads Petrol

Petrol vehicles using major roads account for 9% of the total $CO_2$ emissions in King's Lynn and West Norfolk. This is most likely due to the fact that this district forms the western county border, with the only trunk road into and out of Norfolk and a proportion of the population may reside in West Norfolk, but travel to work via major roads to centres of employment.

### 4.1.2 Minor Roads Petrol

Petrol vehicles using minor roads also contributes significantly towards total $CO_2$ emissions King's Lynn and West Norfolk at 7%. This is most likely due to the rural nature of the area and the wide dispersal of population and services.

### 4.1.3 Major Roads Diesel

The most major source of Road Transport emissions in King's Lynn and West Norfolk is by diesel vehicles on major roads, which accounts for 10% of the total $CO_2$ emissions in King's Lynn and West Norfolk. This is most likely due to the fact that this district forms the western county border, with the only trunk road into and out of Norfolk and also comprises a network of major roads. The diesel component of this data set may be due to the high number of heavy good vehicles using the A47 to transport goods into and out of Norfolk.

### 4.1.4 Minor Roads Diesel

Diesel vehicles using major roads account for 5% of the total $CO_2$ emissions in King's Lynn and West Norfolk. Again, the proportion may be due to the rural nature of the area and the wide dispersion of population and services.

### 4.1.5 Other

There are two other small sources of emissions from road traffic included in the inventory. These are combustion of waste lubricants and emissions from LPG vehicles. Both of these sources are distributed across local authorities using estimates of total vehicle kilometres calculated from the National Air Emissions Inventory maps of traffic flows. In King's Lynn and West Norfolk these emissions are marginal in comparison with other sources, emitting only 2 kt of $CO_2$ in 2004.

## *4.2 Land Use, Land Use Change and Forestry*

Although the smallest source sector proportionally in King's Lynn and West Norfolk, the LULUCF emissions in this area are disproportionately high in comparison to national averages. The LULUCF Sector is different from other sectors in the emissions profile in that it contains both sources and sinks of greenhouse gases. The sources, or emissions to the atmosphere, are given as positive values; the sinks, or removals from the atmosphere, are given as negative values. This is how King's Lynn and West Norfolk is able to account for 132% of the county's emissions in this sector. **Figure 4.2** outlines the detailed emissions profile for this sector.

**Figure 4.2: Detailed description of LULUCF emissions (kt $CO_2$)**

| Description | LULUCF Emissions: Agricultural Soils And Deforestation | LULUCF Emissions: Other | LULUCF Removals | Total |
|---|---|---|---|---|
| Forest Land remaining Forest Land | | | | 0 |
| Land converted to Forest Land | | | -31.52 | -31.52 |
| Cropland remaining Cropland (Yield improvement) | | | -12.47 | -12.47 |
| Cropland remaining Cropland (lowland drainage) | | 281.064 | | 281.06 |
| Liming of Cropland | 9.2727785 | | | 9.2728 |
| Land converted to Cropland (non-forest biomass) | | 0.71793 | | 0.7179 |
| Land converted to Cropland (soil) | | 25.269 | | 25.269 |
| Grassland remaining Grassland (Peat extraction) | | 0.57813 | | 0.5781 |
| Liming of Grassland | 0.3473909 | | | 0.3474 |
| Land converted to Grassland (non-forest biomass) | | | -0.605 | -0.605 |
| Land converted to Grassland (deforestation to grass) | 0.849035 | | | 0.849 |
| Land converted to Grassland (soil) | | | -24.26 | -24.26 |
| Land converted to Settlements (non-forest biomass) | | | -0.271 | -0.271 |
| Land converted to Settlements (deforestation to settlements) | 0.3492127 | | | 0.3492 |
| Land converted to Settlements (soil) | | 30.542 | | 30.542 |
| **Total** | **10.818417** | **338.171** | **-69.13** | **279.86** |

*Source: AEAT*

### 4.2.1 Agriculture and Soils

Liming of Grassland and Cropland

In West Norfolk, liming of grassland and cropland accounts for around 9.6 kt of LULUCF $CO_2$ emissions. "Liming," as the word suggests, is the addition of limestone (calcite), primarily calcium carbonate ($CaCO_3$), to neutralize acid waters and soils and buffer them from rapid fluctuations in pH. Limestone typically is applied to lawns, gardens, pastures, and croplands to supply calcium, an essential plant nutrient, and to decrease soil acidity.

When added to the soil, calcium and/or magnesium dissolved from the liming materials displaces hydrogen from the clay particles, as it is the hydrogen ion that makes soils acid. The displaced hydrogen then reacts with carbonate, reducing soil acidity. Carbonate dissolved from the limestone materials forms carbonic acid. Carbonic acid is not stable in soils and quickly forms $CO_2$ and water, thus releasing $CO_2$ into the atmosphere.

Land converted to Settlements and Grassland (deforestation to settlements and grassland)

Emissions from deforestation to settlements and grasslands in West Norfolk is relatively low in comparison with other land use change sources, and accounted for approximately 1.2 kt of $CO_2$ in 2004. Deforestation releases the carbon stored in trees and also results in less $CO_2$ being removed from the atmosphere by their continued growth and absorption of $CO_2$.

### 4.2.2 Other

Grassland remaining Grassland (Peat extraction)

Only marginal emissions arise from peat extraction in West Norfolk. Storing carbon is an important function of peatlands and affects both local and global climates. Carbon occurs naturally in the atmosphere in the form of $CO_2$. Plants absorb $CO_2$ from the atmosphere during photosynthesis to make food and oxygen. When a plant dies and decays the carbon within the plant is released back into the atmosphere.

The conditions found in peatland limit decomposition, so the carbon is retained and stored in the peat. It is important to note that while intact peatlands store carbon, drainage and extraction releases carbon into the atmosphere. It is vital to protect intact peatlands and reduce drainage and extraction if peatlands are to retain their function as a carbon store.[1]

[1] http://www.peatlandsni.gov.uk/values/carbon.htm

Land converted to Cropland (non-forest biomass)

In West Norfolk, only marginal emissions arise from land converted to cropland (non-forest biomass). Different land use types have different biomass carbon densities at equilibrium ans change from one land use type to another can result in an increase or decrease in biomass carbon density. This category describes the annual change in the carbon stock in vegetation biomass due to all land use change to cropland, excluding forests and woodland.

Land converted to Cropland and Settlements (soil)

Changes from one land use type to another will result in a change in soil carbon stocks over time. The change in vegetation cover and management will affect the amount of carbon that goes into the soil from biomass decomposition. Also, the initial disturbance of the soil will release carbon to the atmosphere. In West Norfolk around 30.5 kt of LULUCF "other" emissions can be attributed to land converted to settlements and 25.3 kt from land converted to cropland.

Soil disturbance and increased rates of decomposition in converted soils can both lead to emission of carbon to the atmosphere, with increased soil erosion and leaching of soil nutrients further reducing the potential for the area to act as a sink for carbon.[2]

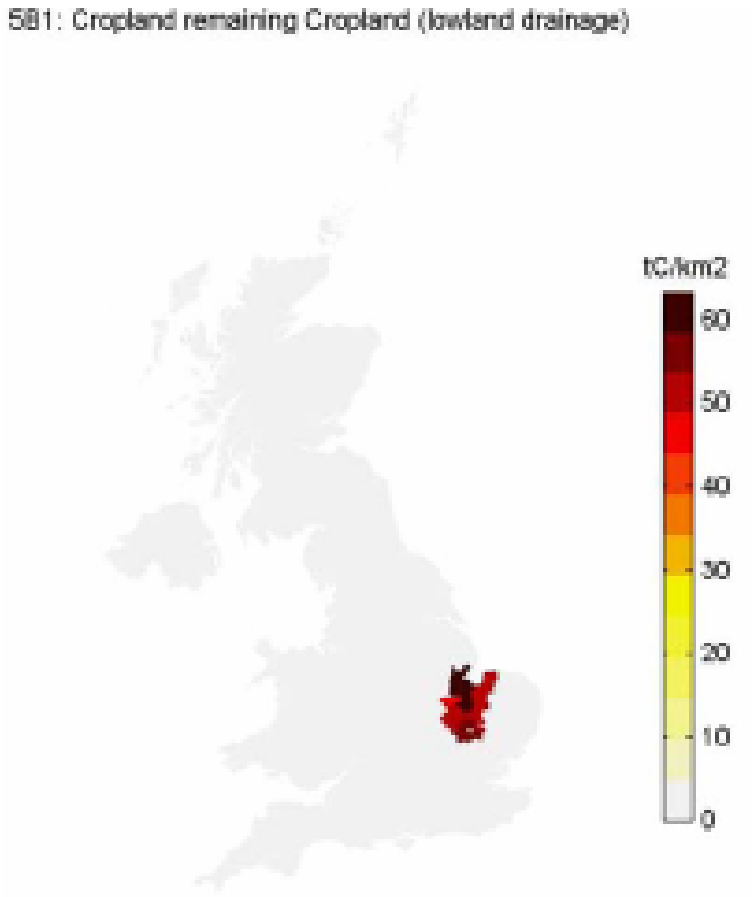
Cropland remaining Cropland (lowland drainage)

By far, the largest source of LULUCF emissions is from the "other" sub-sector. Within this sub-sector, the 83% of these emissions are sourced from "Cropland remaining Cropland (lowland drainage)". Further investigation into this issue revealed that lowland wetlands, comprised of peatland and commonly known as the Fens, were drained many years ago for agricultural purposes and continue to release stored carbon from the soil. Using a map of peatland in England, Defra allocated these emissions to the local authorities falling within and around East Anglia with larger areas of peatland, including King's Lynn and West Norfolk. [3] **Figure 4.2.2** shows the spatial distribution of these emissions by the Defra project.

[2] http://www.ghgonline.org/co2landuse.htm

[3] Local and Regional CO2 Emissions Estimates for 2004 for the UK Report by AEA Energy and Environment for Defra November 2006

**Figure 4.2.2: Carbon emissions in 2004 due to lowland drainage in previous years.**




*Source: Local and Regional $CO_2$ Emissions Estimates for 2004 for the UK Report by AEA Energy and Environment for Defra November 2006*

Reclaimed from the sea, with a low lying aspect, the Fens were subject to major drainage works in the seventeenth century which still form the backbone of water control in this area. A sophisticated network of sluices, relief channels and drainage ditches ensure that water levels within the Fen area are managed and controlled. In general in this area the water table is comparatively close to the surface and much of the land lies below sea level.

Almost 97% of this the Fens Character Area is open countryside with 91% of that land cultivated. Due to the low lying and high quality land found in within the Fens and the type of agriculture is mainly arable farming and the area therefore supports intensive farming and horticulture.[4] The reclamation of salt marsh for agriculture and consequential squeezing of intertidal mudflats has now largely halted.[5]

[4] Borough Council of King's Lynn and West Norfolk, Local Development Framework: Sustainability Appraisal Scoping Report, June 2005.
[5] JCA46: The Fens – Summary. Countryside Quality Counts 1999 – 2003.

### 4.2.3 Removals

Land converted to Forest Land

Forests accumulate carbon (removing it from the atmosphere) in their biomass and soils as they grow, creating a carbon sink or a removal of $CO_2$ from the atmosphere. Conversion of land to forest will increase this removal of $CO_2$. In West Norfolk, nearly 32 kt of $CO_2$ was removed from land converted to forest, offsetting overall land use emissions.

Land converted to Grassland and Settlements (non-forest biomass)

Different land use types have different biomass carbon densities at equilibrium and change from one land use type to another can result in an increase or decrease in biomass carbon density. This category describes the annual change in the carbon stock in vegetation biomass due to all land use change to grassland or settlements, excluding forests and woodland. In West Norfolk, these sub-categories account for the removal of approximately 0.88 kt of $CO_2$.

Land converted to Grassland (soil)

Changes from one land use type to another will result in a change in soil carbon stocks over time. The change in vegetation cover and management will affect the amount of carbon that goes into the soil from biomass decomposition. Land converted to grassland will work to remove $CO_2$ from the atmosphere and act as a carbon sink. In West Norfolk, this removal sub-category was responsible for the removal of 24.26 kt of $CO_2$.

Cropland remaining Cropland (Yield improvement)

There is an annual increase in the biomass of cropland vegetation in the UK that is due to yield improvements (from improved species strains or management, rather than fertilization or nitrogen deposition). Increases in yield in croplands increase the amount of vegetation, which in turn leads to absorption of additional $CO_2$ from the atmosphere during crop growth. In 2004, this sub-category accounted for the removal 12.47 kt of $CO_2$.

# 5. Recommendations

There are several ways of reducing/minimising growth in $CO_2$ emissions from sources and sectors and they are discussed in more detail below. The information in this section should be used as a basic starting point for considering $CO_2$ emissions reductions options, and is by no means exhaustive.

Deciding which carbon reduction/minimisation option to pursue may vary depending on the scheme type and also whether or not certain options will help to achieve wider policy objectives for West Norfolk. Carbon reduction schemes can sometimes be used to maximise benefits by working toward achieving multiple objectives.

## *5.1 Industrial and Commercial*

Industrial and Commercial business operations in West Norfolk are responsible for over 551 kt $CO_2$ annually and is highest contributing sector in the area at 32%. Facilitating the use of energy efficiency audits in the this sector can reduce $CO_2$ emissions by up to 12 tonnes per annum per business. The Carbon Trust offers free energy surveys to organisations with annual energy bills over £50,000 per annum.

Additionally, encouraging new and existing commercial operations to adopt environmental management systems can lead to operational efficiencies that minimise environmental impacts, reducing $CO_2$ and other greenhouse gas emissions.

On site renewable energy generation may also be plausible in the industrial sector. The Local Development Framework for West Norfolk should include policies to support renewable energy generation to facilitate this at new and existing industrial and commercial development. Additionally, the Local Development Framework could include policies to support applications for renewable energy generation and give consideration to increasing the required proportion of renewable energy supply at substantial new commercial developments.

## *5.2 Domestic*

Opportunities for reducing $CO_2$ emissions are most likely to be found most easily and cost effectively in the Domestic sector. Promoting renewable energy supply, both at new and existing development, should work to reduce these emissions.

### 5.2.1 Existing Development

The Domestic sector is the third largest contributing sector of $CO_2$ emissions in West Norfolk, accounting for 22% of all $CO_2$ emissions. There is substantial scope for improving energy efficiency in the existing housing stock and reducing energy consumption from the domestic sector will lead to reductions in $CO_2$ emissions. There are 343,135 households in the county and it is estimated that:

- 70% are owner occupied
- 85% are inadequately insulated
- 64% of those constructed with cavity walls are not insulated

Currently, 73.4% of local authority housing stock in King's Lynn is not considered to be of a decent standard, and government targets dictate that no homes should be classed as non-decent by 2010. A component of decent homes is the thermal rating – and focusing on improving this to the highest standards in local authority housing stock (such as double glazing, heating improvements and insulation) could significantly reduce Domestic emissions from this sector. Promotion of schemes to improve the energy efficiency and thermal rating in local authority housing stock can also work to address affordable warmth issues and, if properly implemented, can help to alleviate fuel poverty.

Additionally, West Norfolk can work to encourage householders in the area to reduce energy consumption or offer fiscal incentives to encourage them to use energy more efficiently. Discounting loft insulation, more efficient central heating systems, micro generation of on site renewable at existing development, or even low energy light bulbs could work to reduce $CO_2$ emissions from the Domestic sector.

Organisations such as Energy Savings Trust offer advice for improving energy efficiency and reducing $CO_2$ emissions in existing housing stock. By investing £500-£1000, an average household can reduce emissions of $CO_2$ by up to 70% through actions such as:

- Switching electricity to a renewable energy tariff
- Behavioural efficiency through advice from non-lighting and appliance related energy use
- Investment in improving insulation, thermal resistance, lighting, appliances, central heating and hot water systems

### 5.2.2 New Domestic Development

Reducing growth in Domestic emissions from the allocation of new housing development can be achieved by working with local planning authorities to increase the requirement for energy efficiency in the dwellings and/or commercial developments. The Local Development Framework will offer opportunities for limiting increases in $CO_2$ emissions that are likely to result from growth. West Norfolk should look to minimise growth in domestic $CO_2$ emissions through the Local Development Framework by including policies to:

- Ensure that development is located in such a way as to minimise growth in transport emissions and that development is located as near to services as possible and is accessible by public transport, walking and cycling. Additionally, consideration could be given to encouraging car free residential development.

- Encourage the supply of energy from on site renewable and / or decentralised renewable or low carbon energy sources and to require ambitious, but viable, proportions of the energy supply to substantial new development (as defined in the Planning Policy Statement on Planning and Climate Change) from these sources. This will be integral to limiting growth in emissions from the Domestic sector.

- Stipulate sustainable construction and minimum energy efficiency standards at new development. Again, this will be key to limiting growth in $CO_2$ from the domestic sector.

- Stipulate the use of travel planning as part of Section 106 agreements.

### *5.3 Road Transport*

West Norfolk has a dispersed population in a rural setting and the high rate of $CO_2$ emissions from road transport is therefore relatively unsurprising due to its rural nature and the distances involved in accessing services throughout the district. The King's Lynn Area Transportation Strategy (under review) and Norfolk Local Transport Plan provide the framework for delivering transport improvements in the area.

Additionally, most measures taken to reduce $CO_2$ emissions from road transport will have the ancillary benefit of reducing air pollution from traffic as well. Schemes designed to tackle this issue would best be focused in central King's Lynn, where beneficial effects could also be enjoyed within the Railway Road Air Quality Management Area.

#### 5.3.1 Car Parking

The provision of car parking in King's Lynn is likely to lead to continued car journeys to the centre of King's Lynn. The provision of additional parking may increase traffic volumes, which in turn may lead to increases in $CO_2$ emissions from Road Transport.

One solution for mitigation, which has successfully been trialled in other parts of the UK, is the introduction of variable charging rates based on vehicle emissions in cark parks. As the Borough Council owns and operates the majority of car parks in King's Lynn, the application of this measure could be significantly more straightforward than through car parks owned and operated by the private sector. There are applications for making this type of scheme revenue neutral for the car park operator. A similar approach can be taken forward through residential on street parking schemes.

### 5.3.2 Park and Ride

Park and Ride in King's Lynn could work to reduce car travel for those residing around King's Lynn. In Norwich, the average Park and Ride reduces $CO_2$ emissions by 1,088 tonnes per annum. However, the provision of additional/improved car parking in King's Lynn may continue to reduce the viability of Park and Ride in this area.

### 5.3.3 Low Emission and Alternative Fuel Vehicles

Promotion of low emission vehicles can help to achieve reductions in $CO_2$ emissions from road transport. The average private car in Norfolk emits 209 g/km of $CO_2$ (2005) or approximately 3.78 tonnes of $CO_2$ per annum. Lowering emissions from existing vehicles can be encouraged and promoted. Cars, lorries and buses can be converted to run on alterative fuels that emit less $CO_2$.

Low Emissions Vehicles are often encouraged through the use of financial incentives such as:

- Grants towards purchase of Low Emissions Vehicles
- Grants toward conversion of existing vehicles to operate on alternative fuels
- Differential pricing structures based on $CO_2$ for car parks, residential parking permits, Council Tax
- Exemption from congestion charges/tolls

Additionally, the annual $CO_2$ emissions profile on existing vehicles can also be lowered through promotional campaigns and soft measures aimed at influencing driver behaviour in ways that will reduce emissions, including:

- Proper tyre inflation
- Driving with windows rolled up
- Less aggressive driving practices
- Changing the air filer regularly
- Travelling at the speed limit on motorways
- Removing roof racks when not in use

### 5.3.4 Modal Shift

Encouraging a modal shift away from single occupancy vehicle use toward more sustainable transport options can also be used to reduce in $CO_2$ emissions. There are a number of measures that can be used to encourage modal shift including:

- Workplace travel plans
- School travel plans
- Section 106 travel plans
- Travel awareness campaigns
- Intensive information and marketing of sustainable transport modes
- Personalised journey planning
- Car Sharing
- Car Clubs

### *5.4 Land Use, Land Use Change and Forestry*

As the Fens are such a substantial source of the LULUCF sector emissions it is important to look for ways of reducing these emissions as much as possible. Countryside Quality Counts for the Fens Joint Character Area provide a detailed description of the Fens landscape and a sound basis for guiding landscape enhancements that may work to reduce carbon dioxide emissions from land use sources. Many of the measures for improving the landscape will provide the ancillary benefit of reducing land use change emissions and also enhancing local biodiversity.

Lowland bogs should be protected from inappropriate development and enhanced wherever possible, as these areas not only act as a carbon storage facility but also provide an important habitat for wildlife. However, limiting the amount of land converted to cropland to prevent further releases of stored $CO_2$ could have detrimental impacts on the rural economy. Lowland drainage is the largest source of land use change emissions, but halting of this practice may have detrimental effects on the agricultural economy, as much of this land is used for arable farming. Consideration should also be given as to how lowland drainage practices affect flood risk.

Reducing emissions from land use change will be challenging in the face of growth. Conversion of land to settlements disrupts soil and releases stored $CO_2$.The Proposed Changes to the East of England Plan require that the minimum dwelling provision in King's Lynn and West Norfolk be 12,000 between 2001 and 2021. In 2006/07, only 39.81% of new or converted dwellings were built on previously developed land. Increasing this proportion will be key to ensuring that land use emissions from conversion of land to settlements is minimised.

The urban capacity study found that 10,206 dwellings built between 2004 and 2021 could potentially be built on previously developed land within the district. By 2004, 10,367 houses remained to be built in order to meet growth targets. The capacity for remaining housing development to be built on previously developed land is therefore nearly 100%, which, if achieved, should effectively minimise land use emissions from the conversion of land to settlements.

Enhancing and promoting carbon removals within the LULUCF sector may offer good value for money carbon storage opportunities which, if properly planned and implemented, can offer wider environmental benefits. Encouragement of the following land use practices will work to increase carbon removals:

- Converting land to forest or large scale tree planting
- Converting land to grassland
- Yield improvements in cropland

## 6. Next Steps

The most effective way for the above measures to be delivered in an integrated manner is through the development of a climate change strategy for West Norfolk. As the overarching plan for the Borough Council of King's Lynn and West Norfolk and other key agencies in an area, the sustainable community strategy can provide the necessary policy impetus to influence other plans and strategies throughout West Norfolk on climate change.

An integrated, community-wide response to climate change is therefore best achieved being addressed at this strategic level. Due to its cross-cutting nature, climate change is well suited to be taken forward through community strategies, as collaborative effort across the West Norfolk community will be required to tackle this issue.

Strategic action on climate change can be defined by the desired outcomes, depending on their scope. These are:

- **Climate Change Mitigation:** Focuses action on the reduction of greenhouse gas emissions that contribute to climate change
- **Climate Change Adaptation:** Focuses action defining a pro-active approach through which to cope with the impacts of climate change
- **Climate Change Mitigation and Adaptation:** A holistic approach to focus efforts both on reducing greenhouse gas emissions to mitigate climate change and also preparing the local area for adapting to the likely impacts of climate change

Due to the high level of vulnerability to the effects of climate change, it is recommended that a holistic climate change mitigation and adaptation strategy is developed for West Norfolk. This would provide a strategic framework through which to reduce $CO_2$ emissions across sectors and limit increases from growth, whilst adequately preparing the area for adapting to climate change and reducing vulnerability to climate change impacts.