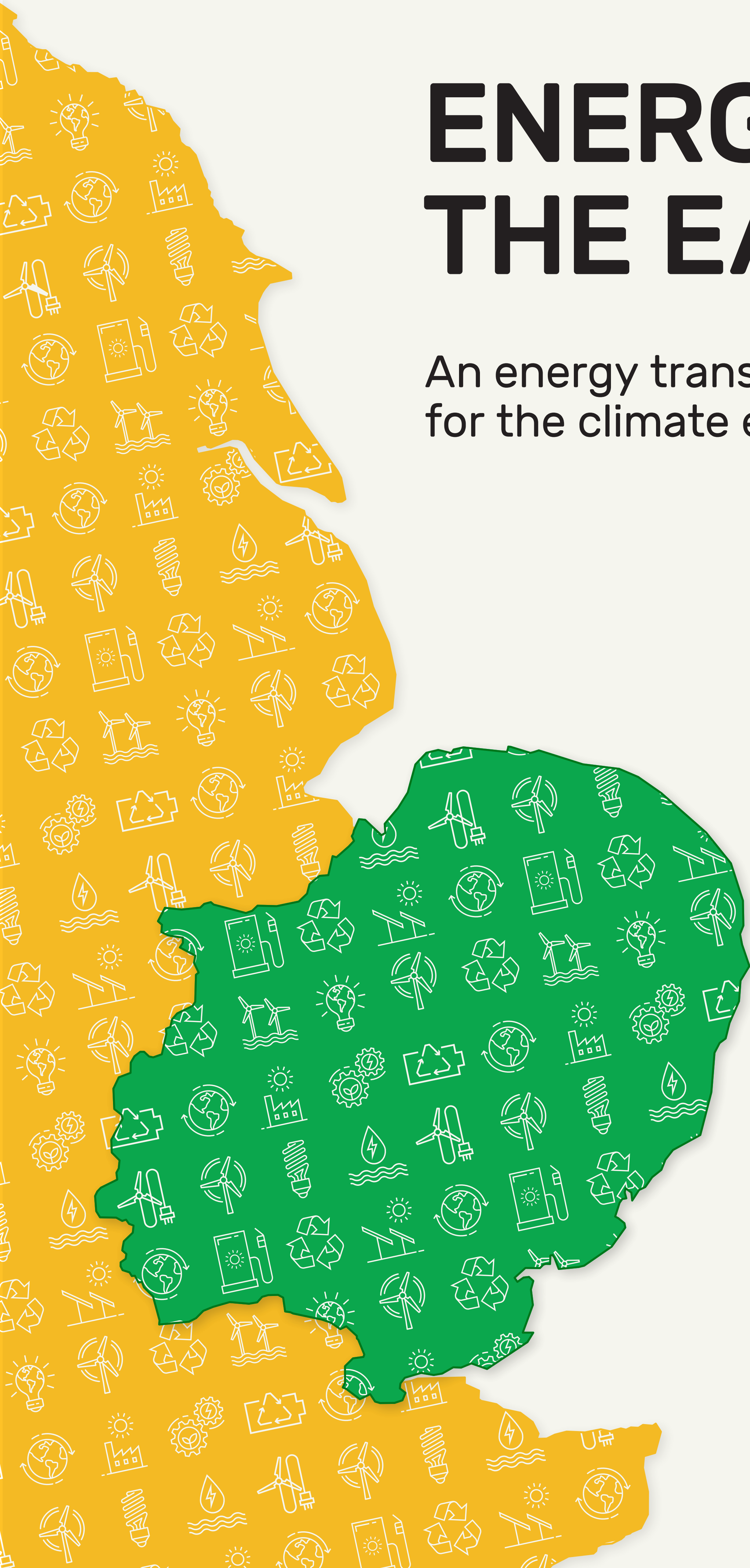
# ENERGISING THE EAST

## An energy transformation plan for the climate emergency



THE GREENS/EFA
in the European Parliament

# ENERGISING THE EAST

An energy transformation plan for the climate emergency

Energising the East
An energy transformation plan for the climate emergency



Produced by the office of Catherine Rowett,
Green Party MEP for the East of England
www.catherinerowett.org

Designed and typeset by Emily Benton
www.emilybentonbookdesigner.co.uk

Printed and bound by Page Bros, Norwich, UK

This report has been printed on Revive Natural, by Denmaur Paper. Revive Natural is a 100% recycled paper and comes carbon balanced (a scheme operated by the World Land Trust).

# FOREWORD

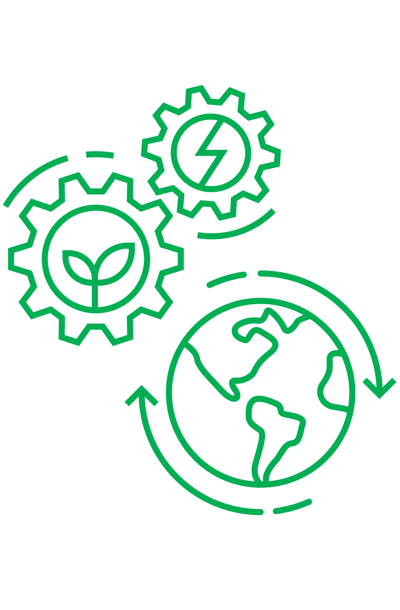
As we enter 2020 the world is on the brink of a climate and ecological disaster. We can already see the ghastly effects from Australia to Brazil, the Arctic to North Africa. Here in the East of England we are currently relatively protected from a crisis that will nevertheless soon engulf our shores along with all the others. Yet it is in places such as this, where we have become accustomed to an economy based on ever-increasing consumption and exploitation of finite resources, that we can make the greatest difference.

This report presents one strand of the pathway to a genuinely sustainable future. It is not, as so many other reports have been, about "green growth projects". Rather, the ambition is to propose a quite different way of life that will deliver a different kind of prosperity, one that prioritises wellbeing and builds resilience via a localised circular economy.

We focus in this report on the need for carbon-free, renewable energy as the basis for a transformation of industry, homes and transport. The East of England is blessed with the resources to lead the UK, and even the world, in producing renewable electricity. But increasing renewables is no help if it just adds more energy on top of existing unsustainable fossil fuel consumption. That would not get to the root of the crisis. We need a fundamental change to our entire economic model and, relatedly, to our expectations about energy use and distribution. *A Green Energy Future for the East of England*, the technical paper that accompanies this report, explains how a distributed energy system could enable communities to lead on such a sea change. Here in this report you will find a radical proposal for making that happen, politically.

In 2019, the UK Parliament, a raft of local authorities in the East of England, and finally the European Parliament officially acknowledged the climate emergency. They now need to act in a way commensurate with the scale of the problem. This report offers a way forward: *Energising the East*.

**Catherine Rowett**
Green Party MEP
for the East of England



# INTRODUCTION

This report explores the options for decarbonising the East of England by 2030. As 2020 begins, we embark on a decade which needs to see unprecedented change to prevent ecological and climate disasters becoming the norm across the globe.

The science has now been evolving for decades, but it is ever clearer that the earth is warming at an alarming rate. Historic projections of the impacts we were likely to see mid-century are starting to come to fruition much earlier than anticipated. We are indeed facing a climate emergency, and the best information available tells us we have just 10 years to tackle it.

Here in the East of England (the Eastern region), we are fortunate to have an abundance of beautiful landscapes, natural resources, cultural centres and vibrant communities. There is significant potential to use these assets to transform our economy and society while redressing the environmental harms of our fossil fuel-powered lifestyles and industry, and create a better future for all. By using all the natural capital the Eastern region has to offer in a creative and ambitious way, we can create a sustainable future that reframes how we approach our environment, what counts as valuable work, and how things are powered. This report attempts to outline one version of what such a system could be and how it could be brought about.

Chapter 1 discusses the broader context, before delving into the details of the region in terms of current energy usage, carbon footprint and the main challenges it faces, including climate impacts. Through presenting a carbon budget, it maps out the level of reductions required to decarbonise by 2030. It also looks at some of the most recent developments in the climate debate, such as the local authorities across the region that have declared a climate emergency in the last 12 months.

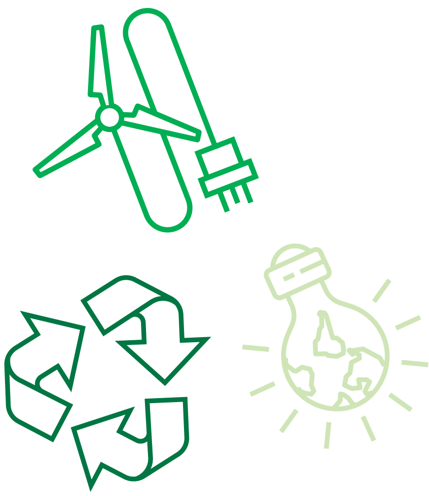
Chapter 2 examines and explains the current strategic response to the climate crisis at the national and regional levels, considering some of the developments over the last decade that have moved focus away from the regional level and away from robust, cohesive responses to these pressing issues.

Chapter 3 presents information about how zero carbon can be achieved in the East of England, exploring the implications of different scenarios. Taking this information into consideration, it outlines the conditions under which such a transition would be best developed, namely through shifting towards a more comprehensive local circular economy where unabated growth can be tackled head-on. It outlines the key areas that would need to be focused on and how they could be addressed to allow the required changes to the system to be made.

Chapter 4 demonstrates that, in practical terms, reaching zero carbon by 2030 can be done. It offers a model for decarbonisation in the industry, commercial and agriculture (ICA) sectors, and in the domestic and transport sectors. The parameters of the model and the assumptions made are explained throughout, creating a clear outline of the policy measures needed, as well as the 2030 goal itself.

Chapter 5 takes a closer look at making the connections between what is required and how it can be achieved. Focusing on societal and political changes to bring about such carbon emission reductions, it goes into more detail about what a local circular economy looks like and how it can be delivered.

**IN PRACTICAL TERMS, REACHING ZERO CARBON BY 2030 CAN BE DONE**



# WHERE WE ARE

This chapter provides a context for the rest of the report. It explains a little about the Eastern region, then looks at some of the major climate concerns and latest available information about the global situation and the Eastern region, including the contribution the region makes to national emissions and the current energy mix. It then outlines the rest of the report in brief.

## 1.1 THE EASTERN REGION: AN OVERVIEW

The Eastern region includes the counties of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk, and in 2018 had a population of 6.2 million people. The region is diverse in many ways. Geographically, areas of the region are in stark contrast, with large swathes of agricultural land and countryside juxtaposed with commuter belt suburban areas.

The socio-economic make-up of the region's constituent parts highlights these differences. Jaywick in Essex is home to the most deprived neighbourhood in England. Great Yarmouth is the most deprived local authority area in the region, ranking 24th among the 317 local authorities in England. Nine local authorities in the region are in the 100 most deprived in the UK, but more than half (27 of 45) are among the least deprived 50% nationally. East Hertfordshire is the least deprived area (ranking 307 of 317), with South Cambridgeshire (300) and St. Albans (306) close behind.[1] The region is home to several distinguished universities and research institutes, with pro-EU communities in the corresponding catchment areas, while more rural areas are more Eurosceptic.

Economic activity is also varied. The region is a traditional agricultural centre and is home to Felixstowe, the country's busiest container terminal, and some notable companies. Tesco and Ocado are both based in Hertfordshire, which is also home to News International's printing press, the world's largest. Bedfordshire is home to carmakers Chevrolet and IBC Vehicles, Hanson Building Products (cement manufacturer), and Amazon's main UK distribution centre. Four international airports (Luton, Norwich, Southend and Stansted) are based in the region, which is also home to two key players in the low budget airline industry: Easyjet at Luton and Ryanair at Stansted. Harwich is the region's only international ferry port. The region also has two nuclear power stations, Sizewell B in Suffolk and Bradwell in Essex. The Bradwell site was decommissioned in 2002, but there are plans to open a new nuclear facility at the site in the coming decade. A summary of large point sources of industrial emissions in the Eastern region is given in Box 1.

## LARGE INDUSTRIAL SITES IN THE EAST

1

The Environment Agency Pollution Inventory[2] and National Atmospheric Emissions Inventory (NAEI) data[3] enable the identification of sites with large point sources of carbon emissions (more than 10,000 tonnes of carbon dioxide ($tCO_2$) a year). In 2017, 72 sites (see Map 1) across the region generated almost 5.4 million metric tonnes (megatonnes or Mt) of $CO_2$, roughly equivalent to the emissions from 5.5 million transatlantic flights.[4] More than half (2.9 $MtCO_2$) of this comes from three gas-fired power stations: Little Barford (Cambridgeshire), Great Yarmouth (Norfolk) and Coryton (Essex), which together produce 1,879 megawatts (MW) of electricity. The distributed energy model presented in this report would substantially reduce the need for these plants, enabling operators to power them down and replace them with renewable energy alternatives, essential for reaching zero carbon energy by 2030 (see below).

Emissions from point emissions sources in landfill, energy from waste (incineration), and the food and drink industries also contribute significant climate change impacts in the Eastern region (Table 1).

| INDUSTRY | $tCO_2$ /YEAR | CONTRIBUTION TO TOTAL (%) | NUMBER OF SITES |
|---|---|---|---|
| Combustion | 2,947,653 | 54.8 | 6 |
| Food and drink | 858,466 | 16 | 12 |
| Energy from waste | 590,371 | 11 | 4 |
| Landfill | 484,006 | 9 | 24 |
| Refineries and fuel | 149,057 | 2.8 | 2 |
| Biowaste | 112,897 | 2.1 | 3 |
| Cement and minerals | 94,160 | 1.8 | 1 |
| Paper and textiles | 75,135 | 1.4 | 1 |
| Chemicals | 41,328 | 0.8 | 16 |
| Water | 29,000 | 0.5 | 3 |
| TOTAL | 5,382,073 | 100 | 72 |

TABLE 1 – **Annual carbon emissions for large industrial sites in the Eastern region (2017)**
(Source: Calculations based on Environment Agency, NAEI data)

Politically, the region has traditionally been and predominantly remains Conservative, with just six of the region's 58 Parliamentary seats held by other parties in the 2019 election (five Labour, one Liberal Democrat).

The region finds itself vulnerable to particular climate change impacts, given that it has the lowest elevation range in the UK, and because East Anglia (Cambridgeshire, Norfolk and Suffolk) is one of the driest parts of the UK, with between 450mm and 750mm average rainfall per year. Areas such as the Essex Coast and parts of Cambridgeshire lying 10 metres below sea level, so seawater inundation and drought are real threats in a warming world. Indeed, recent predictions suggest that large swathes of the Norfolk coast and parts of coastal Suffolk are also at risk of inundation, including the areas surrounding the Sizewell nuclear site.[5] See Map 1.

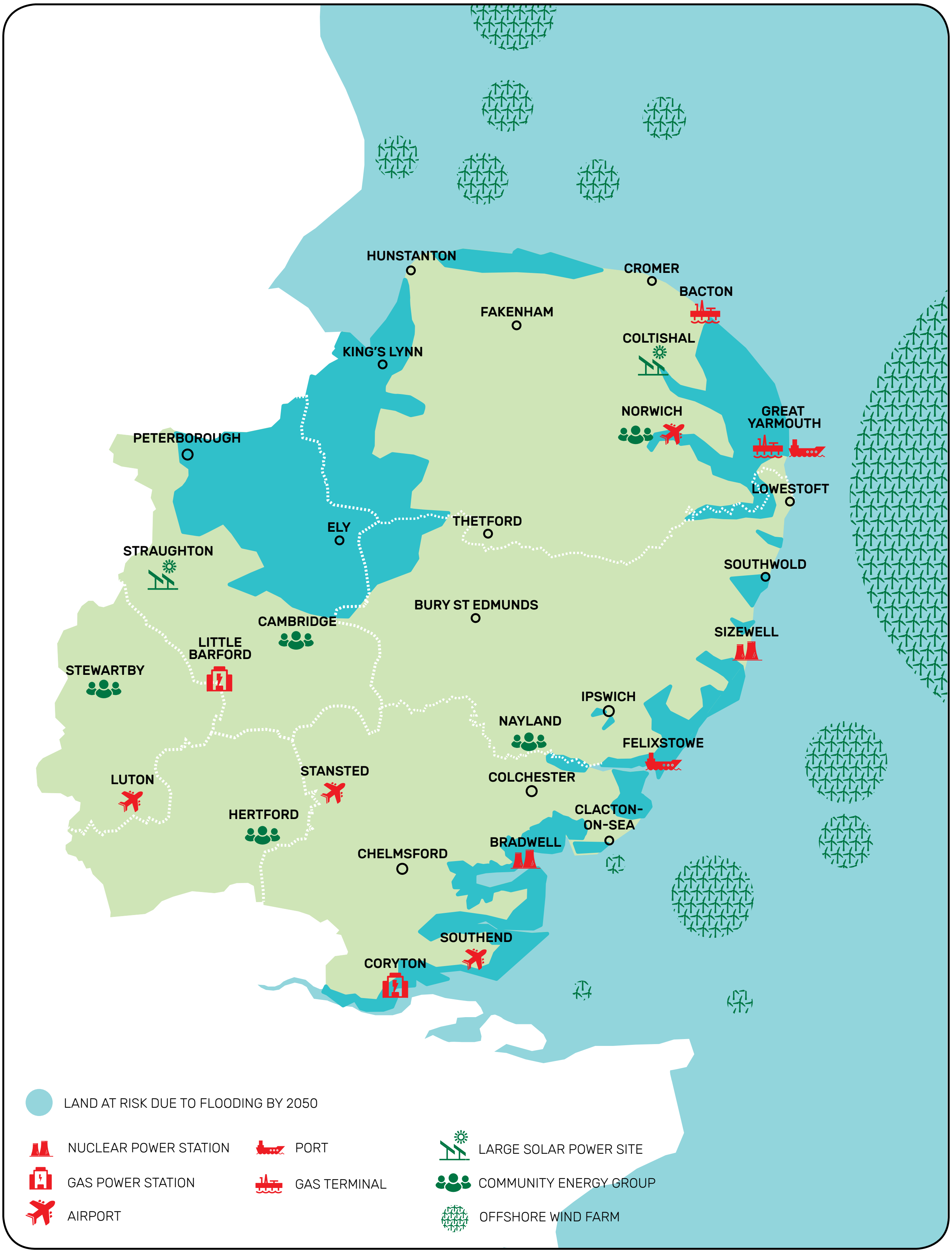
## 1.2 THE STATE OF THE CLIMATE: A GLOBAL VIEW

2019 was an unprecedented year for the climate, not just because the science concerning the impacts continued to issue stark warnings about tipping points being reached. At the same time, the latest Intergovernmental Panel on Climate Change (IPCC) data highlights that emissions and atmospheric concentrations of greenhouse gases (GHG) continue to rise. Simply put, time to act is running out. The natural world is providing growing evidence that the warnings need to be heeded urgently. The Amazon and even the Arctic have been on fire and Australia continues to blaze to an extent not witnessed before.

But it has also been a year in which the population, particularly younger generations, started to say "no more". They took to the streets to voice their concerns, Fridays for Future protests have ignited climate action on a new scale, Extinction Rebellion is rising up globally, and a young climate activist is *Time Magazine*'s Person of the Year. Times are changing, but the window of opportunity is closing fast. There are 10 years left to take action which will give us a 50% chance of keeping the temperature rise since pre-industrial times below 1.5°C, and these projections are modest. Emissions must peak in 2020 and start stabilising, reaching net zero by 2030. The urgency of the situation should not be underestimated. More details on what is required to achieve this level of emission reduction are provided below.

**EMISSIONS MUST PEAK IN 2020 AND START STABILISING, REACHING NET ZERO BY 2030**

Sadly, political will, a critical element to a robust response, is currently lacking, as demonstrated by the outcome of the recent United Nations (UN) Climate Conference negotiations in Madrid (COP25). The world's leaders are not taking the issue seriously. And without government at all levels committing to action, investing in action, and making decisions that reflect the need for urgent decarbonisation, the challenge will be insurmountable. While nationally, action has been slow, at a local level, councils are starting to pledge their intention to tackle the problem, including in the Eastern region.




MAP 1 – Overview of the Eastern region

## 1.3 ACTION TO DATE: CLIMATE EMERGENCY DECLARATIONS IN THE EASTERN REGION

In 2019 a raft of councils across the Eastern region joined the 700-strong list of UK local authorities that have declared climate emergencies (see inside back cover).

From Southend to Hunstanton, East Suffolk to Kempston, nearly 40 Eastern local authorities have committed to taking decisive action to address the threat posed by climate change.

- three county councils: Cambridgeshire, Hertfordshire, Suffolk
- 27 district councils
- seven town councils
- at least four parish councils

HISTON AND IMPINGTON PARISH COUNCIL

In September 2019, the Histon and Impington Youth Eco Council called on the Parish Council to declare a climate emergency and commit to net zero by 2021. In approving the motion, the parish became the first in Cambridgeshire to do so.

The majority of the county and district councils that have declared a climate emergency are working towards a 2030 goal. Cambridge, Hertsmere and South Cambridgeshire are working towards 2050, while the remainder have not specified a target date.

Norwich City Council and Babergh District Council have acknowledged but not declared a climate emergency. Norfolk County Council has not declared a climate emergency but has adopted an environment strategy that commits to becoming carbon neutral by 2030. Of the 15 district councils that have not declared a climate emergency, three ruled out declaring one in 2019, three have opted to enact climate action plans instead of declaring an emergency, King's Lynn and West Norfolk has delayed its vote, and Central Bedfordshire endorsed the emergency declared by the Local Government Association without declaring its own. Seven district councils are yet to mention climate emergency in their activities or plans.

Environmental law charity ClientEarth wrote to 100 local authorities that were in the process of formulating new local plans in September 2019, calling them out for failing to write and implement sufficient climate action targets within those plans.[6] Seventeen of these local authorities are based in Eastern region, 11 of which are among the authorities that have declared or acknowledged a climate emergency.

This highlights an extremely important point: declaring a climate emergency means nothing without an implementable plan to 2030 that will tangibly reduce emissions.

This is easy to say, but it is important to fully understand the scale of the challenge. In order to develop robust, actionable responses to climate change, we first need to consider our current emissions and the order of magnitude of reductions needed in order to meet the 2030 targets.

**DECLARING A CLIMATE EMERGENCY MEANS NOTHING WITHOUT AN IMPLEMENTABLE PLAN THAT WILL TANGIBLY REDUCE EMISSIONS**

## 1.4 A GLOBAL CARBON BUDGET TO BE DIVIDED BETWEEN NATIONS AND REGIONS

The nations of the world agreed via the UN Paris Climate Agreement in 2015 to limit average global temperature rises from human activity to “well below 2°C” and to “pursue efforts towards 1.5°C”. For any temperature, scientists can produce a global carbon budget to meet the temperature target with a certain probability.

In 2018, the IPCC produced the *Special Report on Global Warming of 1.5°C* (SR15), which changed the landscape of the debate. SR15 significantly updated the scientific basis underlying global carbon budgets (how much more $CO_2$ may be produced before meeting or exceeding the Paris targets). The report produced a global carbon budget of 420 billion tonnes (Gt) of $CO_2$, staying within which would give a 66% probability of limiting global average temperature rise to 1.5°C. On publication in 2018, the world output of $CO_2$ was slightly less than 40Gt$CO_2$ per year, meaning the remaining budget would last only to 2030 at that “burn rate”.

Exceeding a Paris-aligned $CO_2$ budget means that the chances of exceeding the Paris temperature targets increases. Scientific analysis of different projections for $CO_2$ production against carbon budgets until 2100 indicates a range of scenarios: these estimate that the current commitments under the Paris agreement will lead to a 3°C to 4°C increase, a clear international failure with catastrophic consequences globally.

The carbon budgets for energy transition in the Eastern region are based on SR15 data. Below we show that on current $CO_2$ output the region would exceed its fair share of the budget by around 2026.

## 1.5 THE EASTERN REGION CARBON BUDGET

In 2019, a team of scientists produced carbon budgets for every UK local authority area, known as SCATTER models.[7] These are based on SR15 and a UK budget calculated using climate equity principles[8] from the Paris Agreement.

The Eastern region budget to 2100 is 200.5 million tonnes carbon dioxide (Mt$CO_2$),[9] and keeping within this requires an annual carbon footprint reduction of 13.5%. The United Nations Environment Programme (UNEP) stated that global emission reductions of 7.6% per year are required.[10] These figures are broadly consistent as the UK, a rich northern nation, requires more rapid reductions to meet the equity principles of the Paris Agreement.

Figure 1 shows carbon emissions reduction in the Eastern region since 2005 followed by the 13.5% future emissions reductions required from 2020 to meet a Paris-aligned carbon budget. The historic graph shows only the total of domestic, transport and industrial, commercial and agriculture (ICA) energy emissions, as reported by the Department for Business, Energy and Industrial Strategy (BEIS) (33 Mt$CO_2$/year).[11] When aviation, shipping and consumption emissions are also considered, then the real carbon footprint is much greater, as illustrated in Box 2.

At this annual footprint, the Eastern region would have six years of current activity from 2020 before the 200.5 Mt$CO_2$ carbon budget is spent. Using the SCATTER trajectory (Figure 1) to meet the Paris-aligned carbon budget, the Eastern region per capita footprint would need to be reduced from 5.31 t$CO_2$/year in 2017 to 0.93 t$CO_2$/year by 2030.[12]

This report focuses solely on reducing emissions in the domestic, transport and ICA sectors, where robust data is available, but it is vital to acknowledge that these sectors only cover about 54% of real emissions in 2017 (see Box 2). Figure 2 below shows that in the Eastern region, ICA and domestic emissions have reduced while transport emissions are still at 2005 levels and rising.

In chapter 4, the emissions of the domestic and ICA sectors are broken down further to show where reductions have already been made, broadly between oil and gas fossil fuels, and electricity demand.

This enables a more detailed picture of current energy demand and its associated carbon footprint, and thus what needs to be replaced by 2030 and how this can be achieved.

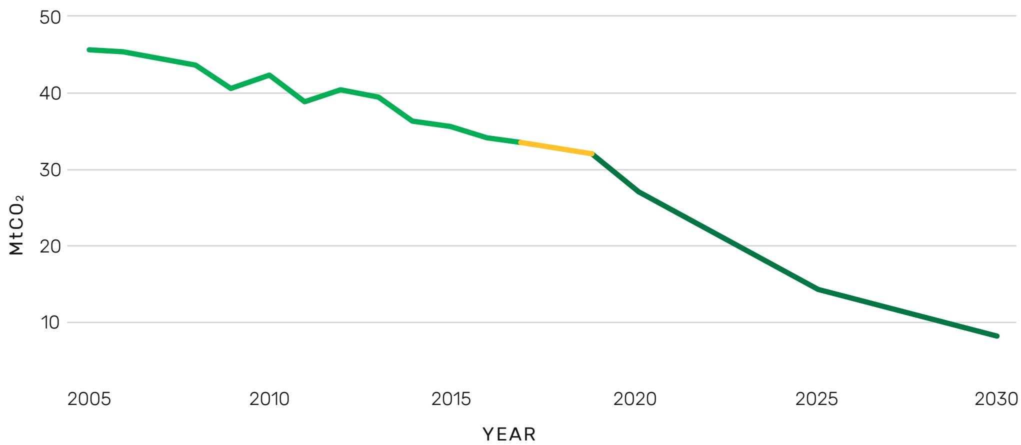



**FIGURE 1 – Historic and future emissions in the Eastern region ($MtCO_2$)**
(Data derived from BEIS (2019) and SCATTER project (2020))

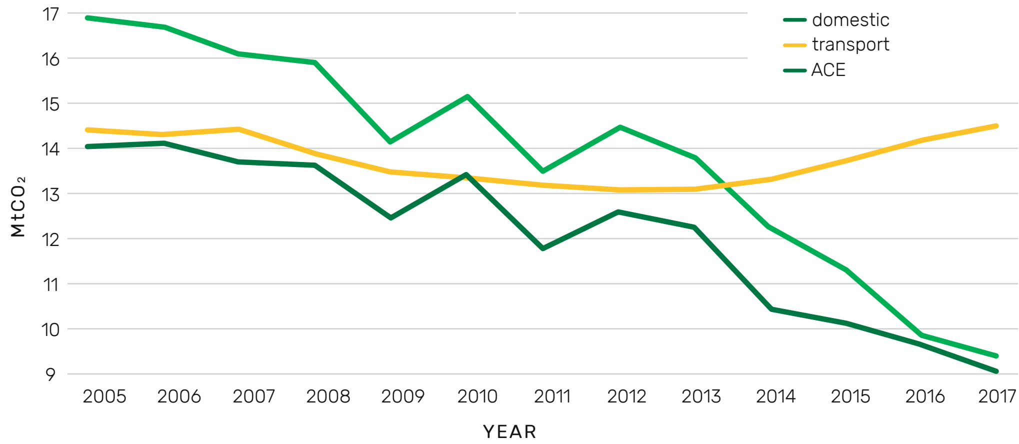



**FIGURE 2 – Historic sectoral emissions ($MtCO_2$) (2005–2017)**
(Source: BEIS (2019))

# CARBON FOOTPRINT OF THE EASTERN REGION

2

Presented here is a comprehensive carbon footprint for the Eastern region, encompassing the whole economy. It includes data collected at a national level that cannot reliably be scaled down to precise regional figures. So all national sector data is used pro rata, with population-adjusted figures for national aviation, shipping and consumption data, then combined with BEIS local authority data.[13]

When these sectors are considered collectively for 2017, the total per-capita footprint in the Eastern region is 9.9 $tCO_2$ as opposed to 5.3 tCO2 for the BEIS-only data. Figure 3 highlights that aviation, shipping and consumption emissions have all increased as a proportion of the total since 2005. Between 2005 and 2017, these emissions grew from 38.7% to 46.4% of the total with the growth in consumption emissions particularly marked. Based on these calculations, emissions in the Eastern region fell between 2005 and 2017 by 17%, less than for the ICA, transport and domestic emissions alone.

The very high contribution of consumption emissions is worthy of note. These emissions are largely based on energy systems elsewhere in the world, for example, coal powered factories in China. However, the Eastern region makes a significant structural contribution to UK consumption emissions by hosting facilities that make this massive import of goods, and export of emissions, possible. These include the country's busiest container port at Felixstowe, air cargo facilities at Stansted and Luton airports, and significant logistics, warehousing and distribution infrastructure in Bedfordshire, as outlined above.

Any further investment in such infrastructure poses a significant risk to reaching zero carbon by 2030 in both the Eastern region and the UK as a whole. Quite simply, any further development of logistics, road and warehousing infrastructure, the container ports on our coasts, and road-based distribution freight systems will lock in future consumption emissions in ways that are extremely difficult to reverse. While this issue lies outside the main scope of this report, it is fundamental that it is acknowledged as an urgent problem to solve.

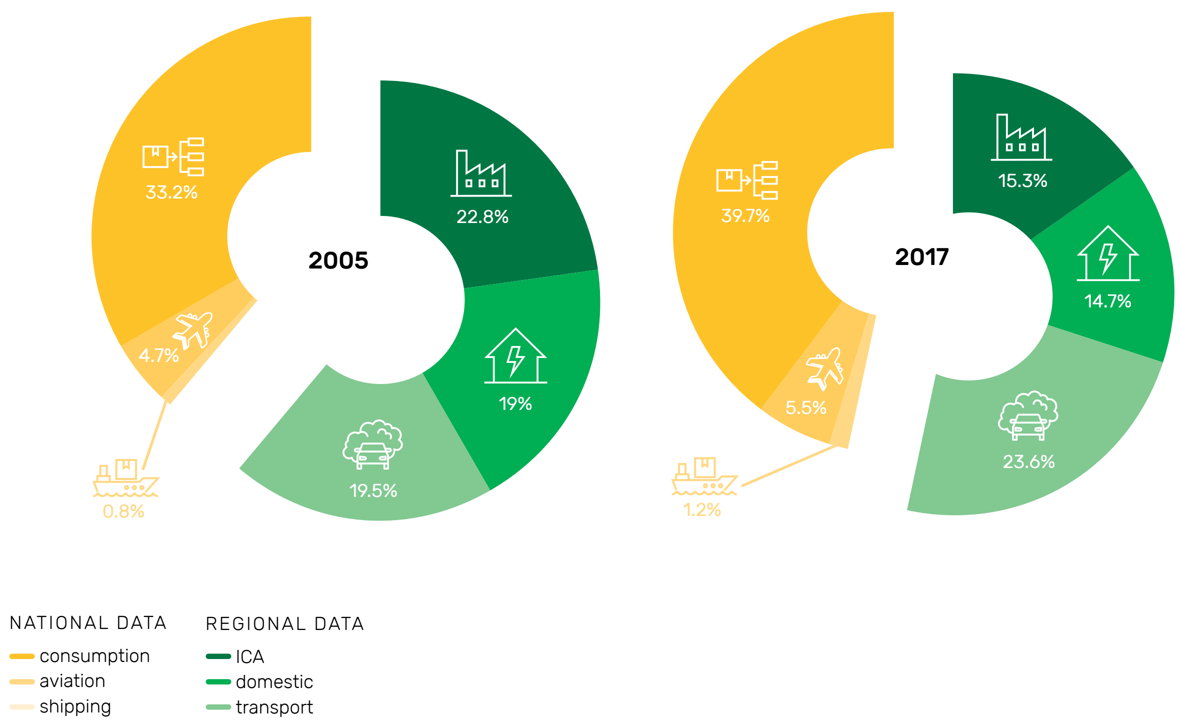
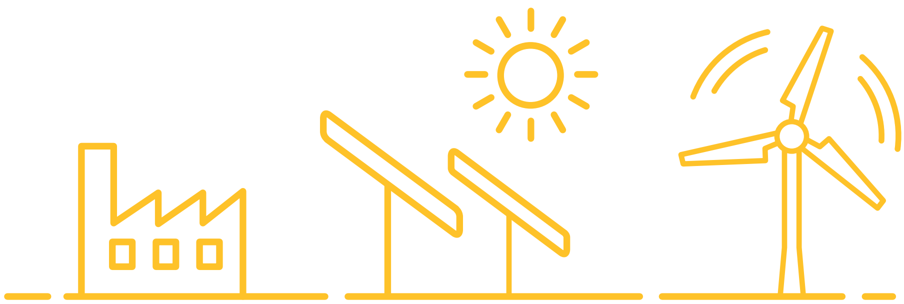
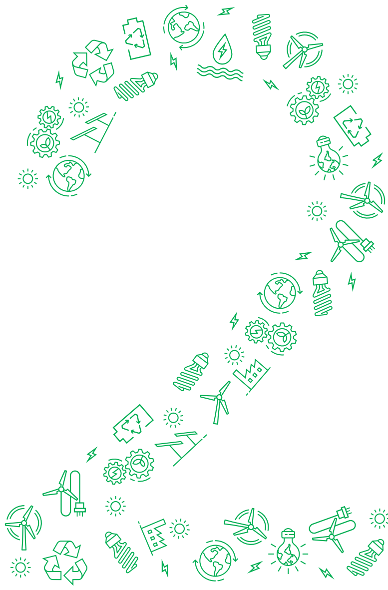



**FIGURE 3 – How the total share of carbon emissions changed from 2005 to 2017**
(Data derived from BEIS and other datasets[14])

Given the clear imperative to act highlighted above, it is clear that we need commitment and action on an unprecedented scale. The challenge ahead is staggering – we have a decade to halt the growth in emissions and we must rapidly work to remove carbon from across all areas of societal activity. But as our emissions continue to grow, it is important to understand what government responses to tackling the climate crisis are, and what this means for the Eastern region.

1 UK Government Indices of Multiple Deprivation (England) (2019): www.gov.uk/government/statistics/english-indices-of-deprivation-2019
2 Environment Agency *Pollution Inventory*, (December 2019), https://data.gov.uk/dataset/cfd94301-a2f2-48a2-9915-e477ca6d8b7e/pollution-inventory
3 NAEI, *Emissions from NAEI large point sources* (October 2019), https://naei.beis.gov.uk/data/map-large-source
4 One flight from London – New York is estimated to emit about 1 tonne of $CO_2$, as reported at: www.theguardian.com/environment/ng-interactive/2019/jul/19/carbon-calculator-how-taking-one-flight-emits-as-much-as-many-people-do-in-a-year
5 Climate Central, *Coastal Risk Screening Tool: Land Projected to be Below Annual Flood Level in 2050* (2019), https://coastal.climatecentral.org/map/11/1.7131/52.2/?theme=sea_level_rise&map_type=coastal_dem_comparison&=&elevation_model=coastal_dem&forecast_year=2050&pathway=rcp45&percentile=p50&return_level=return_level_1&slr_model=kopp_2014
6 Client Earth, "Lawyers put local authorities on notice over climate inaction" (September 2019) www.clientearth.org/press/lawyers-put-local-authorities-on-notice-over-climate-inaction/
7 Anthesis Group, Nottingham City Council, BEIS, Greater Manchester Combined Authority and the Tyndall Centre for Climate Research (Manchester), "SCATTER – Setting City Area Targets and Trajectories for Emissions Reduction" (2019), https://scattercities.com/ NB: "City Area" is a reference to Manchester, where the method was originally used; the method is not in fact limited to cities or urban areas.
8 Articles 2 and 4 of the United Nations Paris Agreement enshrine a fair (equitable) distribution of global GHG emissions between nations at different stages of economic development. Industrialised nations are expected to show leadership towards a low-carbon future. Any subdivision of the global carbon budget must therefore account for the development needs of what the Paris Agreement refers to as "developing country parties" in setting a fair national or subnational carbon budget.
9 Tyndall Centre (Manchester), "Setting Climate Committments for the East of England" (January 2020), https://carbonbudget.manchester.ac.uk/reports/EE/
10 UNEP World Conservation Monitoring Centre, *Emissions Gap Report* (November 2019), www.unep-wcmc.org/news/2019-emissions-gap-report
11 BEIS, *Emissions of carbon dioxide for Local Authority areas – 2017 estimates* (June 2019), https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/emissions-of-carbon-dioxide-for-local-authority-areas
12 This includes an adjustment for population growth. This calculation is based on the average annual population growth in the Eastern region 2005-2017 (+0.78%/year) in the BEIS data and extrapolated to 2030.
13 This combined dataset still excludes emissions from land use and military activity.
14 Office of National Statistics, *The decoupling of economic growth from carbon emissions: UK evidence* (October 2019), www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence





# INADEQUATE UK PLANNING AND ACTION

It is clear that if we are to successfully reduce annual emissions to less than a tonne per person in the next decade, the energy sector and the way we use energy need to be radically different ... and soon. We need a clear roadmap that will guide action and enable us to start immediately. But in taking stock of what is currently available and the trajectory that the current level of ambition aims for, it is clear that the strategies being implemented are not fit for purpose and require radical rethinking.

## 2.1 UK EMISSION REDUCTION COMMITMENTS

The UK's 2008 Climate Change Act (CCA) was changed in 2019, replacing a goal for 80% emission reduction on 1990 levels by 2050 to one of reaching zero carbon by 2050. While this made the UK the first national government to set a zero-carbon target, it sets the timeframe too late and is insufficient. As highlighted in chapter 1, global emissions must decline by 7.6% (on average) *every year* for the next decade.[1]

When the UK-based carbon footprint is calculated taking Paris agreement equity into account, as in SCATTER, the steeper 13.5% or more annual reduction target for the Eastern region is produced. Other proponents of the notion of a 'fair' carbon budget, as set out in SR15, suggest that the UK should reach zero carbon *between* 2025 and 2030. Tim Jackson argues that the *later* we plan to reach zero carbon (e.g. by 2030), the *more rapidly* we need to reduce carbon emissions now.[2] A target of zero carbon by 2030 should be the minimum target for the region.

The UK's goal as it stands is inadequate, not just because it needs to be achieved two decades earlier, but also because (a) it excludes the true extent of our emissions contribution and (b) it is likely to be missed, as explained below.

1. NOT ACCOUNTING FOR ALL GHG EMISSIONS
The target in the CCA only considers emissions produced in the UK, and even here, not all sectors are included. International aviation, shipping and imports are not included in the scope of the 2050 reduction target as they fall outside the scope of UK domestic emissions, yet these are some of the worst and most change-resistant contributions to climate change. The CCA target also does not include the entirety of our consumption-based emissions in the UK (due to international travel) and net imports of goods made overseas. UK consumption-based emissions (e.g. those coming from electronic goods produced by coal-fired factories in Asia, or fruit grown in Africa) only started to reduce in 2007, and have not fallen below the level they were at around 20 years ago (Figure 3). If they were considered in the scope of the target, the UK's climate budget would be around 50% higher (Figure 4).

2. NOT ON TRACK
Despite an inadequate and limited target, the UK is not currently on track to meet even its existing commitments. The latest UK government projections[3] conclude that the fourth five-year carbon budget (2023–2027)[4] will not be met, with the projected shortfall in required reductions standing at 139 Mt carbon dioxide equivalent ($CO_2e$).[5] For the fifth carbon budget (2028–2032), UK emissions are currently projected to overshoot by 245 $MtCO_2e$.

3. RELIANCE ON NON-EXISTENT AND RISKY TECHNOLOGIES
One response to inadequate policies to reduce emissions has been to introduce the concept of negative emissions technologies (NETs). NETs would, if they existed, extract $CO_2$ from the atmosphere from industrial processes, via carbon capture and storage (CCS). In theory, NETs could work in conjunction with real emission reductions, enabling us to reach net zero emissions earlier and with less significant reductions in consumption. However, these technologies are practically unproven at even a small scale, let alone the scale on which policymakers would have to rely on to contribute to decarbonisation by 2030. One such technology, bioenergy with carbon capture and storage (BECCS) has been mooted as having agricultural and energy policy implications for the Eastern region (Box 3).

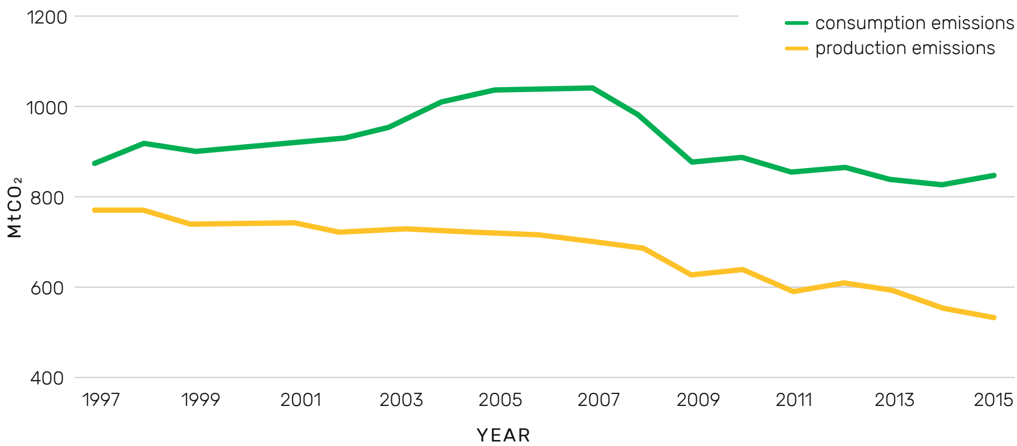



**FIGURE 4 – UK GHG emissions on a consumption and production basis ($MtCO_2$) (1997–2015)**
(Source: UK Committee on Climate Change (CCC) (2018))[6]

## BECCS

3

BECCS combines the burning of biomass to produce electricity with downstream technology to capture the flue $CO_2$ and then store it, usually underground. But experts are wary about its application. Fajardy et al. (2019) made this headline recommendation: "Policymakers should be sceptical about a future that is uniquely or heavily reliant on BECCS, and instead prepare for and implement alternative mitigation options as soon as possible."[7]

Jacobson (2019)[8] found that CCS technologies are inefficient at extracting carbon when the full carbon cycle is analysed: the carbon footprint of a power station is only reduced by some 10% by the addition of CCS. There are social costs as well, as CCS increases local air pollution from the power systems running it. This is in addition to the innate pollution from biomass burning in the case of BECCS, which would exacerbate the current public health crisis from particulate pollution. In summary, the paper concluded that social costs always increased when investment was diverted to CCS in preference to replacing fossil fuel or bioenergy systems with wind power.

Other risks of BECCS include the need to grow huge quantities of industrial, monoculture biomass: massive land use change requirements, impacts on biodiversity, impacts on food price as biomass competes for available farmland, very high water demands[9] and the destruction of high carbon content ecosystems for crops, which can increase $CO_2$ emissions for decades and deplete biodiversity.[10]

The National Farmers Union's (NFU) *Achieving Net Zero* report[11] requires growing enough biomass to burn and capture 22 $MtCO_2$ per year by 2040 across the UK. That is simply not credible with such a low proven efficiency rate. Energy and agricultural policymakers and investors should avoid making decisions that may include BECCS and lock us into bioenergy burning for decades. Apart from the downsides already listed, such a policy would not deliver the necessary emissions cuts in time, leading to climate policy failure where other investments could have succeeded.

Natural climate solutions,[12] including new subsidies to enable rapid carbon storage and peatland management in the Fenland areas of Cambridgeshire, Lincolnshire and Norfolk, provide a viable alternative to industrialised energy agriculture,[13] and complement the other proposals in this report.

A major issue with an inadequate national response is that the current plans and strategies being rolled out across the UK at regional and local levels are guided by targets set nationally. This can be already seen playing out in the Eastern region, as the energy strategies for the next decade take woefully inadequate shape.

# 2.2 THE EASTERN REGION RESPONSE

The last time the government had a plan to direct development across the Eastern region was in May 2008, when the Government Office for the East of England (GOEE) published an update to the East of England Plan.[14] This was six months *prior* to the UK publishing its CCA.

This was the last plan in the Eastern region to set targets for renewable generation: install onshore renewable power generation capacity of at least 1,620MW by 2020 together with 4,250MW of offshore wind capacity, such that at least 44% of the region's electricity by 2020 would come from onshore renewable sources.

The generating capacity for onshore wind[15] in 2018 was 474.3MW, approximately 25% of the plan's target for onshore capacity. This indicates an urgent need to unlock the social and political barriers to onshore wind, now the cheapest source of energy. The 2018 generating capacity for offshore wind was 2,393MW,[16] 56% of the 2020 target. The region has constructively developed offshore capacity for a decade now, supported by national government policy. Progress to date suggests that the region is in a strong position to further develop offshore wind capacity.

## 2.3 LOCAL ENTERPRISE PARTNERSHIP PLANS FOR THE EASTERN REGION TO 2030

A more fragmented approach to regional planning has been taken in recent years, with the government operating on an increasingly piecemeal scale than previously. In 2011, the coalition government set up Local Enterprise Partnerships (LEPs) as joint private-public sector bodies with a fair degree of autonomy. They broadly work to drive economic growth in their respective areas, but in 2017 each was required to produce an energy strategy. The five LEPs that cover the counties of the Eastern region have collaborated to produce three energy strategies, summarised in Table 2 below. These are currently the guiding force for overarching action to remove GHG from the energy sector across the Eastern region.

| AREA | TARGET & DATE | BRIEF OVERVIEW |
|---|---|---|
| ESSEX<br>Included in Energy South 2 East Local Energy Strategy (2019)[17] | Aligned with government targets for 2032 and 2050 | Quantified plan of 18 projects valued at £14.9 billion investment to create 75,000 jobs with a target to reduce carbon emissions by 57% on 1990 levels by 2032 across the LEP area.<br><br>Includes lobbying to restore a standard for zero-carbon new homes, targeting retrofit for the 20% of homes that are off gas grid, scaling up renewables including offshore wind, solar PV on car parks and landfills, onshore wind generation.<br><br>Scaling up energy storage and reducing peak demand for electricity.<br><br>Reducing carbon emissions and air pollution for transport together, noting that Essex is currently one of the five worst performing local authorities for air quality. |
| BEDFORDSHIRE<br>Included in South East Midlands (SEM) Energy Strategy (2018)[18] | Aligned with government targets for 2030 | Actions around grid capacity requiring active network management and a distributed energy network, identification of heat network opportunities, aiming for one building in five to be connected to a heat network (although also suggests that in the absence of certain prerequisites these are unlikely to be viable).<br><br>States that improved building standards are needed through stronger planning regulations, including reinstating zero-carbon homes and by enabling retrofit programmes.<br><br>Integrated approach to public transport infrastructure delivery, including new east-west rail link between Oxford, Milton Keynes, Bedford and later Aylesbury, and infrastructure to support the rollout of electric vehicles (EVs). |
| HERTFORDSHIRE, NORFOLK, SUFFOLK, CAMBRIDGESHIRE & PETERBOROUGH COMBINED<br>Local Energy East – Tri-LEP Area Strategy (2018)[19] | Aligned with government targets for 2050 | Decentralising the energy network, stressing the need to combine small-scale renewable energy generation with improved battery storage technologies to develop distributed smart grids.<br><br>Notes the potential for at least another 10 large offshore wind farms off East Anglia, which alone could double the UK's offshore capacity. |

**TABLE 2 – Contrasting the Eastern region's LEP energy strategies**

Reviewing these LEP strategies highlights the following:

1. THEY ARE ALREADY OUT OF DATE.
None of the LEP strategies aligns to the government's targets for zero carbon by 2050, never mind a 2030 target. While the Tri-LEP strategy states that it will "reduce carbon emissions, in line with national targets",[20] it was released in winter 2018, before the net zero target for 2050 was put into place, and only covers the period to 2030. Similarly, SEMLEP aims for a 19-31% reduction in gas use by 2050 and a 60-70% reduction of fossil fuel use by 2050, but uses outdated energy modelling.[21] The Energy South 2 East Strategy proposes to connect off-grid houses to the gas grid and rollout compressed natural gas (CNG) as a transport fuel. In contrast, National Grid modelling of the government's zero-carbon target does not include any natural gas by the time the economy has decarbonised.[22] This highlights how inappropriate these energy strategies are for meeting a 2050 net zero-carbon reduction target, let alone the Paris Agreement-aligned 2030 budget, which many local authorities have subscribed to with their climate emergency declarations.

2. THESE TARGETS ARE SUBSERVIENT TO ECONOMIC GROWTH.
While these energy strategies link with the current UK policy context, identifying the government's industrial and clean growth strategies,[23] they also link to competing growth targets. Furthermore, SEMLEP energy scenarios are modelled against housing growth targets of local authorities together with an even higher housing target modelled by the National Infrastructure Commission: "If the arc is to maximise its economic potential, current rates of house building will need to double – delivering up to one million new homes by 2050".[24] No consideration is given to the embodied carbon of building the homes, nor to whether such growth targets align to national climate change targets, much less the Paris Agreement-aligned 2030 target.

**NONE OF THE LEP STRATEGIES ALIGNS TO THE GOVERNMENT'S TARGETS FOR ZERO CARBON BY 2050, NEVER MIND 2030**

## 2.4 INCOMPATIBLE PRIORITIES

The primary objective of LEPs is to drive growth, and the regional focus on large-scale transport infrastructure projects undermines any progress towards the 2030 climate imperative. Across the region, Norfolk and Suffolk aim to expand the A14 and the Norwich Northern Distributor road, Bedfordshire plans an M1–A6 link, and regional bodies lobby central government to make the A47 a dual carriageway throughout. The illustrative Zero Carbon East model (chapter 4) replaces such high-carbon road projects with large-scale modal shift and the electrification of transport. This would release more funding for wider investment in rail, mobile infrastructure, flood defences, coastal management, housing and, crucially, a zero-carbon energy sector, all better aligned to dealing with the climate emergency.

The increase in road transport capacity will lead to higher carbon emissions, at the very time when the LEPs' own energy strategies say this should be reduced. For example, the M1–A6 link through an area of outstanding natural beauty supports plans for huge new logistics warehouses, linked to expanding imports freighted by road and air. Carbon reduction cannot exist side by side with plans to lock in our current high-carbon production, distribution and consumption patterns.

But that energy is being considered in parallel with driving growth isn't the only issue. The framing of energy itself is also inadequate. For example, unlike in the East of England Plan (see section 2.2) the LEPs' economic and energy strategies include no spatial planning for renewable energy.

The region's planning should also consider strategies to adapt to climate change, alongside decarbonisation, but this is largely missing from LEP activities thus far. With more visionary and comprehensive long-term planning, there is potential for solutions to be implemented that have multiple co-benefits. For example, the Eastern Scheldt storm-surge barrier in the Netherlands not only protects against storm risk, but since 2016 its five turbines have been producing tidal energy. The array has a capacity of 1.2MW (enough to power around 1,000 homes) and initial monitoring on the soil protection and impacts on the estuaries behind the barrier has been positive.[25] Potential for such initiatives exists in the Eastern region, for example on the River Yare,[26] but currently existing flood defences are being upgraded by a partnership including the New Anglia LEP, without any vision for the significant, long-term co-benefits (resilience, renewable locally produced energy, jobs etc.) that such an ambitious scheme might deliver.

Adaptation is not just about infrastructure investment, but also about ensuring that plans are flexible and able to adapt in the future. Perhaps most significant for the region is to plan for changing land use due to the combination of flood risk and increasing prevalence of drought, particularly for food production. But ultimately resilience in the long term will only be assured by rapid decarbonisation (here and globally) in the short term. That requires the region to shift rapidly to new economic strategies that amplify climate action rather than conflicting with the climate emergency. Planning at all levels should take account of the true magnitude of the crisis, and should reflect on, plan and implement optimal solutions across all sectors.

## 2.5 CONCLUSION

Current national targets are perilously insufficient, yet they are framing the action that is under way subnationally. The additional danger here is that these insufficient goals become embedded and it is then difficult to upgrade them with adequate ambition. Also, energy policy capable of addressing climate change is being traded off against other policy areas and economic growth, which leaves decarbonisation vying for resources with other incompatible and energy intensive developments.

Strategic economic planning over the past 10 years under private sector-driven LEPs has led to a narrower focus, with less accountability and transparency. Concerned primarily with growth and employment creation "largely at the expense of environmental sustainability and social equity considerations",[27] the LEPs are inadequate bodies to plan for a zero-carbon future. Similarly, the new subregional transport bodies, including Transport East (covering New Anglia, Essex and Southend-on-Sea) also lack an overarching carbon reduction remit and are not directly accountable to the public.

Overall, this leaves regional governance as a complex matrix of subnational transport bodies, LEPs and councils (themselves split between two-tier and unitary authorities), resulting in unclear accountability, gaps and overlaps in jurisdiction, and a lack of public scrutiny.

So while the majority of the public now want greater action on climate change, there is no clear and appropriate regional authority to raise ambition levels and plan for an acceptable long-term future that takes into account the context of the Eastern region and the unique challenges the area faces. In the absence of such a body this report offers insight into how overall demand for energy and transport can be reduced to the extent that the Eastern region can be fully decarbonised by 2030.

1 UNEP World Conservation Monitoring Centre, *Emissions Gap Report* www.unep-wcmc.org/news/2019-emissions-gap-report
2 Jackson, T., *Zero Carbon Sooner: The Case for an Early Carbon Target for the UK* (July 2019) www.cusp.ac.uk/wp-content/uploads/WP18—Zero-carbon-sooner.pdf
3 BEIS, *Updated Energy and Emissions Projections 2018* (April 2019) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794590/updated-energy-and-emissions-projections-2018.pdf
4 Committee on Climate Change (CCC), *The Fourth Carbon Budget – reducing emissions through the 2020s* (December 2010) www.theccc.org.uk/publication/the-fourth-carbon-budget-reducing-emissions-through-the-2020s-2/
5 $CO_2e$ is a standard unit for measuring carbon footprints. It takes into consideration GHGs other than just $CO_2$, but is used to express the impact of these other gases in terms of the amount of $CO_2$ that would lead to the same degree of warming.
6 CCC, *Reducing UK Emissions: 2018 Report to Parliament* (June 2018) www.theccc.org.uk/wp-content/uploads/2018/06/CCC-2018-Progress-Report-to-Parliament.pdf
7 Fajardy, M. et al, *BECCS deployment: a reality check* (December 2019) www.imperial.ac.uk/grantham/publications/briefing-papers/beccs-deployment-a-reality-check.php
8 Jacobson, M., "The health and climate impacts of carbon capture and direct air capture", in *Energy & Environmental Science*, 2019, 12, 3567 (October 2019) https://web.stanford.edu/group/efmh/jacobson/Articles/Others/19-CCS-DAC.pdf
9 Fern, *Six problems with BECCS* (September 2018) https://fern.org/sites/default/files/news-pdf/Fern%20BECCS%20briefing_0.pdf
10 Harper, A.B., Powell, T., Cox, P.M. et al., "Land-use emissions play a critical role in land-based mitigation for Paris climate targets", in *Nature Communications 9, 2938* (August 2018) www.nature.com/articles/s41467-018-05340-z.pdf.
11 NFU *Achieving Net Zero: Farming's 2040 Goal* (May 2019) www.nfuonline.com/nfu-online/business/regulation/achieving-net-zero-farmings-2040-goal/.
12 Rewilding Britain, *Rewilding and climate breakdown: How restoring nature can help decarbonise the UK* (May 2019) www.rewildingbritain.org.uk/assets/uploads/Rewilding%20and%20Climate%20Breakdown%20-%20a%20report%20by%20Rewilding%20Britain.pdf
13 Clark, A., *The Carbon farmer* (December 2018) www.creativecarbonscotland.com/news-new-film-the-carbon-farmer/
14 GOEE, *East of England Plan: Revision to the Regional Spatial Strategy for the East of England* (May 2008) www.ipswich.gov.uk/sites/default/files/pscd07_-_east_of_england_plan.pdf
15 UK Government, *Regional Statistics, 2003-2018, Installed Capacity –MW* (September 2014, updated September 2019) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/834144/Regional_statistics__2003-2018__-_installed_capacity__MW_.xls
16 *Ibid.*
17 Energy South 2 East, *Local Energy Strategy: Towards a Low Carbon Economy. Commissioned to Siemens and Published by Coast to Capital, Enterprise M3 and South East Local Enterprise Partnerships* (March 2019) www.southeastlep.com/app/uploads/2019/03/Local-Energy-Strategy-FINAL.pdf
18 Seguro, F., *South East Midlands Energy Strategy* (December 2018) www.semlep.com/modules/downloads/download.php?file_name=1271.
19 Local Energy East Network, *Local Energy East Strategy: An Energy Strategy for the Tri-LEP Area* (*Endorsement copy for stakeholders*) (May 2018), https://cambridgeshirepeterborough-ca.gov.uk/assets/Uploads/Local-Energy-East-LEE-Strategy.pdf
20 *ibid.*
21 The SEMLEP refers to National Grid's 'Gone Green' scenario, which was retired by National Grid in 2017. New Power, "Future Energy Scenarios: National Grid retires 'Gone Green' option" (July 2017) www.newpower.info/2017/07/future-energy-scenarios-national-grid-retires-gone-green-option/)
22 National Grid, *Future Energy Scenarios* (July 2019) http://fes.nationalgrid.com/media/1409/fes-2019.pdf
23 UK Government, *Industrial Strategy: Building a Britain fit for the future* (October 2017, updated April 2018) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf; and BEIS, *Clean Growth Strategy: Leading the way to a low carbon future* (April 2018) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
24 National Infrastructure Commission, *Partnering for Prosperity: A new deal for the Cambridge-Milton Keynes-Oxford Arc* (November 2017) www.nic.org.uk/wp-content/uploads/Partnering-for-Prosperity.pdf
25 Tocardo Tidal Power, "Eastern Scheldt tidal project starts producing power" (February 2016) www.tocardo.com/eastern-scheldt-tidal-project-starts-producing-power/; MarineEnergy.biz, "Zeeland could get more tidal power" (March 2019) https://marineenergy.biz/2019/03/28/zeeland-could-get-more-tidal-power/
26 In 2011, Lowestoft-based firm 4NRG built a prototype to be tested with support of the Broads Authority but the project was not carried forward. Greath Yarmouth Mercury, "Tidal power could happen on River Yare in four years" (February 2011), www.greatyarmouthmercury.co.uk/news/tidal-power-could-happen-on-river-yare-in-four-years-1-792412
27 McDaniel, S., and Berry, C., citing Hildreth and Bailey (2014) and Rossiter (2016), *Local economic performance and development: a literature review* (January 2018), http://speri.dept.shef.ac.uk/wp-content/uploads/2018/11/Local-economic-performance-and-development-literature-review.pdf

# ZERO CARBON 2030

This chapter sets out a workable vision for a zero-carbon future as the Eastern region accelerates its ambition and eliminates fossil fuels.

## 3.1 WHAT DIFFERENCE DOES A TARGET OF ZERO MAKE?

The shift from a carbon reduction target to a target for zero carbon is a dual challenge, as the two types of target are both *qualitatively* and *quantitatively* different. It is possible to reduce emissions by increasing energy efficiency and reducing the carbon intensity of fuels. But to reach zero carbon requires a much deeper, broader programme: far more ambitious energy conservation measures, the elimination of fossil fuels, and a step-change increase in renewable energy alongside a transformation in how we live. This requires a fundamentally different approach, not just a variation on business as usual. To change policy and practice requires us to envision where we heading, and then work backwards to now to unpack how to get there.

Two alternative visions of zero carbon created in 2019 are explored below. These are UK energy scenarios developed by National Grid and the Centre for Alternative Technology (CAT). These are summarised in Boxes 4 and 5, before key aspects are related to the Eastern region.

**TO REACH ZERO CARBON REQUIRES A DEEPER, BROADER PROGRAMME, NOT JUST A VARIATION ON BUSINESS AS USUAL**

## NATIONAL GRID 'COMMUNITY RENEWABLES' SCENARIO FOR ZERO CARBON[1]

**4**

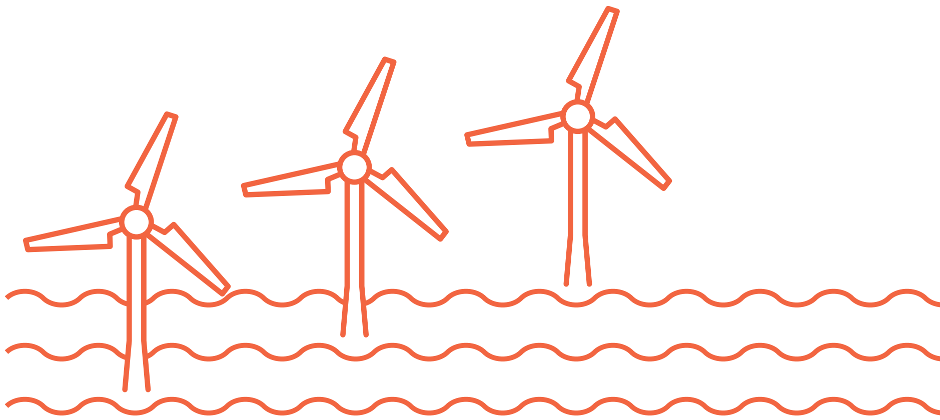
This modelling from National Grid is important for two reasons: firstly as it extended its model of the UK government's old '80% by 2050' carbon reduction targets to zero carbon; and secondly as its latest scenario, Community Renewables, is concluded to be the fastest way to decarbonise the UK (i.e. respond to the climate emergency).

To achieve zero carbon National Grid evaluated how their energy generation scenarios impact on energy efficiency, consumer behaviour, new technologies and electrification. They were looking at a longer timescale, to 2050, which does not address the climate emergency rapidly enough, but their conclusions support the principle of a local, distributed, smart energy grid as being key:

- Community renewables lead to greater improvements in building energy efficiency and consumer engagement to reduce energy demand. Heat storage and smart heating help to shift demand away from peak times.
- Elimination of all fossil fuels (including gas) in transport. Smart charging[2] and other smart applications reduce peak demand and vehicle-to-grid[3] connection increases system flexibility.
- Transfer to electrification across the economy, and the provision of 100% renewable electricity generation.

The National Grid Community Renewable scenario describes a future where *"local energy schemes flourish, consumers are engaged and improved energy efficiency is a priority. UK homes and businesses transition to mostly electric heat. Consumers opt for electric transport early and simple digital solutions help them easily manage energy demand. Policy supports onshore generation and storage technology development … and a platform for other green energy innovation to meet local needs."*[4]

This model of decentralised energy includes front-loaded growth in battery storage, which replaces gas for much of the need to address intermittency of generation. It connects to the local distribution network, and integrates storage in EVs, which can supply energy back into the network. EVs left plugged in when not in use can both charge from the network, and discharge when additional power is needed. This scenario has the greatest reduction in total energy demand, falling to just over half the 2010 level. National Grid proposes further delay and lower capacity for new nuclear power.



## CAT ZERO-CARBON BRITAIN 100% RENEWABLE ENERGY SCENARIO[5]

5

In 2007 CAT first produced its visionary Zero Carbon Britain model of how the UK could decarbonise to a 100% renewable energy economy. The model was updated and republished in 2019 to reach decarbonisation by 2030. Key features include:

1. SIGNIFICANT ENERGY DEMAND REDUCTION
   - Improve insulation on existing buildings to cut heat demand by 50% and require a zero-carbon 'Passivhaus' standard for all new buildings.
   - Reduce travel; shift to more public transport, walking, cycling; electrify all vehicles and fly much less – 78% less transport energy use.

2. INCREASE TO A 100% RENEWABLE ENERGY SUPPLY
   - Use full range of renewable energy to help balance supply and demand. Unlock onshore wind so that together with offshore wind, it can supply almost half our energy.
   - Demand management and storage including hydrogen from surplus wind power.

| RENEWABLE ENERGY | GENERATION (TWh/YEAR) | HOW WILL THIS BE SUPPLIED? |
|---|---|---|
| Offshore wind | 530 | 14,000 x 10MW turbines |
| Onshore wind | 77 | 15,000 x 3MW turbines |
| Wave & tidal power | 67 | 10GW wave & 20GW tidal |
| Solar PV | 74 | 90GW covering 15–20% roofs |
| Geothermal | 24 | 3GW capacity |
| Hydropower | 8 | 3GW capacity |
| Heat from heat pumps, solar thermal & geothermal sources | 175 | Mostly heat pumps, solar thermal on 3% roofs, some geothermal |

**TABLE 3 – 100% Renewable Energy by 2030 for the UK**
(Extract[6] from Zero Carbon Britain 2019 model[7])

Both National Grid's Community Renewables and CAT's Zero Carbon Britain energy models present a 100% renewable energy supply; relying heavily on a combination of onshore and offshore wind, as well as a decentralised grid model. Both entirely eliminate fossil fuels from heating buildings and fuelling vehicles. The two main differences between these two models are the slower decarbonisation and the inclusion of nuclear power in the latest National Grid model.

The slower decarbonisation of the National Grid model is reflected in the reliance on BECCS (Box 3) and on EVs for energy storage. The Zero Carbon Britain approach should be advocated because it delivers a much more rapid transition to zero carbon combined with greater demand reduction, both in heating and the transport sector, where a significant modal shift is promoted alongside a limited transition to EVs.

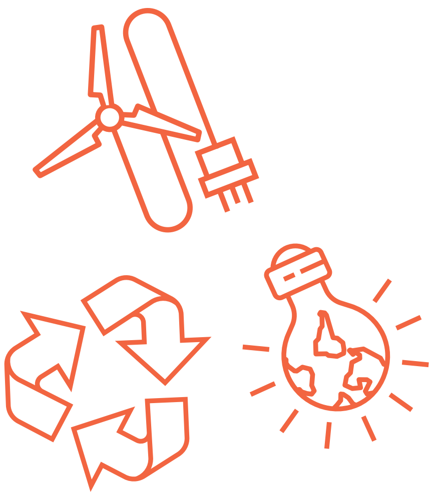
The second difference between the Zero Carbon Britain 2030 and National Grid's 2050 ambition is reflected in the continued reliance on nuclear power in the National Grid model. This is increasingly at odds with a more localised energy generation, demand management and storage.

The development of new nuclear power stations, such as proposed at Sizewell, is incompatible with a local energy future for the following three reasons:

- Nuclear would be rolled out more slowly than an energy scenario based on scaling up decentralised renewables and offshore wind, and so would miss the climate emergency window for action.
- Comparatively new nuclear generation capacity will cost two to three times more.
- Nuclear is highly vulnerable, and not easily adaptable to the flood risk caused by rising sea levels.

While there are some benefits of nuclear due its higher load factor than solar and wind, these issues can be addressed through a distributed energy system approach, as demonstrated by Zero Carbon Britain above.

The local, clean energy future is possible. It is deliverable. We have achieved such rapid transitions in the past and generally tend to understate our collective capacity, ability and resourcefulness for change.[8] But to make it happen we must transform our energy and economic systems together.



# 3.2 A BETTER FUTURE: VISIONING A 100% RENEWABLE ENERGY TRANSFORMATION

Our current economic system increases resource exploitation, energy use and inequality globally. Focusing on financial benefits and relying on them to trickle down to benefit all in society, without environmental and climate impacts, is not working. Instead we should reframe the economy to become solely a means of getting to a better future, which requires a clear vision of what kind of future we want and need. A future that makes life both better and more equal for all, while responding not only to the climate emergency, but also to wider ecological crises (e.g. biodiversity loss, topsoil degradation, deforestation). We call this a circular economy, which is contrasted with the current linear economy in Table 4 below.

The reframing approach requires us to shift away from a 'take-make-use-throw-away' mindset to one where resources, energy and money circulate within environmental limits in ways that benefit everyone.

| | LINEAR ECONOMY | CIRCULAR ECONOMY |
|---|---|---|
| OBJECTIVE | **To grow** not just money, but physical assets, increasing throughput. | **To sustain** natural and physical assets, and make best use of and restore resources. |
| ECONOMIC PROCESS | **Linear:** maximising profit increases throughput, driving continued investment in production capacity and capital assets (infrastructure), enabling continued growth in consumption. | **Circular:** retaining value in the system for as long as possible; treating resources as scarce from the outset. Maximising value of and recovering/reusing resources. |
| SCALE | **Global:** minimising cost centralises production globally, increases transport of goods and separates our homes and work from other people. | **Local:** production co-located with consumption, minimising transport and energy use. Collaboration strengthens communities and increases fairness. Localising economy increases circularity, especially if there is local ownership. |
| ENERGY SYSTEM | Exploitation, transport, use and disposal of non-renewable resources and energy use on an unsustainable scale. | Powered by renewable resources and energy use minimised through conservation, reuse and sharing. |
| MEASURES | **Standard of living** (measured as Gross Value Added (GVA)/Gross Domestic Product (GDP)). Increased productivity[9] tends to increase consumption. Waste and exploitation are included in this. | **Quality of life** for all is prioritised over increasing personal 'standards of living'. Wellbeing and happiness are valued. |
| OUTCOMES | Unequal distribution of resources tends to increase **inequality**. Increased use of resources and energy leads to **climate** and **ecological breakdown**. | More shared wealth increases **local equality** and **reduces global exploitation**. Potential for reduced carbon emissions and **ecological impact**. |

TABLE 4 – Contrasting linear and circular economies

# 3.3 WHAT DOES SUCH A CIRCULAR ECONOMY LOOK LIKE?

While it is possible that renewable energy could power a linear economy, investing in such a system would not solve the long-term issues outlined in chapter 1. The differences between what a linear economy and a local circular economy could deliver in terms of the energy sector, resource use and waste, and transport sectors are explored in turn below.[10] For each sector a hierarchy of policy options is presented. The top of each triangular hierarchy (green) represents what a sufficient climate emergency response might entail and where attention should be focused in promoting circular economy solutions. The bottom (red) areas represent business-as-usual policies from the linear approach. Renewables, recycling and EVs are shaded from green to red as these are technology-led solutions that can fit within either vision.

## KEY PRINCIPLES FOR A 100% RENEWABLE ENERGY SYSTEM

- Massive reduction in energy use for heat, transport and electricity through personal demand reduction and energy efficiency (including insulation of existing homes and buildings, so all can be provided by renewables).
- Scale-up mix of renewables to generate more electricity, in a decentralised way combined with energy storage.
- No fossil fuel used for electricity, heat or transport.
- Design energy system with co-benefits across all sectors.

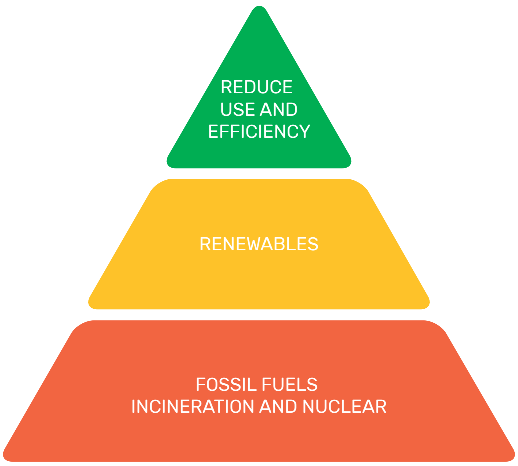



FIGURE 5 – **Energy generation and use**

## A ZERO-CARBON PLAN FOR ZERO WASTE

- Shift investment to reduce-reuse-share-recycle to create local jobs, save carbon and strengthen local communities and culture. Should apply to councils, business and construction waste.
- Avoid incineration. This increases the carbon intensity of electricity and blocks zero waste investment.
- Focus 'beyond waste' – to address consumption emissions.
- Design waste system with co-benefits across all sectors.

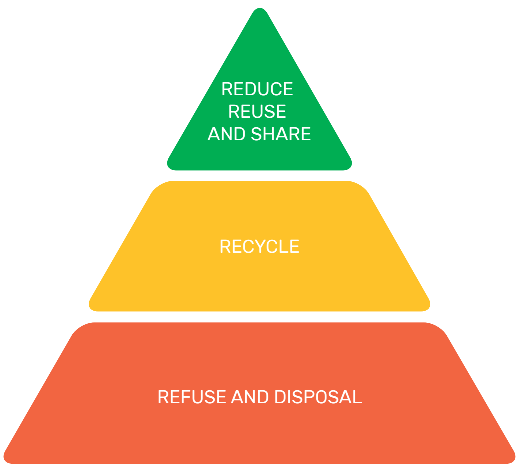



FIGURE 6 – **Resource use and waste**

# TRANSFORMING THE ECONOMY WILL REQUIRE A SHIFT AWAY FROM PROVIDING EVER MORE INFRASTRUCTURE FOR GROWTH

## A PLAN FOR ZERO-CARBON TRANSPORT

- Stop making things worse: halt investment in new roads and airport expansion, and plan development to be less car-dependent.
- Focus measures on traffic and congestion reduction by providing infrastructure and services to enable modal shift (to public transport, walking and cycling).
- Plan for co-benefits (e.g. air pollution and climate change).
- Embed zero-carbon transport in broader planning activities.
- Provide a level playing field for rail- and water-borne freight to reduce the monopoly of road and air freight.
- Eliminate fossil-fuel vehicles.

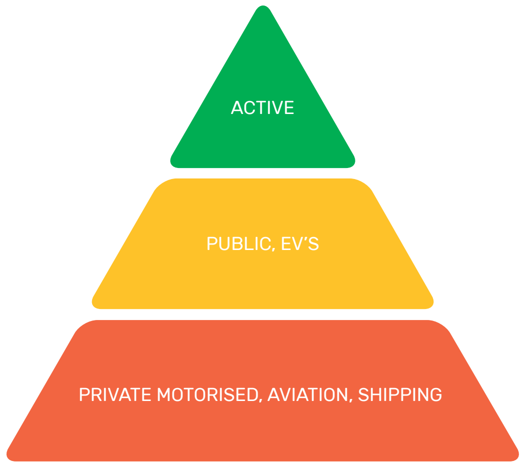



FIGURE 7 – **Transport**

## LEVEL OF TRANSFORMATION

To bring about this economy-wide transformation will require a change in investment. A shift from predicting and providing ever more infrastructure for growth (such as expanding road capacity) towards new infrastructure which makes our economy zero-carbon: primarily renewable energy production and retrofitting what we have already. This will shift us away from resource intensive investment to the creation of new livelihoods that enable us to transition from a take-make-use-throw-away culture to a local circular economy.

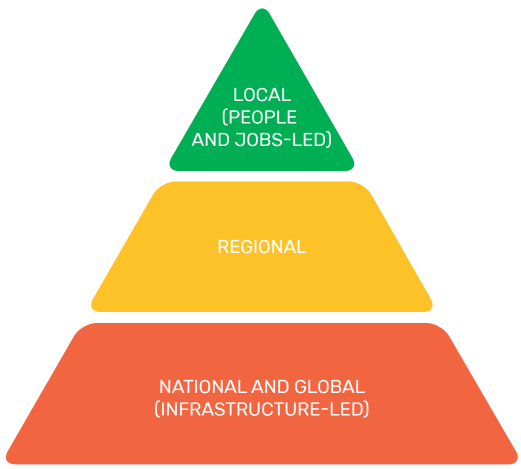



FIGURE 8 – **Level of transformation**

# 3.4 A DIFFERENT WAY FORWARD: CARBON PLANNING

Planning must make reduction of carbon emissions a priority across all sectors and provide clarity as to how national targets will deliver the transformation to zero carbon locally. This must ensure that not only is renewable energy generation increased, but also that the remaining fossil fuel use – particularly in heating, transport and the ICA sectors – is powered down to zero.

Research by Leeds University has set out a plan to address the gap between national policy and actual local emissions reduction, to inform the work of the Leeds Climate Commission (Box 6).

**THE EASTERN REGION COULD LEAD THE UK IN RAISING ITS TARGETS IN THE RUN-UP TO COP26 IN GLASGOW IN 2020**

## LEEDS CLIMATE COMMISSION: MAKING PLANS FOR STRONGER CLIMATE ACTION LOCALLY

6

Leeds Climate Commission has been set up to bring together the public and private sectors and civil society across the city to accelerate progress on climate action. The Commission is led by Leeds University and has set carbon reduction targets based on a calculation of Leeds' fair share of the science-based 'carbon budget' to limit climate change to 1.5°C. These agreed targets (with a 2005 baseline) are 85% carbon reductions by 2030 and 95% by 2035. In 2019 the Commission completed the Leeds Carbon Roadmap,[11] which sets out what is needed to deliver these reductions locally; deeper and faster than the UK. It maps the changes in national policy (particularly to decarbonise electricity) with these targets, and proposes extra effort is needed locally. This is broken down into measures that are already economically viable, those that are technically viable, and wider innovations needed, together with details of the necessary societal and individual behaviour change.

This way of looking at the climate emergency challenge could be applied in the Eastern region. Assuming a similar energy mix and viability:

- AROUND 50% OF REDUCTIONS NEEDED, over and above current government action, are already economically viable and include energy efficiency improvements and renewable energy deployment set out.
- A FURTHER 15% REDUCTION REQUIRES STRATEGIC EFFORTS i.e. councils, LEPs and government taking a planned approach in the region to deliver carbon reductions that are technically feasible but currently more expensive than the status quo, such as a deep retrofit of all buildings or the transformation of transport behaviour from car-dominant to public transport and active travel. This requires government policy support and significant public sector investment as well local capacity and widespread buy-in from the public.
- THE FINAL THIRD OF REDUCTIONS REQUIRES A TRANSFORMATION IN HOW WE LIVE AND WORK**,** such as making all buildings carbon neutral and higher ambition on demand reduction through behaviour change, which will be a crucial part of the shift to a zero-carbon region. The Leeds roadmap highlights the need to extend emission reductions beyond locally-produced emissions to include our travel and consumption emissions.

This change is needed now. Without this extra effort locally Leeds estimates that it will use its entire carbon budget within the next nine years. The Leeds University team has completed similar reduction pathways for other areas across the UK, similarly highlighting the need for local and regional plans for action.

The Eastern region could play a key role in linking global targets and national ambition to subnational, regional and local actions to meet the climate emergency. Yet, as noted in chapter 2 above, the region's current response to the climate emergency (including plans by the three LEP energy strategies) lacks sufficient ambition and coordination. What if, instead, the region as a whole matched the demand of those local councils that have already declared a climate emergency (Map 2) and raised its ambition? The Eastern region could lead the UK in raising its targets in the run-up to COP26 which will be hosted by the UK in Glasgow in 2020. A plan for the primary sectors of direct emissions in the region – domestic, homes and ICA – is outlined in the next chapter.

1 National Grid, *Future Energy Scenarios* (July 2019), http://fes.nationalgrid.com/fes-document/
2 For example, see https://evbox.com/uk-en/learn/faq/how-does-smart-charging-work
3 Vehicle-to-grid is where EVs have the capability to interact with the power grid, either by storing energy from or returning it back into the system, or by limiting their charging patterns as required in response to demand levels.
4 National Grid, *Future Energy Scenarios* (July 2019).
5 Centre For Alternative Technology (CAT), *Zero Carbon Britain: Rising to the Climate Emergency* (November 2019), www.cat.org.uk/info-resources/zero-carbon-britain/research-reports/zero-carbon-britain-rising-to-the-climate-emergency/
6 Only technologies that do not involve burning fuels are listed here.
7 CAT, *Zero Carbon Britain: Rising to the Climate Emergency*.
8 Simms, A., & Newell, P., *How Did We Do That? The Possibility of Rapid Transition* (April 2017), https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/12973/How_Did_We_Do_That.pdf?sequence=1
9 Commonly considered as GDP/hour worked. This is maximised when it is not just made up of labour but also material and energy costs, increasing overall resource use. HM Treasury, *Fixing the Foundations: Creating a more prosperous nation* (July 2015), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/443897/Productivity_Plan_print.pdf
10 The resource and waste plan is drawn from Webb, J. and Essex, J., *A Zero Carbon Plan for Zero Waste* (September 2019), www.greenhousethinktank.org/uploads/4/8/3/2/48324387/zero_carbon_means_zero_waste_14sept19.pdf. The transport vision is summarised from Joseph, S. and Todd, C., *A Climate Emergency Plan for Transport* (September 2019), www.greenhousethinktank.org/uploads/4/8/3/2/48324387/climate_emergency_plan_-_transport_sjoseph_14sept19-printed.pdf
11 Leeds Climate Commission, *A Science-based Carbon Budget, Carbon Targets and Carbon-Roadmap for Leeds* (April 2019), www.leedsclimate.org.uk/sites/default/files/Leeds%20Carbon%20Roadmap%20v4.pdf

# ZERO CARBON EAST: AN ILLUSTRATIVE MODEL

In chapter 1, a carbon budget for the Eastern region was introduced alongside an overview of historic trends in emission reductions, and the necessary future emission cuts to meet a Paris-aligned target. The ideas introduced in the previous chapters are now combined to provide a simple illustrative model for decarbonising at a regional level the three main energy sectors reported by government: domestic, transport and ICA. As previously noted, this is only an estimated 54% of total emissions, since aviation, shipping and consumption emissions are not considered.

## 4.1 CARBON FOOTPRINTS TO 2030

This section looks at the breakdown of the BEIS reported carbon footprints for the main energy sectors of domestic, transport and ICA. First, emissions cuts made during the last 15 years are examined. As this is only an illustrative model, there are various assumptions and limitations, which are explained along the way.

A first limitation is that in Table 5 below, only road transport is considered, because it is by far the biggest transport emitter, while diesel rail and domestic aviation are omitted because they have relatively small footprints.

BEIS land-use emissions data is also not included. Although natural climate solutions such as peat restoration and rewilding have significant potential in the region, they lie outside the scope of the distributed renewable energy system that is the focus of this study, and would be better treated as part of a study of land use, agriculture and forestry. However, while they are not the focus here on this occasion, they are not unimportant, and it is imperative that they are rapidly developed in the Eastern region to maximise the contribution of negative land-use emissions (i.e. natural carbon sink projects) to overall carbon targets, and to counterbalance any sectors that present particular barriers to decarbonisation.

## FAILURE TO REDUCE EMISSIONS IN THE TRANSPORT SECTOR HAS EXACERBATED THE EMERGENCY

The energy TWh for each sub-sector is provided where a straightforward conversion from $MtCO_2$ is possible.[1]

In general, national trends in the decarbonisation of electricity, since 2005, have enabled significant reductions for the electricity element of domestic and ICA carbon footprints, as shown in Table 5 below.

For the Eastern region energy system to reach genuine zero emissions by 2030, it needs to meet and overcome several substantial challenges, in particular the following:

- TRANSPORT EMISSIONS ARE A NATIONAL CRISIS; this is true in the Eastern region as elsewhere. Transport emissions have continued to grow since 2005 and this reflects major policy failures by recent governments. Since other sectors also need to decarbonise their processes, we cannot expect to balance out excessive transport emissions by finding capacity in the budgets of other sectors. The failure to reduce emissions in the transport sector has seriously exacerbated the climate emergency. This can only be remedied by a very tough set of policy interventions, in particular to deliver a modal shift away from private car use. While there will be a role for EVs in decarbonising transport, it is limited.
- THE NEXT BIGGEST FOOTPRINT IS THE 8.16$MtCO_2$ CURRENTLY EMITTED FROM GAS POWER AND HEAT IN THE DOMESTIC AND ICA SECTORS. The 29.3TWh of gas used in domestic properties is a key challenge: this requires a mass retrofitting programme of deep insulation first, and then installation of heat pumps to replace existing gas heat and hot water. A further 0.87$MtCO_2$ for oil heated properties needs to be addressed in a similar way.
- THE REMAINING 6.68$MtCO_2$ EMISSIONS FROM ELECTRICITY (19.01TWh AT 2017 CONVERSIONS) in the domestic and ICA sectors have to be eliminated by full decarbonisation of supply via the distributed energy system proposed in this report. However, demand for electricity will be increased by two main factors: transitioning to EVs and transitioning to heat pumps to replace fossil fuels in space heating. The government projections of the grid carbon factor (Table 8) already show very significant decarbonisation of electricity by 2030. But this needs to be intensified, and then a smart, local, distributed renewable electricity grid needs to follow.
- THERE REMAINS A FURTHER 2.71$MtCO_2$ IN ICA TO DECARBONISE IN THE "LARGE", "OTHER" AND "AGRICULTURAL" SUB-SECTORS. Some of this will be from the point sources identified in chapter 1: food and drink; cement and minerals; paper and textiles; and chemicals. These require very specific approaches to reducing emissions that do not fit under the broad policy interventions of the model below, so they cannot be addressed in the scope of this report. Nonetheless, they also require urgent attention.

| SECTOR | SOURCE | 2005 $MtCO_2$ | REDUCTION | 2017 $MtCO_2$ | 2017 TWh |
|---|---|---|---|---|---|
| Domestic | Electricity | 6.30 | -56.17% | 2.76 | 7.86 |
| Domestic | Gas | 6.57 | -17.74% | 5.40 | 29.34 |
| Domestic | Other (oil) | 1.19 | -26.82% | 0.87 | 4.74 |
| Transport | Roads | 14.05 | +0.17% | 14.08 | 45.98 |
| ICA | Large | 1.16 | -54.76% | 0.53 | -[2] |
| ICA | Other | 2.50 | -26.83% | 1.83 | - |
| ICA | Agriculture | 0.45 | -20.16% | 0.36 | - |

**TABLE 5 – Historic reductions and increases in national subsectoral emissions between 2005 and 2017 ($MtCO_2$)**
(Source: BEIS, 2019)

# 4.2 POLICY INTERVENTIONS FOR FAST TRACKING DECARBONISATION

In this section, a set of policy interventions are modelled together to deliver the emission reductions outlined above. These are illustrative, but indicate the scale of response needed to tackle the climate emergency. It is important to understand that different parameters (such as the number of homes to retrofit) may be applied to the data to produce different scenarios; here just one possible pathway is explored.[3] Further, this policy set is not exclusive, and in reality will be augmented by some of the approaches described in the previous chapters, especially from the Zero Carbon Britain model.

The key point is to demonstrate that zero carbon by 2030 is possible, that each of these policy interventions exists today and simply needs to be applied at scale to reach full (or close to full) decarbonisation within a decade. The model front-loads the policies to start this journey quickly. This is consistent with the 13.5% overall emission reductions required per year from the SCATTER model, and the UNEP report of 7.6% global reductions. The emissions descent must be rapid and steep if it is adequately to address our urgent predicament. Each of the sectors (domestic, transport, ICA) is explained in turn.

## DOMESTIC GAS AND OIL

In 2017, domestic gas use had a carbon footprint of 5.4Mt$CO_2$, and domestic 'other' (effectively oil) 0.87Mt$CO_2$ (Table 6). Together, the demand currently provided by fossil fuels is over 35TWh of energy, using standard conversions.

| SOURCE | 2017 Mt$CO_2$ | 2017 TWh |
|---|---|---|
| Electricity | 2.76 | 7.86[4] |
| Gas | 5.40 | 29.34[5] |
| Other (oil) | 0.87 | 4.74 |

TABLE 6 – Domestic sector emissions breakdown (2017)

To start with, we should eliminate these 6.27Mt$CO_2$ with two complementary policies as follows:

### POLICY DOM 1 – INSULATION

A deep insulation programme of homes in the region would aim to eliminate 80% of heat demand, starting with the lowest energy-rated properties, and those in the most deprived areas to tackle fuel poverty.[6] A key element is assessing the homes carefully to prioritise the biggest energy savings, and those that are most socially beneficial. Out of nearly 2.6 million homes, half need to have their insulation upgraded to the highest standards and the roject would be front-loaded with 156,000 homes insulated in 2020, decreasing year on year to 104,000 in 2029. This measure would, by itself, remove more than 40% of the fossil fuel-powered heat demand in homes across the region.

### POLICY DOM 2 – HEAT PUMPS

A mass transfer of the remaining home heat requirements can be made by rapidly replacing fossil fuel heating and replacing it with air- and ground-source heat pumps. 1.5 million homes would cease to be heated by fossil fuels, and again this would be front-loaded with 180,000 homes in 2020, decreasing to 120,000 homes in 2029. Identifying and prioritising suitable homes is key, first the homes with the best insulation first, and those that do not require additional insulation. By the end of the decade this will have removed nearly all the remaining 60% of the demand for fossil fuel-based heat.

The reduction of $CO_2$ by these two policy interventions is shown in Figure 9 with the historic record for domestic gas and oil emissions from 2005. The rapid emissions descent is clear.[9]

The (light green bars for heat pumps) indicate energy that is transferred from fossil fuel. A small proportion of this demand will be transferred to electricity (to power the pumps) while the rest is simply demand that has been eliminated by the use of ground-source heat instead. By contrast, the yellow bars show heat demand removed by insulation.

However, it is now apparent that some 2.60TWh of new electricity is required to drive the installed heat pumps, so by 2029, 10.46TWh of fully decarbonised electricity will be needed from the distributed grid to meet the domestic demand. In order to address this new additional demand for power, one future domestic policy is required, namely rooftop solar panels:

POLICY DOM 3 – ROOFTOP SOLAR

The installation of rooftop solar PV on 1.5 million homes[8] will generate 2.68TWh of zero-carbon electricity.

Together these three domestic policies leave a residue of 7.78TWh required for domestic electricity, which will continue to be supplied from the grid, partly for the existing electricity demand and partly for the new demand to run

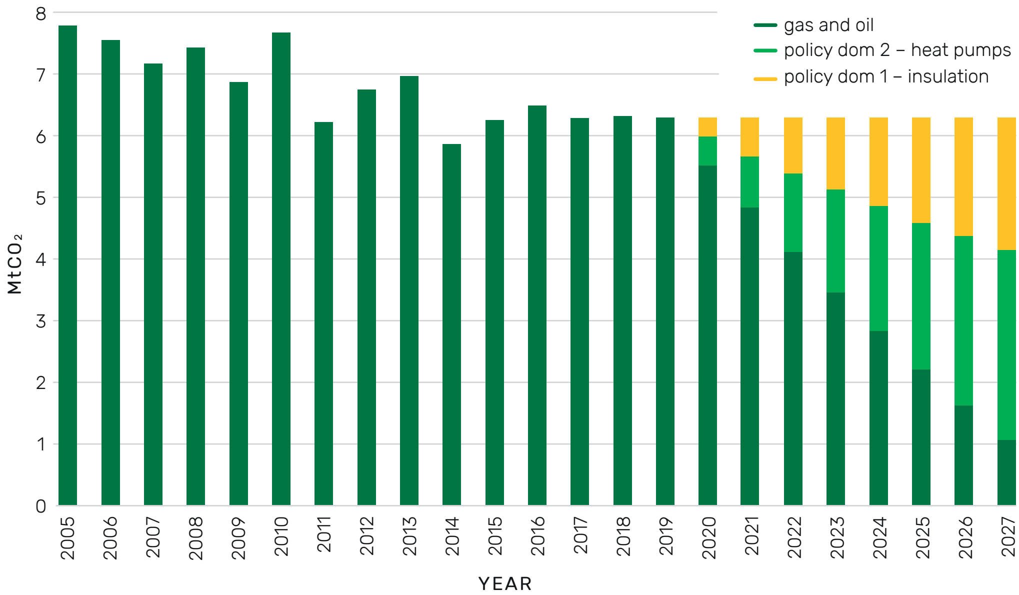



**FIGURE 9 – Historic domestic sector emissions and two policy interventions to reduce carbon footprint ($MtCO_2$)**

| ENERGY SOURCE | 2017 TWh | 2029 TWh | 2017 $MtCO_2$ | 2029 $MtCO_2$ | POLICIES APPLIED |
|---|---|---|---|---|---|
| Gas | 29.34 | 0 | 5.40 | 0 | 1. 1.3million deep insulations |
| Other (oil) | 4.74 | 0 | 0.87 | 0 | 2. 1.5million heat pumps |
| Electricity (remaining) | 7.86 | 7.86[7] | 2.76 | – | – |
| Electricity (heat pumps) | 0 | 2.60 | 0 | – | – |
| Electricity (sub-total) | – | 10.46 | – | – | – |
| Electricity (total after solar PV) | – | 7.78 | – | Depends on grid decarbonisation (see below) | 3. Rooftop solar PV (2.68TWh) |

**TABLE 7 – Moving domestic sector emissions to zero by 2030**

the heat pumps. Thus any remaining carbon footprint from this residual domestic demand will depend on the level of grid decarbonisation. This is measured by the grid carbon factor. In 2019, BEIS published its *Updated Energy and Emissions Projections* (EEP) 2018,[9] and Table 8 below shows the remaining domestic carbon footprint at government projected EEP 2018 grid factors for 2030 and 2035.

Together, the three domestic policy interventions above reduce the current domestic footprint of 9.03Mt$CO_2$ to less than 1Mt$CO_2$ in 2030, assuming conservative government projections for emission factors and decarbonisation of electricity. However, for full decarbonisation, we must remove further carbon from the system. It is only with these two further 'stretch actions' that we could bring the footprint closer to zero:

- STRETCH ACTION 'A': MORE RAPID ELECTRICITY DECARBONISATION THAN THE EEP. It is worth noting that the EEP in 2017 and 2018 differed by a significant factor, showing projections for the 2030 grid factor about 20% better in the 2018 projections than in the 2017 projections.[10] This reflects the fact that renewable energy is currently replacing fossil fuels more rapidly than expected. This trend can and should be accelerated, and the Eastern region is in a particularly good position to contribute to the acceleration of this progress, given its abundant natural resources for renewable energy. Consequently it is reasonable to require the Eastern region to adopt 'stretch targets' calculated to reduce the grid carbon factor more quickly than the EEP. As well as stretching delivery of distributed, local renewable energy, the more rapid power-down of fossil fuel infrastructure such as gas power stations is vital. The distributed energy smart grid proposed here, with integrated storage resources (Box 7) and peer-to-peer energy trading will facilitate more optimal balancing of the grid for peaks and troughs in supply, and the earlier closure of old fossil fuel infrastructure.
- STRETCH ACTION 'B': ADDITIONAL DECARBONISATION FROM THE ROLLOUT OF FLEXIBLE, DISTRIBUTED, SMART GRIDS (Box 8) in the Eastern region. These systems accrue additional benefits in terms of energy storage, flexible distribution of renewable energy, optimising balance of supply and demand in a local energy market, and have the potential to further reduce the carbon footprint of the electricity system (i.e. reducing the above grid carbon factor more rapidly than the EEP).

| GRID CARBON FACTOR kg$CO_2$e/kWh | 7.78 TWh DOMESTIC ELECTRICITY REMAINING Mt$CO_2$ | PROJECTION SCENARIOS |
|---|---|---|
| 0.085 | 0.66 | EEP 2018 for 2030 |
| 0.041 | 0.32 | EEP 2018 for 2035 |
| 0 | 0.00 | With stretch actions (date unspecified) |

TABLE 8 – Domestic carbon footprints at government projected EEP 2018 grid carbon factors

## ENERGY STORAGE

7

Energy storage at all scales is a pervasive feature of the local distributed energy network.[11] Home batteries and EVs provide storage on the domestic level coupled to either cheap peer-to-peer grid supply or domestic solar panels.

Sponsoring medium-scale storage systems is increasingly an opportunity for local authorities to take significant action on the climate emergency.[12] For example, Gateshead council has provided an award-winning area-wide heat and energy system to domestic, commercial and public sector customers: it also offers peak power generation to help balance the grid through a mixture of 3MW of battery storage[13] and combined heat and power with heat storage.[14] Warrington Borough Council is the first local authority in the UK to generate all its electricity needs from renewable sources, initially with a 34.7MW hybrid solar plant with a 27MW battery storage system:[15] the council aims to reduce its own energy bills by up to £2 million a year, as well as selling electricity to the grid.

Late in 2019, the UK's first subsidy free solar farm, 40MW with battery storage, came online in the Eastern region at Staughton.[16]

## FLEXIBLE, DISTRIBUTED, SMART GRIDS

8

The associated technical study[17] accompanying this report offers further analysis and discussion of the economic and technical advantages of a local, distributed renewable energy system. It sets out a vision for an electricity smart grid, ranging from small scale domestically produced energy with storage (in the home or by EV), through local community renewable energy (e.g. a solar farm with battery storage), and up to large scale grid resources such as offshore wind power. Peer-to-peer trading of energy[18] enables balancing of the grid at, and between, all levels of the distributed energy network. This efficiency cuts out wastage and, therefore, carbon.

The local energy system can balance local supply and demand – first-order balancing which is self-balancing – without requiring energy from regional or national grid resources. Such a grid is constantly evolving, and as time progresses the degree of resilience and local self-balancing will increase, as will the efficiency. As time goes on, the need for long distance balancing reduces until it becomes the exceptional case. A US Department of Energy (DoE) paper found that such a smart grid will in itself return quantifiable carbon reduction benefits: the paper identified nine mechanisms that would draw further carbon reductions just from the grid itself.[19]

Benefits of such a system include: enabling an enhanced renewable generation penetration into total energy supply; pervasive energy storage to reduce demand for, and eliminate, fossil fuel baseload provision; and, local resilience that reduces transmission and distribution losses.

The policy interventions described in this chapter are envisaged as being embedded within a local distributed renewable energy system, which accelerates electricity grid decarbonisation to zero. If such smart grid technology is rapidly implemented in the Eastern region, then towards the end of the decade, we may expect to see grid carbon factors reducing faster than currently projected, as in 'stretch action' B.

## TRANSPORT

We have noted above that transport is the sector that has been particularly resistant to change, and subject to serial policy failure. Yet, the necessary policy interventions for modal shift from car based journeys are well developed, and form the basis for decarbonising transport[20] in the 2019 Zero Carbon Britain scenario.[21] This is based around two key steps: demand reduction and increased efficiency.

Across all of transport (including aviation and shipping), Zero Carbon Britain policy interventions reduce the energy footprint of transport (i.e. TWh/year) by 78%. Of the sectors covered under the BEIS data, Zero Carbon Britain reduces energy by around 81%. When only considering car transport, this figure rises to 86% at the UK level.[22] It is assumed that similar scale reductions can be made in the Eastern region by applying Zero Carbon Britain policies.

The Zero Carbon Britain policies are explained in detail in Zero Carbon Britain Methodology Papers[23] and while not covered extensively here, the main areas focused on include: significant modal shift by increasing walking, cycling, and use of public transport depending on journey length. For example, transfer 50% of car journeys of one to two miles to walking (20%), cycling (15%), e-bike/scooter (10%) and bus (5%): similar modal shifts are specified for other distance ranges.

After this demand reduction stage, Zero Carbon Britain then switches most car journeys to very efficient EVs although hydrogen and other fuels may also have a small role.

Table 9 below provides an indicative model[27] for the carbon footprint in the BEIS transport sector, and particularly the car subsector of it, in the Eastern region.

Zero Carbon Britain demand reduction policy interventions are estimated to reduce the energy footprint from 46TWh/year to around 9TWh/year, of which the car sector reduces from 36TWh/year to around 5TWh/year. In 2017 above, this energy was predominantly oil based, petrol and diesel, although there was also some LPG and electricity.

At this level of demand reduction, if remaining car journeys were completely electrified, carbon emissions would be less that 500,000t$CO_2$/year on current government grid factor projections. However, as described above, further decarbonisation of electricity by stretch actions (A) and (B) could potentially reduce the car sector's emissions to zero by 2029.

We cannot overstate how important the demand reduction part is: for cars, this delivers the first 86% of decarbonisation in the Zero Carbon Britain model. The necessary policy interventions do not replace current ICE miles with EV miles: they replace most ICE miles with sustainable transport, leaving a much smaller number of vehicle miles overall.

It is also important to understand that a one-to-one replacement of ICE vehicles by EVs is not viable. There are a number of drawbacks with EVs, so the model only introduces them to a limited degree: however, the aim is to have enough of them to offer a key component in the decarbonisation project, since they provide crucial, flexible, storage nodes in a local distributed electricity grid.

| TRANSPORT SECTOR | 2017 Mt$CO_2$ | 2017 TWh | 2029 TWh | 2029 Mt$CO_2$ (GRID FACTOR 0.085) | 2029 Mt$CO_2$ (GRID FACTOR 0.041) | 2029 Mt$CO_2$ (GRID FACTOR 0) |
|---|---|---|---|---|---|---|
| Roads | 14.08 | 45.98 | 8.94 | 0.76 | 0.37 | 0 |
| Cars only | 11.14 | 36.36 | 5.16 | 0.44 | 0.21 | 0 |

**TABLE 9 – Moving road transport emissions to zero by 2030**

The drawbacks with EVs include:

- EMBODIED EMISSIONS: significant embodied carbon emissions, between 6 and 35t$CO_2$ per vehicle (depending on size), in the production of EVs frontloads an additional emissions cost which undermines the aim of reducing emissions;[24]
- POWER HUNGRY: significantly increased demand for electricity which would slow the overall decarbonisation of the energy supply;
- PARTICULATE POLLUTION: $PM_{2.5}$ and $PM_{10}$ pollution from EV brakes and tyres will continue to contribute to the air quality public health crisis;[25]
- CONGESTION AND ROAD SPACE: no reduction to congestion, continued need for road building, which is carbon hungry;
- NON-VIABILITY AND EXPLOITATION: a future EV market at the level of ICE vehicles today is probably unachievable and unsustainable, due to the finite reserves of crucial minerals such as lithium.[26] Also, Amnesty International has raised very serious concerns about human rights abuses and child labour in cobalt mining, in the poorest countries such as the Congo;[27]
- SLOW UPTAKE: research shows fleet turnover takes much longer than people think (20 years with 100% market share), and uptake is lagging behind government policy – the current UK market share is 2.5%, falling way short of the 3.4% target set for 2018.[28]
- DECOMMISSIONING PROBLEMS: replacing the entire fleet would also create additional complex waste problems in terms of bringing all current vehicles to end-of-life; this is an issue that needs more consideration.

On the other hand, an indigenous market in retrofitting existing ICE vehicles with electric engines and batteries might address some issues. In summary, EVs have a role, but on a much smaller scale than current government projections, so first, we must reduce demand. If EVs then provide the remainder of car journeys (around 15%), it may be viable to reach a fully decarbonised electric transport system by 2030, based on the assumptions above. Such an EV fleet could then form part of a flexible, distributed energy system providing battery storage for energy created either on the grid, or by home renewables (e.g. solar PV), for use later on the grid through intelligent energy trading.

## ICA (INDUSTRIAL, COMMERCIAL AND AGRICULTURE)

In 2017, 6.68Mt$CO_2$ was produced from gas and electricity used in the ICA sectors: this corresponds to 71% of the total (Table 10).

Most of this is used for heating and lighting buildings, and to run industrial processes. While 75% of gas demand is for space heating in commercial buildings, only 13% of gas is used for heating in industry. 76% of gas use in industry is for processing and drying.[29]
To decarbonise this by 2030, all of the space heating needs to be transferred from gas to electricity by deep building insulation and heat pumps, as for the domestic sector above. Gas use for cooking and water heating may also be transferred to electricity. This leaves the use of gas for processing and drying in industry which would need to be addressed in detail in a separate more extensive study of the ways to decarbonise industrial production.[30] These measures taken together, and delivered by rapid programmes, on a similar scale to those described above for the domestic sector, can reduce much of the 2.76Mt$CO_2$ footprint for gas, by 2030.

Roofs of commercial and industrial buildings offer significant potential for solar PV array installation on a larger scale than homes. These should be built with battery storage and connected to the distributed, smart grid where possible. The installation of roof mounted solar PV arrays at an average 40KW rating on 200,000 industrial and commercial buildings (from an estimated 232,000 in the region) will generate an estimated 3.78TWh/year. The remaining electricity can be decarbonised in line with the remaining domestic sector electricity, as explained above. Here, as there, the result will depend on the grid carbon factor in 2030.

| ENERGY SOURCE | 2017 Mt$CO_2$ | 2017 TWh |
|---|---|---|
| Electricity | 3.92 | 11.15 |
| Gas | 2.76 | 14.97 |
| Large | 0.53 | - |
| Other | 1.83 | - |
| Agriculture | 0.36 | - |

**TABLE 10 – ICA sector emissions breakdown (2017)**

# 4.3 CONCLUSION

To be effective this plan must empower citizens and communities, and impel both the public and private sectors into action. This means that a plan such as this cannot just be adopted by councils, but should be 'owned' by all. One way to achieve this is by engaging the public in direct democracy, such as through climate citizen assemblies or juries. For example, the Big Leeds Climate Conversation found that overall public opinion in the city was in favour of citywide retrofit of homes, and public ownership of buses, while being opposed to airport expansion.[31] But above all, this engagement will come from actioning targets, securing funding, and implementing plans that can realistically deliver the outcomes. This challenge underpins the next chapter.

1 The 2017 conversion factors from BEIS have been used www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017

2 These sub-sectors are not analysed further in this illustrative model, as they would require a further, more extensive study. For example, energy for processing and drying in industry would need to be addressed in detail in a separate, more extensive study of the ways to decarbonise industrial production.

3 A model with very similar interventions, but different configurations of scale, is presented in the companion technical document to this report. Hargreaves, N. and Gough, S., *A Green Energy Future for the East of England* (January 2020)

4 Emission factor 0.35156 used from BEIS, "Greenhouse gas reporting: conversion factors 2017" www.gov.uk/government/uploads/system/uploads/attachment_data/file/635632/Conversion_factors_2017_-_Condensed_set__for_most_users__v02-00.xls

5 Emission factors 0.18416 for gas and 0.2466 for oil used from BEIS, "Greenhouse gas reporting: conversion factors 2017" www.gov.uk/government/uploads/system/uploads/attachment_data/file/635632/Conversion_factors_2017_-_Condensed_set__for_most_users__v02-00.xls

6 For example, the 'whole house' retrofit approach pioneered by *Energiesprong* (energy leap), successful in the Netherlands and in a pilot scheme in Nottingham: www.energiesprong.uk/

7 Remaining domestic electricity use in 2029 assumed to be same as 2017.

8 Efficiency of solar PV increases each year, and under the latest published load factors, we would only need 1.42 million for this part of the model (6% reduction). UK Government, *Quarterly and annual load factors* (October 2019, updated December 2019), www.gov.uk/government/publications/quarterly-and-annual-load-factors

9 BEIS, *Updated Energy and Emissions Projections* (April 2019) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794590/updated-energy-and-emissions-projections-2018.pdf

10 ICAX, "Grid Carbon Factors" (April 2019), www.icax.co.uk/Grid_Carbon_Factors.html

11 World Bank, "Four things you should know about battery storage" (May 2019), www.worldbank.org/en/news/feature/2019/05/16/four-things-you-should-know-about-battery-storage

12 LocalGov, "Are local authorities the new power players in the energy market?" (May 2019), www.localgov.co.uk/Are-local-authorities-the-new-power-players-in-the-energy-market/47497

13 The Energyst, "Centrica to use Gateshead Council's 3MW battery storage system for both local and national grid balancing" (September 2017), https://theenergyst.com/centrica-to-use-gateshead-councils-3mw-battery-storage-system-for-both-local-and-national-grid-balancing/

14 Gateshead Council, Gateshead District Energy Scheme, www.gateshead.gov.uk/article/2993/Gateshead-District-Energy-Scheme

15 Energy Live News, "UK council to generate all its power needs from renewables" (February 2019) www.energylivenews.com/2019/02/28/uk-council-to-generate-all-its-power-needs-from-renewables/

16 Edie, "UK's largest subsidy-free solar farm powers up" (December 2016), www.edie.net/news/10/UK-s-largest-subsidy-free-solar-farm-powers-up/

17 Hargreaves, N. and Gough, S., *A Green Energy Future for the East of England*

18 Hargreaves, N. "Paving a way for user-centric energy service system design" (March 2019) www.linkedin.com/pulse/paving-way-user-centric-energy-service-system-design-hargreaves-?articleId=6512294660009000960

19 US Department of Energy, *The Smart Grid: An Estimation of the Energy and $CO_2$ Benefits* (November 2010) www.smartgrid.gov/files/The_Smart_Grid_Estimation_Energy_CO2_Benefits_201011.pdf

20 CAT, Zero Carbon Britain.

21 *Ibid.*

22 *Ibid.*

23 *Ibid*. The Zero Carbon Britain model notes the difficulties in decarbonising HGVs and other heavy commercial vehicles (tractors and diggers, for example), but foresees these being powered by a mixture of electricity (50%), carbon neutral synthetic liquid fuel (30%), and hydrogen (20%) by 2030. Rail freight also doubles as around 30% of road freight is switched

24 Recent research and reports indicate that the full lifecycle carbon emissions for EVs are around 50% of equivalent ICE vehicles. Most of this comes from embedded emissions in the manufacture of the vehicle and crucially the battery itself (which is carbon intensive), some comes from running on fossil fuel based electricity. Most of the full lifecycle carbon footprint comes in Year 0. For example, an EV coming onto the road in 2025 may produce on average a 15t$CO_2$ 'burp' in 2025, although total emissions may be less up to 2045 (20-year lifetime) that an ICE equivalent. Fleet electrification therefore creates a big carbon footprint at outset just when there is urgent need to reduce emissions at the outset. (Sources: www.carbonbrief.org/factcheck-how-electric-vehicles-help-to-tackle-climate-change; www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-full-report.pdf)

25 UK Government, Brake, tyre and road surface wear call for evidence: summary of responses (July 2019), www.gov.uk/government/consultations/air-quality-brake-tyre-and-road-surface-wear-call-for-evidence/outcome/brake-tyre-and-road-surface-wear-call-for-evidence-summary-of-responses

26 Forbes, "Electric Vehicles Are Driving Demand For Lithium - With Environmental Consequences" (June 2019), www.forbes.com/sites/jamesellsmoor/2019/06/10/electric-vehicles-are-driving-demand-for-lithium-with-environmental-consequences/

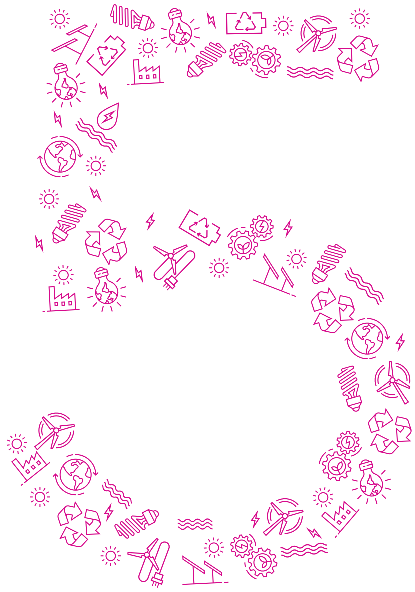
27 Amnesty International, "Industry giants fail to tackle child labour allegations in cobalt battery supply chains" (November 2017), www.amnesty.org/en/latest/news/2017/11/industry-giants-fail-to-tackle-child-labour-allegations-in-cobalt-battery-supply-chains/

28 CCC, *Progress Report to Government* (July 2019), www.theccc.org.uk/wp-content/uploads/2019/07/CCC-2019-Progress-in-reducing-UK-emissions.pdf

29 National Grid (2019)

30 However, there are some interesting developments that could offer significant reductions in this area. The European DryFiciency project, for example, is developing new heat pump technology that can use waste heat from industrial processes to power industrial scale heat pumps https://cordis.europa.eu/article/id/125300-new-heat-pump-technologies-for-industrial-drying Additionally, system efficiencies (such as reduced over-drying of products, or improving the thermal efficiency of processes) could also deliver energy savings in this area

31 Climate Emergency UK, "Leeds Citizen's Jury Recommendations Published" (November 2019), www.climateemergency.uk/blog/leeds-citizens-jury-recommendations-published/



# MAKING IT HAPPEN: DELIVERING A LOCAL CIRCULAR ECONOMY

The modelling undertaken in the preceding chapters demonstrates that it is possible to achieve decarbonisation in the domestic, transport and ICA sectors, using readily available technology and resources. How to take these figures and turn them into an implementable plan is the focus of this chapter.

## 5.1 NATIONAL LEVEL INTERVENTIONS

It is clear that a number of steps are required at the national level to shift attention away from targets and towards implementation. Indeed, the UK government must now take urgent action to ensure that (a) its decarbonisation target is sufficient, (b) it includes the full impact of the full range of consumption and production activities, (c) that this target is seen as a minimum – to be either met or exceeded by 2030 – and (d) that it does not rely on non-existent or risky technologies.

But in order to deliver full and genuine decarbonisation in the Eastern region, we must have a very different approach to the economy and regional strategic planning, and a clear commitment to a just transition. We propose that the key element to these developments is to reframe planning, government and business action, and the economy locally.

# 5.2 THE CIRCULAR ECONOMY: ALIGNING MATERIAL FLOWS AND THE CLIMATE EMERGENCY

Any model for the Eastern region must recognise that, despite our bountiful sources of renewable energy, there is a limit to the growth of the region. Future sea level rise will mean that our region gets physically smaller; a (likely) increased population will be living in a smaller space, relying on an agricultural system that is rapidly wearing itself out (the UN's Food and Agriculture Organisation estimates that we have about 60 years of harvests left under current farming practices). Globalisation has apparently removed the barriers on human expansion, delivering unprecedented opportunities for travel and development. But the globalisation that would have us believe we can continue to consume as if the world would never end is the cause of our current predicament, and cannot be sustained. As the example of the Leeds Climate Commission in chapter 4 showed, we must adopt an approach, locally, that relies on the principle of sufficiency, to ensure that we do not produce more than the Earth can bear.

Delivering this within the region in practice means resources must be distributed and reused in the most efficient manner possible; the technical companion document to this report lays out how to achieve that for energy via a distributed renewable energy system.

Critically, creating a sustainable economy in the Eastern region also means accepting that the infrastructure that sustains this should stop getting bigger. This will be anathema to those who currently direct our economic, energy and even environmental strategies in local government and the LEPs. Their approach has hitherto been one that believes big infrastructure is the way to ensure prosperity for the region.

Yet there is another way. Shifting to zero carbon will require the development of local supply chains, skills and new enterprises, which can all deliver local benefits from the circular system to jobs, communities and businesses. Taking steps to relocate jobs and production of resources, to embed them within the local communities across the Eastern region, is a huge enabler for our target of reaching zero carbon in a decade (as it will reduce the need for carbon-intensive transport) and at the same time it will re-energise local economies. Recent research by Greenhouse Think Tank explores the scale of the challenge in shifting to zero carbon across the Eastern region.[1] Their conservative estimates are that some 607,000 full-time person-years of employment would be required to transition the region to zero carbon, and that that zero-carbon economy would then sustain at least 39,300 new jobs into the long term.[2] The jobs would include retrofitting and maintaining buildings and jobs that allow us to use products for longer (e.g. repairing, rehabilitating, refurbishing, reusing, sharing).

To maximise the benefits of this jobs boost, local authorities across the region could apply the lessons of the 'Preston Model'. This proved how a local economy is strengthened by investing in the local supply chains of key local economic 'anchors' (Box 9). For example, this could include scaling up and replicating local energy co-ops and utilising renewable energy sites across the Eastern region. Applying this approach to the deep retrofitting of buildings would mean establishing local supply chains, including offsite manufacturing, material production and supply and installation across the Eastern region.

**THE UN'S FOOD AND AGRICULTURE ORGANISATION ESTIMATES THAT WE HAVE ABOUT 60 YEARS OF HARVESTS LEFT UNDER CURRENT FARMING PRACTICES**

## USING ANCHOR INSTITUTIONS TO STRENGTHEN LOCAL ECONOMIES: THE PRESTON MODEL

9

The Centre for Local Economic Strategies (CLES) worked in Preston to help localise the procurement of 12 'anchor institutions'[3] to existing local cooperatives and businesses. Initial analysis, prior to intervention, showed that of £450m spent on procurement by these organisations, 95% was spent outside of Preston and 61% spent outside of Lancashire. The project redirected the procurement opportunities to a variety of local suppliers (smaller enterprises, community organisations, cooperatives and municipal ownership) while ensuring recruitment focused on lower income areas and paid at least the living wage. The result was a revitalisation of the local economy.[4]

This followed CLES's evaluation of a scheme in Cleveland, Ohio, where newly established local cooperatives bid for local service contracts for local anchor institutions and created over 200 jobs for those living in nearby deprived areas. Similarly, Manchester City Council's local procurement principles have led to 86.5% of its spending with its top 300 suppliers being retained in the Greater Manchester area, supporting 5225 local jobs. Emphasis in this approach was placed on "building larger multipliers by nurturing the growth of dozens of independent yet interconnected small businesses owned by local residents, and to foster local purchasing of locally produced goods and services."[5] This is referred to as building 'community wealth'.

## 5.3 BETTER OUTCOMES: REVITALISING LOCAL ECONOMIES AND INCREASING COMMUNITY OWNERSHIP

Our current energy system is wasteful and heavily reliant on significant energy imports into both the UK and into the Eastern region. An estimated 6.3% of the Eastern region economy is spent on energy and fuel bills: a total of £11.4 billion in 2015.[6] Contrasting data on the renewable generation and power stations across the Eastern region[7] with the region's energy balance shows that around 16% of this energy is generated locally.[8] This means that the current energy system is not just unsustainable in terms of fossil fuel use and carbon emissions, but also tends to leak money out of local economies across the region. Redirecting economic development to invest in establishing a 100% renewable energy system would retain money within the local economy.

Local economies will be strengthened by the *nature* as well as the scale of the investment required to bring about this transition. For example, community-owned wind projects have led to much greater benefits to the local economy as well as increased levels of investment, as highlighted in Box 10 below.

With investment in a renewable-powered local circular economy, there is no need or place for investment in massive new centralised energy generation hubs such as at Sizewell, Bradwell or the gas-fired power stations at Little Barford, Coryton or Great Yarmouth to support livelihoods in the region.

## COMMUNITY WIND ENERGY: ACCELERATING INVESTMENT AND MAXIMISING LOCAL BENEFITS

**10**

A report commissioned by the then Department of Energy and Climate Change found that "community-owned renewable energy projects give 12–13 times more value to communities and local areas than those which are privately owned, through more jobs and investment returns staying locally."[9] Recent research reviewing a range of studies found that local economic benefit is highly dependent on local procurement and ownership.[10] Local ownership, such as co-operative models, deliver greater local economic benefits, including access to more affordable energy, and can increase local support for renewable installations. Research in Denmark found that community ownership of onshore wind led to a dramatic increase in investment in renewables,[11] and no central power plant has been built in Denmark for over 20 years.

## 5.4 REBALANCING THE ECONOMY AND DELIVERING A JUST TRANSITION

If driven by the concept of a local circular economy, accelerating the transition to zero carbon across the UK, including in the Eastern region, could redirect investment from London and other large cities. This is the reverse of what is currently taking place. Many parts of the UK have weak local economies with flow of resources and skilled labour draining out towards the cities, particularly London. The UK has experienced increasing regional inequality since the 1970s, and now has one of the highest levels of inequality in Europe, around 50% less equal than similar sized economies such as France and Germany.[12] Yet London and other city-centred growth is still driving this uneven economic development. In contrast, creating the 'climate jobs' needed to transition to zero carbon could redirect economic development away from London to rural areas and help to rebalance the UK economy by reducing regional and local inequality.[13]

Redirecting our economy to be more of a local circular economy should also reduce local inequalities. Localise West Midlands found that a more localised economy also tends to have more small enterprises and local ownership, increasing efforts by the workforce and local communities to tackle social exclusion.[14] Meanwhile, CLES found that continued investment in community enterprises and assets should increase the inclusiveness of a local economy.[15]

Achieving such outcomes to address inequality must be driven by political will. This is behind the concept – increasingly championed by activists – of a *just transition* to ensure employment losses in the old carbon industries do not leave people worse off, but in fact improve quality of life. Planning for the transition should therefore include partnering with local colleges for training as well as the creation of municipal energy companies, decarbonisation of anchor institutions and greening their supply chains, and enabling community ownership of new institutions (using co-operative, co-production and community involvement in decision-making).[16]

**MORE LOCALISED ECONOMIES TEND TO HAVE MORE SMALL ENTERPRISES AND LOCAL OWNERSHIP**

# 5.5 MAKING IT HAPPEN

Never before has humanity faced such a challenge. Our current economic systems and governance – or lack of it – are not only ill-equipped to deal with the climate and ecological crisis, they are contributing factors, pursuing, to quote Greta Thunberg, "fairytales of eternal economic growth" at the expense of our planet's future.[17]

And yet change is already beginning to occur at a societal level. An increasing, and increasingly active, number of people are demanding action, at local and regional levels as much as at national or international level. Governments taking a lead could allow that energy to be directed into the transformation of our society for the better, establishing more resilient, more sustainable communities, and securing our children's future.

We have very little time, and we will need everybody. *Energising the East* offers a way forward, through high-level interventions to decarbonise the energy we use in our homes, transport and industry. There is a huge amount further to do, not least addressing emissions from land use, international travel and consumption, but, crucially, taking action now could empower our communities and catalyse the change we need.

1 Sims, P. and Essex, J., *Climate Jobs Summary: East of England* (MONTH NOT AVAILABLE 2019) https://greenhouse.chiltern.org.uk/regional_reports/Region_Climate_Jobs_Summary_v2019a_UKH.pdf
2 This is calculated over an 11-year period. It includes home retrofit but not retrofit of other buildings.
3 Organisations with significant levels of spend and local jobs that can create a defining role creating and reinforcing local economic ties, such as local authorities, universities, further education colleges, hospital trusts, and housing organisations
4 CLES, *How we built community wealth in Preston* (July 2019), https://cles.org.uk/wp-content/uploads/2019/07/CLES_Preston-Document_WEB-AW.pdf
5 Goldenberg, M. P., & Meter, K., "Building multipliers, rather than measuring them: Community-minded ways to develop economic impacts", in *Journal of Agriculture, Food Systems, and Community Development*, *8*(C), 1-12 (January 2019) https://foodsystemsjournal.org/index.php/fsj/article/view/663
6 This is the total for analysis of all local authorities in the Eastern region reported at www.pcancities.org.uk/find-your-place. This is based on local authority energy and emissions data for 2014/15, UK level emissions forecasts to 2035, and local authority population projections
7 BEIS, *Digest of United Kingdom Energy Statistics (DUKES) 2019* (July 2019), www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019
8 This is based on 11TWh of renewables generation in the Eastern region in 2017 (BEIS, *DUKES 2019*) out of the total of 68TWh used. The remainder is imported nuclear fuel, and fossil fuels for electricity generation, heating and transport fuel
9 Carpenter, P., *Community Renewable Electricity Generation: Potential Sector Growth to 2020* (January 2014), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/274746/20140108_Community_Energy_Modelling_FinalReportJan.pdf
10 Berka, A.L. and Creamer, E. "Taking stock of the local impacts of community owned renewable energy: a review and research agenda" in *Renewable and Sustainable Energy Reviews* (October 2017), www.research.ed.ac.uk/portal/files/47175758/Berka_Creamer_AAM_RSER.pdf
11 Kooij, H., Oteman, M., Veenman, S., Sperling, K., Magnusson, D., Palm, J., and Hvelplund, F. "Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands", in *Energy Research & Social Science*, *37* (March 2018) www.sciencedirect.com/science/article/pii/S2214629617303006
12 McDaniel, S. and Berry, C., *Local economic performance and development: a literature review*.Error! Hyperlink reference not valid.
13 Essex, J., *Moving Beyond Capital Centred Growth: Planning for Jobs Across the UK* (January 2018). https://gef.eu/wp-content/uploads/2018/01/GEF_UKEcoPro_article_final.pdf; and Chapman, A., Sims, P. and Essex, J. *Unlocking the Potential of Zero Carbon: Report on the case studies of United Kingdom, Hungary and the Republic of Ireland* (December 2018) https://gef.eu/publication/unlocking-the-potential-of-zero-carbon/
14 Leach (2013) cited in McDaniel and Berry, *Local economic performance and development: a literature review*.
15 CLES, *Building an inclusive economy through community business: The role of social capital and agency in community business formation in deprived communities* (October 2019) https://cles.org.uk/wp-content/uploads/2019/10/P2C-and-CLES-final-high-res-web-1.pdf
16 CLES, *CLES on Climate Emergency* (September 2019), https://cles.org.uk/wp-content/uploads/2019/09/CLESonclimate-FINAL.pdf; and IRENA, *Measuring the Socio-Economic Footprint of the Energy Transition: The Role of Supply Chains* (January 2019) www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_-Measuring_socio-economic_footprint_2019_summary.pdf?la=en&hash=98F94BCC01598931E91BF49A47969B97ABD374B5
17 Greta Thunberg, speech at UN climate summit in New York, September 2019, https://www.youtube.com/watch?time_continue=3&v=TMrtLsQbaok&feature=emb_logo

## BIOGRAPHIES

DR. KAREN BARRASS has been working on sustainability and climate issues for 18 years and has been an independent consultant since 2007. Her doctorate related to the organisational governance and policy implementation processes necessary to decarbonise the transport sector (Oxford, 2012). Karen is focused on helping to understand and deliver the institutional changes that are required to transform society to zero carbon in the next decade. Until March 2019, Karen was the air quality, transport and climate lead for Keith Taylor MEP in his South East constituency and is currently supporting Alexandra Phillips MEP, in her work on the Green New Deal. She holds an undergraduate degree in Law and International Politics (2002) and an MSc (with Distinction) in Environment and Development (2003).

DR. ANDREW BOSWELL is an independent consultant in Climate Emergency, specialising in the space where science, numerical footprinting, planning, policy and law meet. His doctorate is in molecular biophysics and protein folding (Oxford, 1981). He subsequently worked in computer science in industry (electronic circuit design, 1984–1994) and academia (high performance parallel computing, University of East Anglia, 1995-2006). For 12 years to 2017, he was on Norfolk County and Norwich City Councils. He is a dedicated campaigner and advocate for climate action, promoting local changes in plan-making, policy and infrastructure as a consultant, and specialising in legal compliance on air quality and carbon emissions.

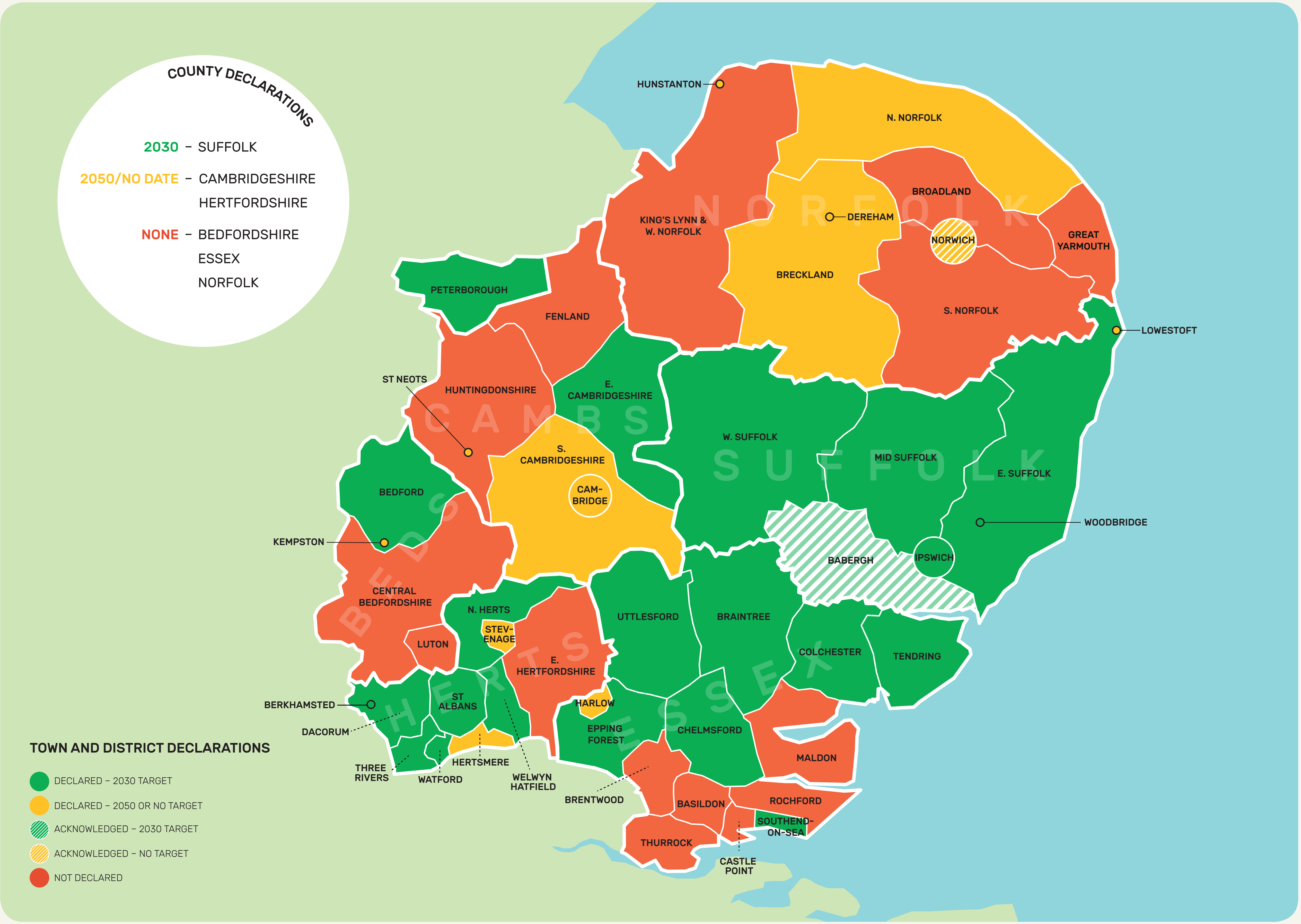
JONATHAN ESSEX is a chartered engineer and environmentalist. He has worked for engineering consultants and contractors in the UK, Bangladesh and Vietnam. This work has included developing strategies and business plans for reuse and recycling, and improving the sustainability and resilience of livelihoods and infrastructure investments worldwide. He is a member of the Green House think tank, where he has researched plans to decarbonise the UK's construction and industrial sectors, and determined the climate jobs potential of local transitions to zero carbon. He also serves as a councillor in Surrey.

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BECCS | bioenergy with carbon capture and storage |
| BEIS | UK Department for Business, Energy and Industrial Strategy |
| CAT | Centre for Alternative Technology |
| CCA | UK Climate Change Act (2008) |
| CCC | Committee on Climate Change |
| CCS | carbon capture and storage |
| CHP | combined heat and power |
| CLES | Centre for Local Economic Strategies |
| CNG | compressed natural gas |
| $CO_2$ | carbon dioxide |
| $CO_2e$ | carbon dioxide equivalent |
| COP | Conference of the Parties (to the United Nations Framework Convention on Climate Change) |
| DoE | US Department of Energy |
| EEP | Energy and Emissions Projections |
| EU | European Union |
| EV | electric vehicle |
| GDP | gross domestic product |
| GHG | greenhouse gas |
| GOEE | Government Office for the East of England |
| GVA | gross value added |
| ICA | industrial, commercial and agriculture |
| ICE | internal combustion engine |
| ILUC | indirect land use change |
| IPCC | Intergovernmental Panel on Climate Change |
| IRENA | International Renewable Energy Agency |
| LEP | local enterprise partnership |
| LULUCF | land use, land use change and forestry |
| NAEI | National Atmospheric Emissions Inventory |
| NET | negative emission technology |
| NFU | National Farmers Union |
| $PM_{2.5}$ | particulate matter (diameter less than 2.5 micrometres) |
| $PM_{10}$ | particulate matter (diameter less than 10 micrometres) |
| PV | photovoltaic |
| SR15 | IPCC's *Special Report on Global Warming of 1.5°C* |
| UK | United Kingdom |
| UN | United Nations |
| UNEP | United Nations Environment Programme |

## UNITS

| | |
|---|---|
| Gt | gigatonne |
| Mt | megatonne |
| t | tonne |
| MW | megawatt |
| TWh | terawatt-hour |


COUNTY DECLARATIONS
2030 – SUFFOLK
2050/NO DATE – CAMBRIDGESHIRE
HERTFORDSHIRE
NONE – BEDFORDSHIRE
ESSEX
NORFOLK
TOWN AND DISTRICT DECLARATIONS
DECLARED – 2030 TARGET
DECLARED – 2050 OR NO TARGET
ACKNOWLEDGED – 2030 TARGET
ACKNOWLEDGED – NO TARGET
NOT DECLARED
NORFOLK
CAMBS
SUFFOLK
BEDS
HERTS
ESSEX
HUNSTANTON
N. NORFOLK
KING'S LYNN & W. NORFOLK
DEREHAM
BROADLAND
NORWICH
GREAT YARMOUTH
BRECKLAND
S. NORFOLK
LOWESTOFT
PETERBOROUGH
FENLAND
ST NEOTS
HUNTINGDONSHIRE
E. CAMBRIDGESHIRE
S. CAMBRIDGESHIRE
CAM-BRIDGE
W. SUFFOLK
MID SUFFOLK
E. SUFFOLK
WOODBRIDGE
BEDFORD
KEMPSTON
BABERGH
IPSWICH
CENTRAL BEDFORDSHIRE
N. HERTS
STEV-ENAGE
LUTON
E. HERTFORDSHIRE
UTTLESFORD
BRAINTREE
COLCHESTER
TENDRING
BERKHAMSTED
ST ALBANS
HARLOW
DACORUM
EPPING FOREST
CHELMSFORD
MALDON
THREE RIVERS
WATFORD
HERTSMERE
WELWYN HATFIELD
BRENTWOOD
BASILDON
ROCHFORD
SOUTHEND-ON-SEA
THURROCK
CASTLE POINT

THEGREENS/EFA
in the European Parliament

Green
Party