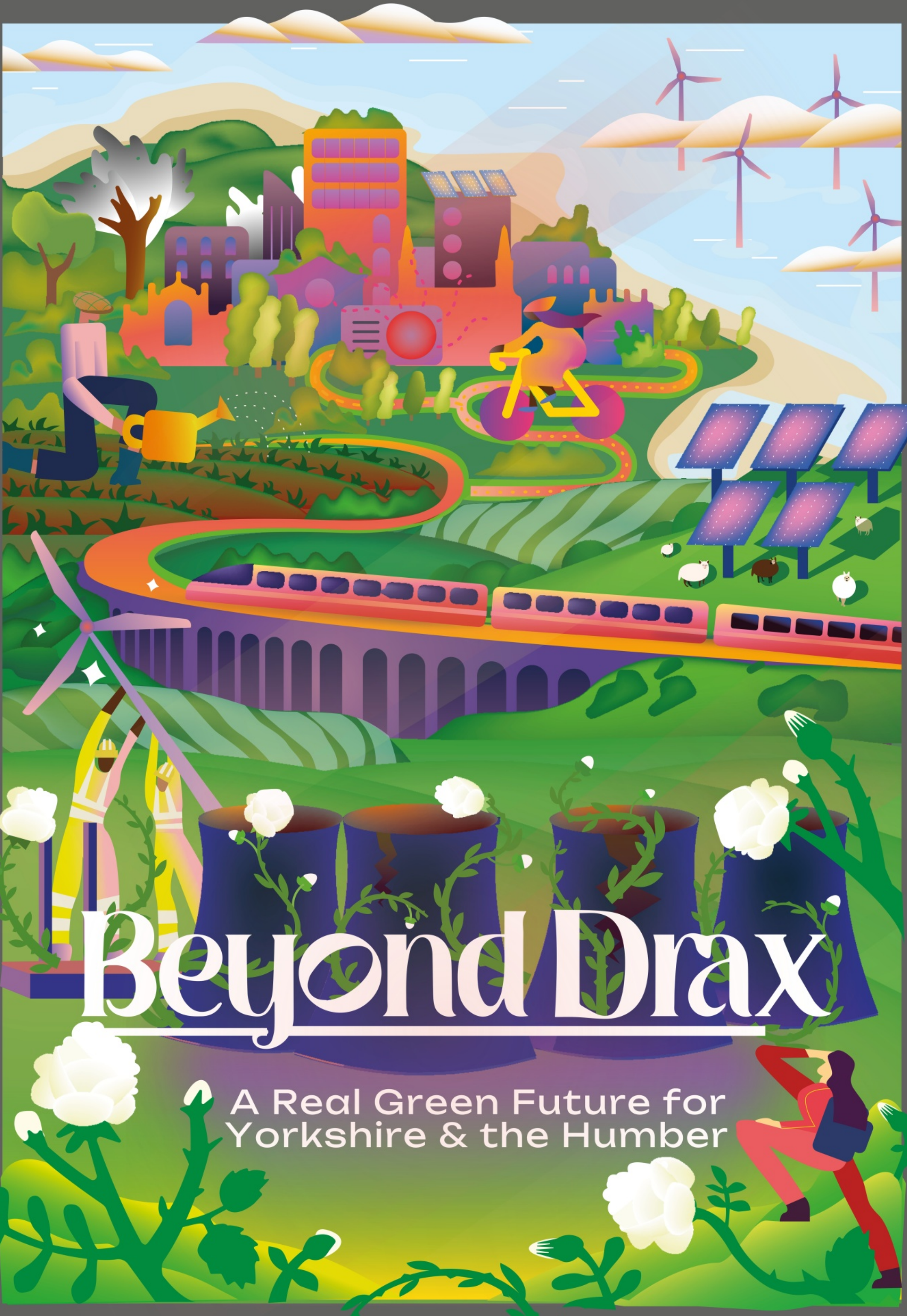

Beyond Drax

A Real Green Future for Yorkshire & the Humber

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Introduction to Green House Think Tank's work on Green Jobs

Since 2016, Green House has been carrying out work to estimate the number of jobs that would be created by a transition to a zero carbon economy - an economy in which climate change is taken seriously and emissions of greenhouse gases are reduced sufficiently to limit global warming to 1.5°C[1]. We have taken a location-specific approach, combining data on population, buildings, transport and land use, a vision of where we want to be in terms of buildings insulated, or renewable energy systems installed, with information about the amount of work involved in getting there. This has enabled us to estimate the number of jobs in particular localities. We started by looking at the Isle of Wight[2], then the Sheffield City Region[3], then the whole of the UK by local authority area[4]. These reports were produced with the Green European Foundation[5]. More recently we have collaborated to estimate the potential for Green Jobs across Cumbria[6], and explored the potential for an investment in Green Jobs as part of a post-Covid recovery across the UK[7].

Introduction to Stop Burning Trees Coalition

Stop Burning Trees (SBTC) is a grassroots coalition working to end all subsidies for wood fueled power stations. The coalition was founded in 2022 by a mixture of environmental, social and worker justice groups in Yorkshire and now has a national membership. We connect each element of the campaign, both resourcing the grassroots folk fighting Drax and supporting political push through NGOs and unions. Since the beginning of SBTC, we have firmly felt that the transition away from burning wood in power stations cannot come at the expense of workers. We all deserve decent, real green jobs. This report forms part of our ongoing work to develop a real green future in Yorkshire and beyond, without harming our planet, workers or communities around the world.

[1] See IPCC (2018) Special Report: Global Warming of 1.5°C. https://www.ipcc.ch/sr15/

[2] Essex J and Sims P (2017) A Green Transition for the Isle of Wight: A Sustainable Local Economic Strategy realised through more Green Enterprises and Employment. https://www.greenhousethinktank.org/static/2016/IoW_Green_Transition_Final.pdf.

[3] Essex J and Sims P (2018) Job Creation from a Sustainable Transition of Sheffield City Region. https://www.greenhousethinktank.org/static/2017/GreenJobs_Sheffield_Report_v2.7-2_Final.pdf.

[4] Chapman A, Essex J and Sims P (2018) Unlocking the Job Potential of Zero Carbon. https://www.greenhousethinktank.org/static/2019/GEF_ClimateJobs-brochure-main.pdf.

[5] The first two reports were part of a project on Ecological Production in a Post-Growth Society (https://gef.eu/project/ecopro) and the third Strengthening Climate Targets, Creating Local Climate Jobs (https://gef.eu/project/local-climate-jobs). All reports available at https://www.greenhousethinktank.org/climate-jobs/.

[6] Chapman A, Essex J, Gouldson A, Sudmant A, Mitchell K (2021) The potential for green jobs in Cumbria. https://cafs.org.uk/wp-content/uploads/2021/03/The-potential-for-green-jobs-in-Cumbria-v4.pdf

[7] Green New Deal UK and Build Back Better Coalition (2020) Green Jobs for All. https://www.greennewdealuk.org/updates/green-jobs-for-all-report/.

Abbreviations

AD	Anaerobic Digestion
BECCS	Bioenergy with Carbon Capture and Storage
C	Degrees Celsius
CCC	The UK government's independent Climate Change Committee, theccc.org.uk
CCS	Carbon capture and storage
CfD	Contracts for Difference (a type of subsidy for UK energy generation)
CO_2	Carbon dioxide
CO_2e	Carbon dioxide emissions equivalent (total greenhouse gas emissions expressed as if it was all carbon dioxide emissions)
CPRE	Campaign for the Protection of Rural England
DEC	Display Energy Certificate (of public buildings)
EPC	Energy Performance Certificate (of buildings)
EV	Electric vehicle
FTE	Full-time Equivalent (such as for jobs)
GW	Gigawatt (unit of power, a billion watts, to quantify electricity generation capacity)
GWh	Gigawatt hours (unit of energy, a billion watt-hours, to quantify electricity generation)
Ha	Hectare (10,000 m^2)
ICE	Internal Combustion Engine (i.e. which are powered by petrol or diesel)
IPCC	Intergovernmental Panel on Climate Change, ipcc.ch
IRENA	International Renewable Energy Agency
kWp	Peak generation power, in thousands of watts, such as in solar PV output
LACW	Local authority collected waste
m/s	Metres per second, a unit of speed
m^2	Square metres, a unit of area
$MtCO_2e$	Mega tonnes of carbon dioxide equivalent
MW	Megawatts (unit of power, a million watts, quantifies electricity generation)
MWh	Megawatt hours (unit of energy, a million watt-hours, quantifies electricity generation capacity)
ONS	Office of National Statistics
PAS 2035	PAS 2035 is the official standard for whole house retrofit in the UK.
PV	Photovoltaic, as in Solar PV panels, which generate electricity.
RHI	Renewable Heat Incentive
REA	Association for Renewable Energy and Clean Technology
TWh	Terawatt hours
W/m^2	Watts per square metre. Used to define the energy intensity of solar panels.
WRAP	Waste and Resource Action Programme, wrap.ngo
Y&H	Yorkshire and Humber (region)

Full glossary in the appendix.

Introduction

The Climate Change Act (2008[1], Target Amendment Order 2019[2]) requires the UK to reach "net zero" emissions by 2050. This means that no more greenhouse gases can be put into the atmosphere than are taken out, either naturally or by engineered technologies. It's a weak target that, if achieved globally, still gives the world only a 50:50 chance of keeping global heating below 1.5 degrees[3].

The speed with which emissions are cut is crucial, to limit the amount of carbon dioxide (CO_2) accumulating in the atmosphere[4]. Britain has a target to cut emissions by 68% by 2030 compared with 1990 levels, but is currently dangerously off track[5]. Therefore, it's important not only to move fast, but to prioritise those actions that can produce the biggest cuts most quickly.

The need for radical climate action is not in question: worldwide, millions of people are already suffering the impacts of killer heatwaves, droughts, floods and food shortages; millions have already been displaced either by catastrophic weather events or by the slower impacts of things like sea level rises[6]. In the UK alone, over five million homes will be at risk from flooding and coastal erosion by 2050[7].

But the necessary transition to a net zero carbon world can't be done at the expense of workers and communities here in the UK and around the world. To cut emissions and decarbonise our economy, we need not fewer, but *many more* workers than are currently employed in polluting sectors[8]. But thousands of jobs are at risk if we don't have plans in place to build the kind of workforce we need for a low carbon economy[9][10].

Drax power station has gained support with policymakers and in the surrounding communities on the basis of the company's claim to be a key provider of good green jobs in the region. They also claim that the electricity they produce is vital for the UK's efforts to reach net zero - even claiming that in the future it will provide "carbon removals" without which that target cannot be reached.

We begin this report by outlining the environmental and human harm caused by Drax's activities, locating Drax within wider problematic government plans for "low carbon" industry and energy in the region, and showing why we think Drax's jobs claims are highly misleading.

We go on to describe and quantify some of the jobs which could be created through an alternative approach to reducing emissions and enabling a better quality of life in the region. We set out the potential for jobs sector by sector, calculating minimum jobs numbers for each sector examined, but also discussing the scope for being far more ambitious given the necessary political will. We also touch on some of the sectors where it has not been possible to quantify potential jobs, but which we know are important sources of work and necessary for building a low carbon economy.

[1] UK Government. “Climate Change Act 2008.” www.legislation.gov.uk/ukpga/2008/27/contents.

[2] UK Government, “The Climate Change Act 2008 (2050 Target Amendment) Order 2019” https://www.legislation.gov.uk/ukdsi/2019/9780111187654

[3] IPCC. “Summary for Policymakers — Global Warming of 1.5 oC.” IPCC, IPCC, 2018, www.ipcc.ch/sr15/chapter/spm/.

[4] Lynas, Mark. “Q&A: How Fast Do We Need to Cut Carbon Emissions?” The Guardian, 4 Nov. 2021, https://www.theguardian.com/environment/2021/nov/04/qa-how-fast-do-we-need-to-cut-carbon-emissions.

[5] Dooks, Tom. “UK off Track for Net Zero, Say Country’s Climate Advisors - Climate Change Committee.” Climate Change Committee, 17 July 2024, www.theccc.org.uk/2024/07/18/uk-off-track-for-net-zero-say-countrys-climate-advisors/.

[6] Prater, Ayesha Tandon, Kerry Cleaver, Joe Goodman, Tom Pearson, Tom. “In-Depth Q&A: How Does Climate Change Drive Human Migration?” Carbon Brief. interactive.carbonbrief.org/climate-migration/.

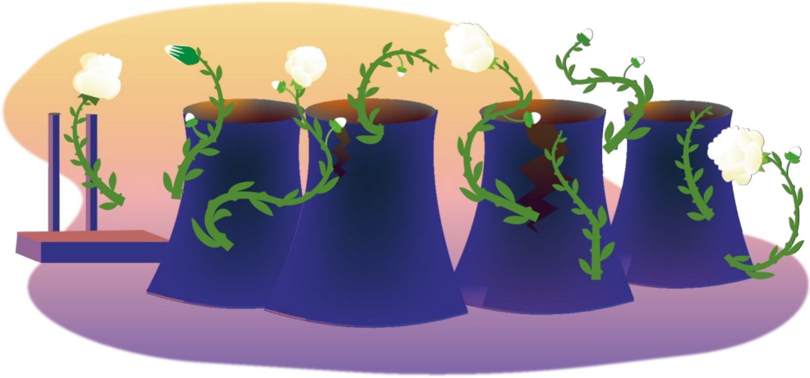
[7] Environment Agency. 2020. National Flood and Coastal Erosion Risk Management Strategy for England. https://assets.publishing.service.gov.uk/media/5f6b6da6e90e076c182d508d/023_15482_Environment_agency_digitalAW_Strategy.pdf

[8] Campaign against Climate Change Trade Union Group. “Climate Jobs: Building a Workforce for the Climate Emergency.”https://www.cacctu.org.uk/climatejobs

[9] TUC. 2023 TUC – 800,000 Manufacturing Jobs Could Be at Risk If Government Doesn’t Implement Biden-Style Climate Plan. https://www.tuc.org.uk/news/tuc-800000-manufacturing-jobs-could-be-risk-if-government-doesnt-implement-biden-style-climate

[10] Ambrose, Jillian. 2024 ““We’re Facing a Critical Shortage”: Why UK’s Green Revolution Urgently Needs Skilled Workers.” The Observer. www.theguardian.com/environment/2024/jan/20/were-facing-a-critical-shortage-why-uks-green-revolution-urgently-needs-skilled-workers.

Drax and Context



What is Drax?

Drax is a wood biomass power station located near Selby, in Yorkshire. It is a former coal-power station that converted to burning coal and biomass, and now entirely burns wood biomass[1]. This conversion followed a long standing campaign against Drax when it was burning coal, and was branded as their move towards becoming 'green'. However, Drax is the UKs single largest carbon emitter and world's biggest tree burner (wood biomass power station)[2][3]. Their actions have been repeatedly linked to driving environmental racism and causing huge amounts of harm to communities, forests and biodiversity[4][5][6][7]. Despite this, Drax collects huge amounts in "green" subsidies[8] paid through our electricity bills, and promotes itself to the local community, and to policymakers, as a provider of good green jobs and skills[9], claiming a key role in cutting UK greenhouse gas emissions.

Where do the wood pellets come from?

Drax sources its wood pellets predominantly from North America (particularly Southeastern US and British Columbia), the Baltic States and Brazil[10]. Drax owns its own pellet production sites in the US and Canada and is also supplied by Enviva, the world's biggest pellet producer[11].

Drax have been found to be sourcing their wood pellets from primary forests in British Columbia[12], from protected forests in Estonia, and biodiverse forests in the Southern US[13]. In 2023, Drax sourced 8 million tonnes of wood pellets, burning 6 million tonnes at Drax Power Station.

To compensate for forests lost to felling, the biomass industry is meant to replant trees lost. However, they are often replaced by monocultures, which have many negatives, from a reduction in carbon absorption, to harm to biodiversity, soil, foraging for livestock on which many people rely and depleting groundwater[14]. To maximise the benefits of forest carbon sequestration, the focus needs to be on protecting and restoring intact forests and ecosystems.

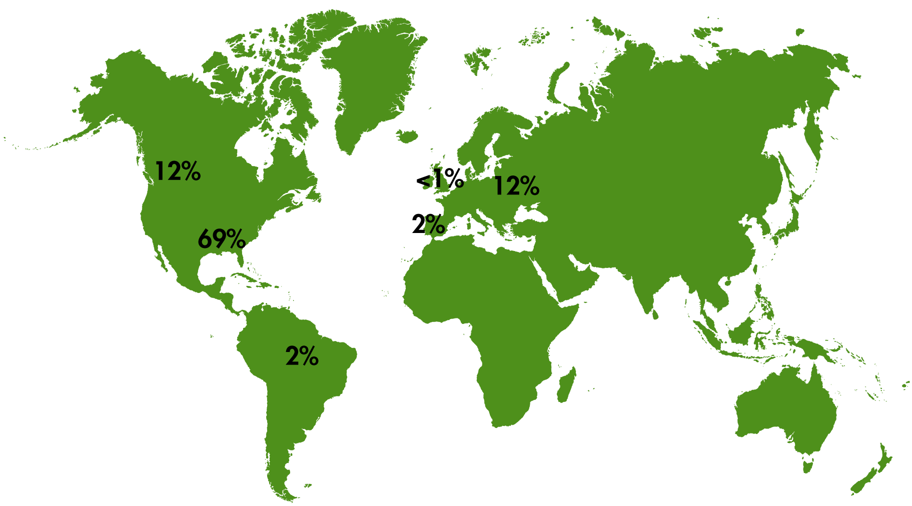


Figure 1.1: Map of Drax sourcing by region of the world

Severe climate impacts

In 2023, from burning wood pellets alone, Drax emitted 11.5mt of CO_2.

According to a 2021 letter signed by 500 scientists: *"The result of this additional wood harvest [for biomass energy] is a large initial increase in carbon emissions, creating a 'carbon debt' which increases over time as more trees are harvested for continuing bioenergy use. Regrowing trees and displacement of fossil fuels may eventually pay off this carbon debt, but regrowth takes time the world does not have to solve climate change. As numerous studies have shown, this burning of wood will increase warming for decades to centuries. That is true even when the wood replaces coal, oil or natural gas."*[15]

Under international carbon accounting rules, wood biomass is counted as carbon neutral[16]. This is despite the fact that burning woody biomass emits as much or more carbon than coal[17]. The carbon payback period (regrowth and reabsorption of carbon by trees) is estimated to be between 44-104 years[18]. However, this accounting loophole allows countries like the UK to ignore emissions from burning trees for energy, instead counting it as part of their renewable energy mix.

Environmental justice and green colonialism

As well as contributing to the destruction of highly biodiverse forests, pellet production for export, much of it to the UK, causes grave social and public health impacts in communities living close to Drax's and Enviva's pellet plants. In the Southeastern USA, wood pellet production facilities are primarily located near majority-Black and low-income communities[19], many of which have repeatedly expressed concerns about the pellet mill operations and accused Drax of driving environmental racism[20].

These facilities emit health-harming pollutants and noxious substances, linked to lung and heart issues, and many of them are carcinogenic (cancer-causing)[21]. Those living near these facilities are also affected by round-the-clock noise and persistent dust, further diminishing their quality of life. This pollution leaves many people in these communities unable to go outside or engage in outdoor activities, with community members struggling to breathe and relying on medication and machinery to survive.

Both Drax and Enviva have repeatedly violated the American Clean Air Act: Enviva breached legal air pollution limits 14 times from 2017 to 2023, and Drax paid $3.2 million in fines for such violations in Louisiana in 2022, as well as $2.5 million in Mississippi in 2021, after which further permit breaches were discovered at the same facility[22]. These wood pellet mills only exist due to demand in the UK for wood biomass. The UK is actively exporting emissions and harm to these countries and communities. By exporting both the harm of wood pellet productions, and emissions, the UK is continuing the cycle of exporting harm whilst reaping the benefits.

Current Subsidies

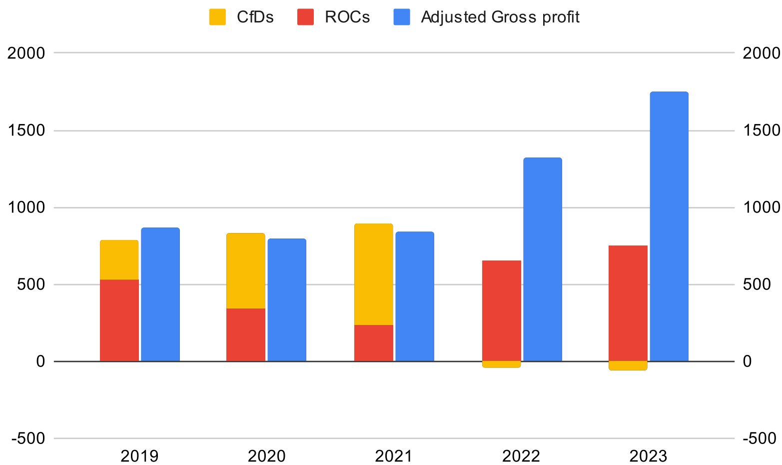


Figure 1.2: Drax profits against total subsidies in ROCs and CfDs

Alongside ignoring the reality of emitting millions of tonnes of CO_2 into the atmosphere, the loophole in the carbon accounting rules allows companies like Drax to receive large amounts of renewable energy subsidies.

Based upon Drax's annual report[23], in 2023 Drax received £539m in direct government subsidies, bringing the total subsidies the group has received to nearly £7bn; including £393 million for the first half of 2024 - more than its £300 million windfall payout to shareholders. This came on the back of Drax making record profits (£1.2bn - up from £731m in

2022, and £398m in 2021)[24]. It is noted that Ember worked out Drax's subsidies for 2023 to be £539m, however we have used the calculation previously used to ensure consistency[25].

In 2021 Drax received £893m in subsidies - the reason for the decrease in 2022 and 2023 is the sharp rise in energy prices. Contracts for Different (CfDs) subsidies work by setting a guaranteed price for the energy generated (called the "strike price") which is usually far higher than energy prices on the market. However, due to a sharp rise in global energy prices during 2022, the market price rose higher than this "strike price". When this happens, generators are required to pay back any profit they make over and above the strike price.

An investigation by Bloomberg found that when market prices soared above the strike price in 2022-23, Drax acted to avoid paying back bill payers the £617 million difference. Drax receives CfDs for two of its smokestacks, and deliberately turned these two off instead of paying back the difference were able to sell the wood pellets for profit on the market.

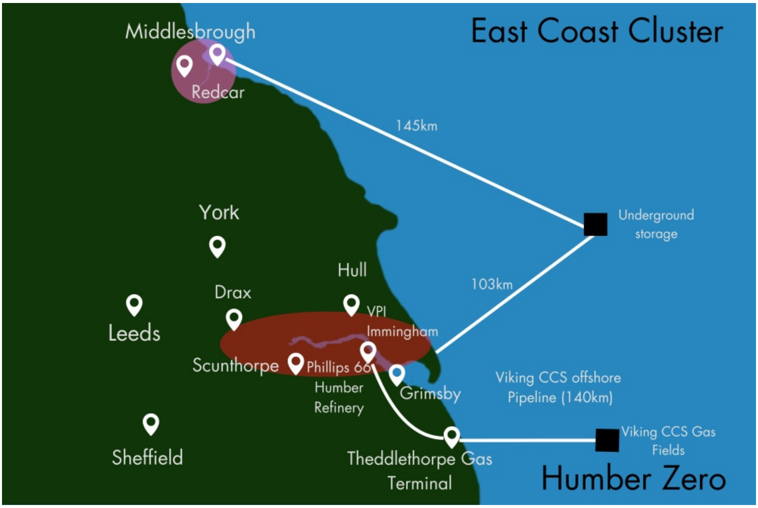
Despite Drax's profits rising, data shows that Drax is progressively generating less electricity for the grid. In 2023 Drax generated 11.5 TWh of electricity, a fall from 12.7 TWh in 2022, and a further fall from 14.1 TWh in 2021. This now means Drax produces just 8% of renewable electricity in the UK, and less than 4% of the UK's total electricity.

What we repeatedly see is a company dedicated to extracting as much money from the public purse and bill payers as possible, to hand to shareholders.

Future subsidies

Current subsidies for wood biomass in the UK are due to run out in 2027, with the government previously announcing this would be the end for subsidies for unabated wood biomass burning. However, Drax is currently lobbying the Government for billions more in subsidies, for both business as usual tree burning and unproven technological fixes. We will interrogate this further in the next section.

Contextualising Drax in the government approach - the East Coast Cluster



To reach the 2050 target, weak as it is, industrial emissions need to be cut by at least 90%[26]. About a third of these industrial emissions (32 $MtCO_2e$) are contained within six industrial clusters[27], locations where a large number of industrial sites are concentrated. The cluster around the Humber has by far the highest emissions of any location in the UK. Combined with the smaller cluster around Teesside, this forms the East Coast Cluster[28].

The idea of focusing industrial decarbonisation (emissions cuts) on these clusters is that the industries and energy installations that form part of them can share some common infrastructure, based on capturing CO_2 from burning fossil fuels or biomass and from other industrial processes, and carrying them via shared pipelines to storage sites underneath the sea bed. This is the process referred to as carbon capture and storage[29] or CCS - a controversial technology widely regarded by critics including many scientists[30] as being promoted by the fossil fuel industry as a way of prolonging the use of oil, gas and

Map reference material: https://humberzero.co.uk/humber-zero-about-us and https://www.netzeroteesside.co.uk/northern-endurance-partnership/

coal[31].

In the Humber region, a land pipeline is proposed, running from Drax power station to Easington in the East Riding of Yorkshire, carrying CO_2 from Drax and from various other installations along the way[32]. This pipeline is planned to connect with another pipeline beneath the seabed, carrying the CO_2 to a storage site in the so-called "Northern Endurance" field, beneath the North Sea[33]. A similar pipeline is planned to bring CO_2 from Teesside to the same storage site[34].

A separate CO_2 pipeline is also planned to run from Immingham to Theddlethorpe in Lincolnshire, serving the Phillips66 refinery and the VPI Immingham gas-fired power station[35]. This is planned to link to an existing undersea pipeline previously used to transport gas, taking the CO_2 for storage in a spent gas field (the Viking field - not shown on this diagram). Drax is also considering using this pipeline and storage, either in addition to or instead of the one ending at Easington and linking to the Northern Endurance field[36].

Table 1: Projects in the Humber	
Bioenergy with CCS Drax Bioenergy with Carbon Capture and Storage	**Hydrogen** Hydrogen to Humber (H2H) Saltend
Industrial Carbon Capture Humber Zero - Phillips 66 Limited Humber Refinery Prax Lindsey Oil Refinery Carbon Capture ZerCaL250 Altalto Immingham waste to jet fuel North Lincolnshire Green Energy Park Saint-Gobain Glass Carbon Capture	**Power** Keadby 3 Carbon Capture Power Station C. GEN Killingholme VPI Humber Zero
Sourced from Humber Zero and Northern Endurance Partnership	

Where does Drax fit in - CO2 removals?

All the industries shown in the diagram are expected to be using carbon capture and storage, in one or more of these ways:

» to capture CO_2 from a gas-fired or a biomass-fired power station

» to capture CO_2 from industries that burn fossil fuels (eg gas) to produce high temperatures, and/or have CO_2 as a by-product of the production process

» to capture the CO_2 emitted as a by-product when hydrogen is produced by splitting ("reforming") methane (the main component of natural gas).*

Even if they capture and store as much CO2 as they claim, this will not bring the emissions from these industries anywhere close to zero[37][38]. But according to Drax, their wood-burning power station will not only reduce its emissions by fitting carbon capture, but will actually *remove* CO_2 from the atmosphere, as well as generating electricity[39].

Put simply, this is because they claim that burning wood pellets can be classed as emissions-free because the emissions it produces are compensated by carbon absorbed (or sequestered) by new tree growth. Therefore, they argue, by capturing and burying these emissions they are, on balance, taking carbon out of the atmosphere. The entire process is known as bioenergy with carbon capture and storage, or BECCS[40].

According to government policy, these so-called "carbon removals" will help to offset the remaining emissions from industry and from other sectors like farming and aviation. However, as we have discussed, these claims are based on faulty carbon accounting and research shows that building BECCS at Drax will do nothing to help achieve net zero by 2050.

According to government policy, these so-called "carbon removals" will help to offset the remaining emissions from industry and from other sectors like farming and aviation[41]. However, as we have discussed, these claims are based on faulty carbon accounting and research shows that building BECCS at Drax will do nothing to help achieve net zero by 2050.

* Some hydrogen is also planned to be produced by a different process, using an electrical current to split water. This has no carbon emissions provided the electricity is renewable-produced. However, under current plans it is likely that most hydrogen would be produced from methane.

BECCS subsidies

The Government is currently deciding on funding mechanisms for BECCS, with the proposed one being dual CfDs - giving one subsidy for energy production and another for capturing carbon[42]. This creates the very real possibility that Drax (and also Lynemouth power station in Northumberland, owned by Czech energy company EPH), could receive subsidies for continued wood burning without even capturing any carbon[43]. Independent energy think tank Ember estimates that subsidising BECCS at Drax could cost the public £43.34b over 25 years[44]. We expect a final decision on BECCS subsidies to be made in 2027.

Currently Drax is in discussions with the Government about bridging subsidies[45] to tide them over until the BECCS subsidies are agreed; these subsidies could cost the public an additional £4.6bn if extended to 2030, or £12.4bn if to 2035[46]. The future promise of BECCS is the last option available to Drax to continue receiving billions in subsidies in the UK, so regardless of the climate and community impacts or technological feasibility, it is being intensively pushed by the industry.

Drax's BECCS plans are operating as a test case for wood biomass BECCS around the world. Due to the desperation of governments to meet emissions targets without addressing politically unpopular areas (like reducing energy needs, meat consumption, flying etc) BECCS offers an easy solution on paper. Promising future negative emissions allows business as usual to continue, distracting from real and rapid climate action by relying on future techno-fixes.

Text Box 1: Does carbon capture and storage work?

The quick answer to this is that the chemical process that separates the CO_2 from an exhaust stream containing a mixture of gases works - in the laboratory, and to a limited extent in real-life industrial scale installations. In fact, the process has been used for decades to capture CO_2 for use in the oil industry, where it is injected into near-depleted oil wells to make the remaining oil easier to get out (known as “enhanced oil recovery”)[47].

However, this is not a test of how efficiently we can capture CO_2 from industry or from power stations. The reality is that **there are *no* examples anywhere in the world** of carbon capture working, at utility scale, with the efficiency that's needed, or that was claimed for them when they were planned. In fact, despite the repeated industry claim that this is a proven technology, there are so far *no* gas-fired power plants, and *no* wood biomass-fired plants using CCS![48]

Developers routinely claim that they will capture 90%, or even 95% of CO_2 emissions, yet every CCS project so far has underperformed or run into major technological problems. For example, Boundary Dam coal fired power station in Canada - one of only two power-CCS plants currently operating in the world averaged a long-term capture rate of just 57% up to the end of 2023[49].

But even if a plant did capture 90% of its CO_2 emissions, that would still leave the other 10%, and the more fuel is burned, the bigger that 10% is. And carbon capture currently requires a lot of fuel; used at a power station, it may require up to a third more fuel (called the "energy penalty"[50]) to produce the same amount of electricity. If that fuel is natural gas, that means a third more methane leakage from gas extraction and transportation - and methane has a global heating potential about 84 times that of CO_2 over the crucial 20 year period.

The energy penalty is also a particular problem for wood biomass burning. Regardless of what happens in the longer-term, the emissions at the smoke stack are even higher than for burning coal[51]. Carbon capture is likely to mean even more wood being burned per unit of electricity generated, and therefore more damage to forests, and more CO_2 and other health-harming emissions.

The scientific consensus is that avoiding truly catastrophic climate change requires an immediate end to new fossil fuel projects and an accelerated shutdown of existing facilities[52]. Based on the arguments above, we believe the same applies to wood biomass projects like Drax, while the immediate effects of projects like Drax are even worse, as the CO_2 and other emissions from the smokestack are even higher for burning wood than from burning coal.

Yet, just as the fossil fuel industry is pushing hard for carbon capture[53] as a way of prolonging the use of oil and gas, so the biomass industry uses the false promise of BECCS to continue its unsustainable and polluting wood burning.

Text Box 2: What about the pipelines and storage?

Given that we constantly hear how CCS is a proven technology, it is surprising to learn that only two working examples of offshore storage exist in the world - both off the coast of Norway, and both capturing and storing CO_2 from gas processing (natural gas contains CO_2, in varying amounts, which has to be separated from the gas before it can be sold as fuel)[54].

Both of these projects have run into problems - one showing unexpected migration of the stored CO_2 out of the layer into which it was injected, and the other having far more limited storage than predicted[55]. Yet these relatively small projects, involving CO_2 inputs from a single industry, are dwarfed in both scale and complexity by what is envisaged for the East Coast Cluster[56].

There is clearly a real possibility of CO_2 leaking from storage sites, and this would contribute to the acidification[57] already being caused by increased CO_2 in the atmosphere, threatening the survival of many marine species and potentially speeding global heating. However good the geological modelling, there is no certainty as to how injected CO_2 will behave in a storage site.

So far, real-world engineering experience with CO_2 pipelines is also relatively limited, and safety standards are underdeveloped[58]. Introducing CO_2 from multiple different industrial sources increases the engineering complexity and potential risks[59]. CO_2 is an asphyxiant and is heavier than air, so in a major leak it will stay near the ground rather than clearing, potentially suffocating people and livestock[60].

Drax - creating good, sustainable employment?

Speculative technologies like BECCS also distract from the genuine climate jobs that are needed for a rapid reduction in emissions, and are not a promising foundation for large-scale job creation.

The publicity produced in support of Drax, BECCS and the wider CCS-based cluster, is riddled with exaggerated claims about job creation. Drax itself, when it announced plans for retrofitting two of its burners with carbon capture, was widely quoted in the local and regional press as claiming that this would create 10,000 jobs[61]. On further scrutiny, it became clear that the 10,000 figure referred only to the number employed briefly at the peak of the construction period, and that many of these would not be local.

The 10,000 figure included not only direct jobs on site and in the direct supply of components, but jobs in the wider supply chain and also so-called "induced" jobs (i.e. jobs supported by the presumed additional spending resulting from this employment). After the peak of construction, according to Drax's own figures, the number of direct jobs was in fact predicted to dwindle from 4,940 to "up to" 375. Most of these would be drawn from Drax's existing employees (i.e. not necessarily additional jobs)[62].

Table 2.1 - an estimate of the jobs "created and supported" by BECCS at Drax, from the report commissioned by Drax from Vivid Economics[63]

	Jobs at peak of construction period	Average jobs over a five-year period	Long-term jobs post-construction
Direct	4,942	4,000	375
Indirect	2,122	1,600	960
Induced	3,240	2,500	1,800

The boost in construction jobs would not only be short-term, but would also be likely to consist mainly of contracted workers who move from place to place and are not tied to the local area. Whilst highly qualified engineering construction workers tend to move on to other contracts (perhaps in other parts of the country), employment in the construction sector is often highly precarious (for example, including widespread use of "bogus self-employment contracts" that mean workers can be taken on for a specific project and then dismissed when it is finished[64]), and this project would be no exception.

The construction phase would therefore be expected to also produce a temporary boost to induced jobs in hospitality and fast food, but little positive impact on the wider local economy. These induced jobs would be highly vulnerable to the drop in custom when the project was finished.

Similar concerns apply across the regional as at the local level. The Drax website (quoting the Vivid Economics report) suggests that "by deploying cutting-edge green technologies across the Humber [jobs created and supported] could rise to 47,800 jobs at peak"[65] - a claim which is likely to conceal a high prevalence of short-term contracts, wide fluctuations in job numbers and precarity, poor wage levels and lack of progression being typical for many of the projected jobs.

The opportunities created by Drax's day to day activities are also very unevenly spread, and don't necessarily benefit those struggling on low incomes. Wages paid to Drax employees across Yorkshire and the Humber are said to be 83% higher than the regional average[66], but this is not surprising since they include some of the region's most skilled and qualified workers. Around a third of permanent workers on site, though, are likely to be in contracted-out roles, on far lower pay and conditions. Job recruitment sites also reveal wide variations in company pay, dependent on role.

What are the alternatives?

It is clearly a fallacy to assume that a concentration of highly skilled and highly paid workers equates to the general "levelling up" of a community. However, doing the things which reduce the amount of energy we need to have a decent quality of life, as well as changing the way we produce that energy, could produce a far larger number of skilled jobs[67], with benefits more widely spread and contributing to greater wellbeing. In the rest of this report we'll be looking at this in more detail.

[1] Drax. 2023.. “Drax Ends Half a Century of Coal-Fired Power Generation.” https://www.drax.com/press_release/drax-ends-half-a-century-of-coal-fired-power-generation/

[2] Harrison, Tom, and Harriet Fox. “Biomass Plant Is UK’s Top Emitter.” Ember, 30 July 2023, ember-climate.org/insights/research/drax-co2-emissions-biomass/.

[3] M, Christian. “Drax: The Largest Biomass Power Station in the World.” AquaSwitch, 19 Aug. 2022, https://www.aquaswitch.co.uk/blog/drax-biomass-power-station

[4] Quashie-Idun, Sam. 2022 “Drax Accused of Driving “Environmental Racism” after Further Pollution Claims against Wood Pellet Mills in US Deep South. unearthed.greenpeace.org/2022/09/26/drax-accused-environmental-racism-further-pollution-claims-against-wood-pellet-mills-us/.

[5] Childs, Simon. 2023 “The Biggest “Renewable” Power Plant in the UK Burns Wood Processed in Poor, Black Communities in the US.” Novara Media. novaramedia.com/2023/05/10/the-biggest-renewable-power-plant-in-the-uk-burns-wood-processed-in-poor-black-communities-in-the-us/

[6] Crowley, Joe, and Tim Robinson. 2022 “Drax: UK Power Station Owner Cuts down Primary Forests in Canada.” BBC News. www.bbc.co.uk/news/science-environment-63089348.

[7] Pepper, Elly. 2022 “BBC Reveals Drax Logging Old-Growth Forests for Biomass.” www.nrdc.org/bio/elly-pepper/bbc-reveals-drax-logging-old-growth-forests-biomass.

[8] Lawson, Alex. 2023 “Call to Cut UK Subsidies as Drax Power Station Profits Nearly Double.” www.theguardian.com/business/2023/feb/23/drax-power-station-profits-nearly-double-call-for-subsidies-cut.

[9] Graham, Ben. 2017 “How Drax Is Boosting Jobs and the Economy throughout the UK - Drax Global.” www.drax.com/sustainable-business/drax-boosting-jobs-economy-throughout-uk/.

[10] Drax Group plc. 2023 Delivering Dispatchable, Renewable Power Drax Group Plc Annual Report and Accounts 2022. https://www.drax.com/wp-content/uploads/2023/03/Drax_AR2022_single_pages.final_.pdf.

[11] World Record Academy. 2023. “World’s Largest Wood Pellet Plant: World Record in Waycross, Georgia.” https://www.worldrecordacademy.org/2023/9/worlds-largest-wood-pellet-plant-world-record-in-waycross-georgia-423351.

[12] Crowley, Joe, and Tim Robinson. 2022 “Drax: UK Power Station Owner Cuts down Primary Forests in Canada.” www.bbc.co.uk/news/science-environment-63089348.

[13] Pepper, Elly. 2022. “Four Ways We Know Drax’s Appetite for Trees Is Still Growing.”, www.nrdc.org/bio/elly-pepper/four-ways-we-know-draxs-appetite-trees-still-growing.

[14] Jesús Aguirre-Gutiérrez, et al. 2023. “Valuing the Functionality of Tropical Ecosystems beyond Carbon.” Trends in Ecology and Evolution, vol. 38, no. 12. https://doi.org/10.1016/j.tree.2023.08.012.

[15] Raven P (2021) “Letter Regarding Use of Forests for Bioenergy - Woodwell Climate.” Woodwell Climate,, www.woodwellclimate.org/letter-regarding-use-of-forests-for-bioenergy/.

[16] Brack, Duncan . 2023. “2. Accounting for Biomass Carbon Emissions.” Chatham House – International Affairs Think Tank. www.chathamhouse.org/2017/02/woody-biomass-power-and-heat/2-accounting-biomass-carbon-emissions.

[17] Smedley, Tim. 2023 “Burning Biomass for Electricity Is Worse than Coal - the New Climate. - Medium.” Medium, The New Climate., https://medium.com/the-new-climate/burning-biomass-for-electricity-is-worse-than-coal.

[18] Sterman, John D, et al. 2018. “Does Replacing Coal with Wood Lower CO2 Emissions? Dynamic Lifecycle Analysis of Wood Bioenergy.” Environmental Research Letters, vol. 13, no. 1, p. 015007, iopscience.iop.org/article/10.1088/1748-9326/aaa512, https://doi.org/10.1088/1748-9326/aaa512

[19] Koester, Stefan, and Sam Davis. 2018. “Siting of Wood Pellet Production Facilities in Environmental Justice Communities in the Southeastern United States.” Environmental Justice, vol. 11, no. 2,, pp. 64–70, https://doi.org/10.1089/env.2017.0025.

[20] Quashie-Idun, Sam, and Damien Gayle. 2022. “UK Accused of Funding Environmental Racism with Subsidies to Drax.” www.theguardian.com/business/2022/sep/26/uk-accused-of-funding-environmental-racism-with-subsidies-to-drax.

[21] Earl, Nicholas. 2023. “Drax under Fire over US Wood Pellet Plant Breaking Air Pollution Rules -

CityAM." www.cityam.com/drax-under-fire-over-us-wood-pellet-plant-breaking-air-pollution-rules/.

[22] Southern Environmental Law Centre. 2024. Pellet Mill Violations in the South. www.southernenvironment.org/wp-content/uploads/2024/06/Pellet-Mill-Violations-in-the-South-updated-2024-06-05.pdf.

[23] Drax Group plc Annual report and accounts 2023. https://www.drax.com/wp-content/uploads/2024/03/Drax_AR23_Interactive.pdf

[24] Lawson, Alex. 2023. "Call to Cut UK Subsidies as Drax Power Station Profits Nearly Double."www.theguardian.com/business/2023/feb/23/drax-power-station-profits-nearly-double-call-for-subsidies-cut.

[25] Ember. 2024. Drax profits rise as electricity generation falls, show new figures. https://ember-climate.org/press-releases/drax-profits-rise-as-electricity-generation-falls-show-new-figures/

[26] Garvey, Alice, and Peter Taylor. 2020. Industrial Decarbonisation Policies for a UK Net Zero Target.

[27] Geels, Frank & Sovacool, Benjamin & Iskandarova, Marfuga. (2023). The socio-technical dynamics of net-zero industrial megaprojects: Outside-in and inside-out analyses of the Humber industrial cluster. Energy Research & Social Science. 98. 103003. 10.1016/j.erss.2023.103003.

[28] "East Coast Cluster." eastcoastcluster.co.uk

[29] Budinis, Sara, et al. 2023. "Carbon Capture, Utilisation and Storage - Energy System." International Energy Agency. www.iea.org/energy-system/carbon-capture-utilisation-and-storage.

[30] CaptureTheTruth.org. 2024, Accessed 23 Sept. 2024.

[31] Morrison, Kevin. 2024. "Why Carbon Capture and Storage Is Not the Solution." ieefa.org/resources/why-carbon-capture-and-storage-not-solution. Accessed 23 Sept. 2024.

[32] Northern Endurance Partnership. "The Humber Carbon Capture Pipeline Is a Proposed Underground, Onshore Pipeline with above Ground Installations That Aims to Transport Carbon Dioxide Produced by Industrial Projects in the Humber Region to Secure Offshore Storage under the North Sea. nephccp.co.uk/.

[33] "Northern Endurance Partnership." Net Zero Teesside, www.netzeroteesside.co.uk/northern-endurance-partnership/.

[34] Net Zero Teesside." www.netzeroteesside.co.uk/.

[35] "- Viking CCS." Viking CCS, 2024, www.vikingccs.co.uk/about. Accessed 23 Sept. 2024.

[36] Drax. 2024. "Drax Signs MoU with Harbour Energy and Bp to Explore Options to Transport and Store CO2 - Drax UK." www.drax.com/uk/press_release/drax-signs-mou-with-harbour-energy-and-bp-to-explore-options-to-transport-and-store-co2/.

[37] Sani, Lorenzo . 2024. "Kind of Blue - Carbon Tracker Initiative." Carbon Tracker Initiative. carbontracker.org/reports/kind-of-blue/.

[38] Calverley, D., & Anderson, K. (2022). Phaseout Pathways for Fossil Fuel Production Within Paris-compliant Carbon Budgets. https://pure.manchester.ac.uk/ws/portalfiles/portal/213256008/Tyndall_Production_Phaseout_Report_final_text_3_.pdf.

[39] Drax Carbon Removals, draxcarbonremovals.com/.

[40] Drax. "Bioenergy with Carbon Capture and Storage (BECCS)." www.drax.com/uk/bioenergy-with-carbon-capture-and-storage-beccs/.

[41] Department for Energy Security and Net Zero. 2023. Biomass Strategy. https://assets.publishing.service.gov.uk/media/64dc8d3960d123000d32c602/biomass-strategy-2023.pdf.

[42] Blackman, David. 2022. Government Proposes Dual CfD Mechanism for BECCS. utilityweek.co.uk/government-proposes-dual-cfd-mechanism-for-beccs/.

[43] Ernsting, Almuth. 2023 "Lynemouth Power Station: A Smaller Version of Drax – Biofuelwatch." www.biofuelwatch.org.uk/2023/lynemouth-power-station/.

[44] Harrison, Tom , and Phil MacDonald. 2024. "Drax's BECCS Project Climbs in Cost to the UK Public." ember-climate.org/insights/in-brief/draxs-beccs-project-climbs-in-cost-to-the-uk-public/.

[45] Mehta, Angeli. 2023. Burning Questions Surround Biomass-Based Carbon Removals. www.reuters.com/sustainability/climate-energy/burning-questions-surround-biomass-based-removals-2023-10-23/.

[46] Harrison, Tom, and MacDonald, Phil. 2024. "Drax's BECCS Project Climbs in Cost to the UK Public." Ember. ember-climate.org/insights/in-brief/draxs-beccs-project-climbs-in-cost-to-the-uk-public/.

[47] Zero Carbon Analytics. 2024. "A Closer Look at CCS: Problems and Potential." zerocarbon-analytics.org/archives/energy/a-closer-look-at-ccs-problems-and-potential.

[48] Institute for Energy Economics and Financial Analysis. "Carbon Capture and Storage: An Unproven Technology." ieefa.org/ccs.

[49] Schlissel, David, and Kalegha, Mark. 2024. "Carbon Capture at Boundary Dam 3 Still an Underperforming Failure." ieefa.org/resources/carbon-capture-boundary-dam-3-still-underperforming-failure.

[50] Center for International Environmental Law. 2023. "Carbon Capture and Storage (CCS): Frequently Asked Questions. https://www.ciel.org/carbon-capture-and-storage-ccs-frequently-asked-questions.

[51] Natural Resources Defense Council. 2017. "Biomass More Polluting than Coal, New Study Finds." EcoWatch. www.ecowatch.com/chatham-house-biomass-study-2288764699.html.

[52] "COP28: The Science Is Clear — Fossil Fuels Must Go." Nature, vol. 624, no. 7991, 12 Dec. 2023, pp. 225–225, https://doi.org/10.1038/d41586-023-03955-x.

[53] Westervelt, Amy. 2024. "Documents, Whistleblowers, and Public Comments Are Clear: Oil Companies Know Carbon Capture Is Not a Climate Solution.". drilled.media/news/ccs.

[54] "Deep Trouble: The Risks of Offshore Carbon Capture and Storage. 2023." Center for International Environmental Law. www.ciel.org/reports/deep-trouble-the-risks-of-offshore-carbon-capture-and-storage-november-2023/.

[55] Hauber, Grant. 2023. "Norway's Sleipner and Snøhvit CCS: Industry Models or Cautionary Tales?" ieefa.org/resources/norways-sleipner-and-snohvit-ccs-industry-models-or-cautionary-tales.

[56] "East Coast Cluster." eastcoastcluster.co.uk/.

[57] Deep Trouble: The Risks of Offshore Carbon Capture and Storage. 2023." Center for International Environmental Law. www.ciel.org/reports/deep-trouble-the-risks-of-offshore-carbon-capture-and-storage-november-2023/.

[58] Health and Safety Executive. 2023 "Pipeline Design Codes and Standards for Use in UK CO2 Storage and Sequestration Projects." www.hse.gov.uk/pipelines/resources/designcodes.htm.

[59] Department for Business, Energy and Industrial Strategy. 2021. Net Zero Teesside & Northern Endurance Partnership Technology Plan. assets.publishing.service.gov.uk/media/6294fd78e90e07039e31b782/NS051-EN-PLN-000-00007-Technology_Plan.pdf.

[60] Health and Safety Executive. "Major Hazard Potential of CCS." www.hse.gov.uk/carboncapture/major-hazard.htm.

[61] Boycott-Owen, Mason. 2022. Bid to Create Thousands of Jobs at Drax Power Station in Yorkshire to Be Greenlit by Government. www.yorkshirepost.co.uk/news/politics/bid-to-create-thousands-of-jobs-at-drax-power-station-in-yorkshire-to-be-greenlit-by-government-3811654.

[62] Drax. NEEDS and BENEFITS STATEMENT Drax Bioenergy with Carbon Capture and Storage the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations, 2009 - Regulation 5(2) (Q) Document Reference Number: 5.3 Applicant: Drax Power Limited PINS Reference: EN010120 Drax Bioenergy with Carbon Capture and Storage Needs and Benefits Statement.

[63] Drax. 2020. "Capturing Carbon at Drax: Delivering Jobs, Clean Growth and Levelling up the Humber - Drax Global." www.drax.com/carbon-capture/capturing-carbon-at-drax-delivering-jobs-clean-growth-and-levelling-up-the-humber/#chapter-1.

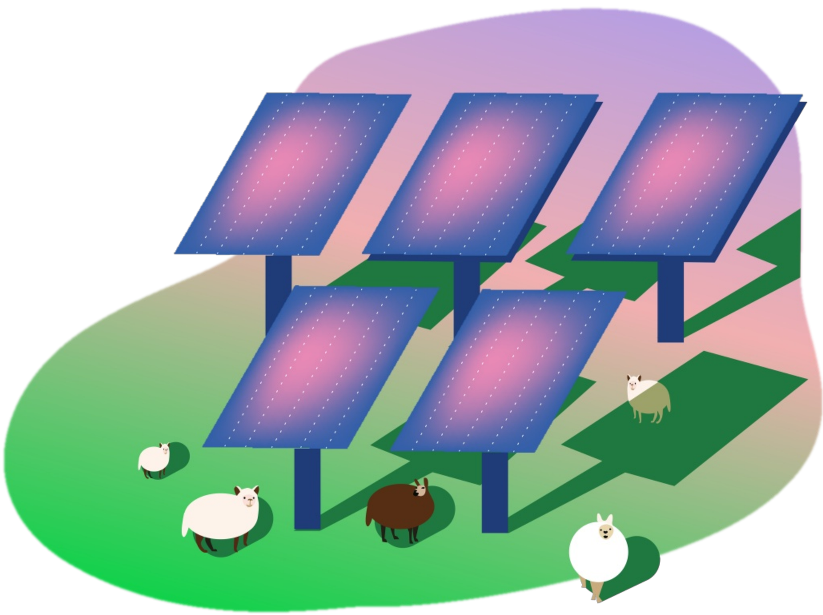
[64] Unite. 2023. Shock Rise in Bogus Self-Employment in Construction. www.unitetheunion.org/news-events/news/2023/august/shock-rise-in-bogus-self-employment-in-construction.

[65] Vivid Economics. 2021. Capturing Carbon at Drax: Delivering Jobs, Clean Growth and Levelling up the Humber Report Prepared for Drax Executive Summary Background.

[66] Sato, Yu. 2023. "The Economic Impact of Drax Power Station in the UK." Oxford Economics., www.oxfordeconomics.com/resource/the-economic-impact-of-drax-power-station-in-the-uk/.

[67] Campaign against Climate Change Trade Union Group. "Climate Jobs: Building a Workforce for the Climate Emergency." www.cacctu.org.uk/climatejobs.

Renewable Energy Generation



Vision: An energy system powered by renewable energy, where electricity is used for most transport and heating as well as its current uses.

This section considers the potential for increasing the amount of renewable electricity generated onshore in Yorkshire and the Humber and estimates the number of new jobs that would be created. Decarbonising our energy system means moving away from fossil fuels – such as the petrol and diesel used in vehicles, as well as fuel oil and gas used in home heating and in other buildings – and instead using electricity generated from renewable sources[1]. Because most renewable generation is intermittent, dependent on the wind, sun or flow of water, we also need to better manage energy demand so that it more closely matches supply, and to invest in energy storage and upgrade the electricity grid.

The latest annual review by the Association for Renewable Energy and Clean Technology (REA), published in 2023 but covering the financial year 2021/22, shows that across the UK there were 140,700 people employed in the renewable energy sector (not just electricity generation)[2]. The REA considers that this number could increase by 70,000 by 2035.

Existing renewable generation in Yorkshire and the Humber

Table 3.1 shows the breakdown by technology of current (2022) renewable energy generation in Yorkshire and the Humber. In 2022 Yorkshire and the Humber produced 3.4 GWh of renewable electricity (excluding biomass), primarily from solar and wind. This compares to 20.7 GWh electricity consumed in the region in 2022[3].

Table 3.1. Renewable Generation across Yorkshire and the Humber (2022 figures)

Council Area	Renewable Energy Generation (MWh)					
	Onshore wind	Solar PV (land)	Solar PV (rooftop)	Hydro	Anaerobic digestion	Total
Kingston upon Hull	26.0	0.1				26.1
East Riding of Yorkshire	63.6	737.5			115.2	916.3
North East Lincolnshire	30.2	2.9	835.7			868.8
North Lincolnshire	71.4	301.7			91.4	464.5
North Yorkshire	157.2	91.3		7.0	36.3	291.8
York	12.7	0.1				12.8
Barnsley	20.0	70.8			1.3	92.1
Doncaster	40.5	137.1			56.6	234.2
Rotherham	19.6	42.9				62.5
Sheffield	25.8	0.1		2.2	11.0	39.1
Bradford	20.3	5.3				25.6
Calderdale	10.2	151.8		0.3		162.3
Kirklees	22.8	5.8				28.6
Leeds	40.1	31.2		1.9	51.8	125.0
Wakefield	26.6	2.7		3.8	22.3	55.4
Total	**587**	**1,581**	**836**	**15**	**386**	**3,405**
	Total electricity consumption (GWh)					**20,726**

Note: This excludes biomass (including from Drax), and anaerobic digestion includes from sewage

Two thirds of this wind generation is onshore, and one third is offshore. The region's offshore wind generation will increase significantly as some of the UK's biggest offshore wind farms come online (Hornsea and Dogger Bank off the coast of North Yorkshire, see Appendix 2)[4]. This has already led to significant investment and government support to bolster the wind farm supply chain in the Humber area[5][6]. Wider investment is proposed to enable these wind farms to be serviced from Scarborough[7]. Such investments are shifting the Humber from being a fossil-fuel powered "Megawatt Valley[8]" to a renewable "Energy Estuary"[9].

Renewable generation potential in Yorkshire and the Humber

The potential for renewable energy in Yorkshire and Humber was investigated in 2011 to assist councils to develop local planning policies[10]. In their study, the consultants AECOM found that by 2025 the region could have installed 5,500 MW of *onshore* renewables and be generating 16 GWh of renewable energy annually. Their study excluded co-firing of biomass at Drax. The methodology for this study was later reviewed and found to be robust[11].

In 2024 research by the Centre for Doctoral Training in Environmental Intelligence (CDT EI) at Exeter University, commissioned by Friends of the Earth, examined the UK's potential to increase onshore wind and solar generation. Both of these onshore renewables generate electricity more cheaply than offshore wind[12]. However, the planning system has held back approval of new onshore wind since 2011. Now government has committed to permit onshore wind this could come forward quickly as research into lead times for solar and wind developments has shown[13]. With many schemes already having completed feasibility studies, many projects could be quickly brought forward now that the Government has put onshore wind on the same footing as other energy development in the National Planning Policy Framework[14].

Since 2011 wind turbines have become much larger, and some older existing turbines, including in Yorkshire, have already been replaced with larger ones and repowered[15]. Larger turbines generate more energy, as reflected in the far higher wind energy potential in the 2024 Exeter University study. One wind farm at Overton Moor in West Yorkshire was repowered in 2016, doubling the original generation capacity. Research has calculated that repowering all UK onshore wind could increase generation capacity by 5.5 GW[16]. The solar potential is far greater than estimated in 2011 as the price of solar panels has fallen substantially such that large-scale solar farms are now viable.

In addition, there may be potential for geothermal energy generation in Yorkshire and Humber. A study to determine geothermal energy potential is underway at a former fracking site near Kirby Misperton[17] and to create a geothermal heat network in Pickering[18]. However, this is still at the research stage, with limited estimates of scale or timetable for potential delivery, so is not included in our estimate of renewable energy potential.

The study estimated potential generation from suitable land as set out in Table 3.2.

Table 3.2 Criteria to estimate onshore wind and land-mounted solar potential

General criteria	Wind farm criteria	Solar farm criteria
» Within 5 miles of grid connection. » Only in AONB and national parks if smaller and sensitively located » 1km buffer around heritage sites	» Excluded land areas < 5 Ha » Excluded sites with average wind speed < 5m/s at 50m » Prioritised wind farm over solar farm where land could be used for both (to increase supply in winter)	» Excluded grade 1 & 2 agricultural land (consistent with the Food and Farming section) » Excluded land areas < 1 Ha » Excluded rooftop solar* and solar on car parks

* Rooftop solar is calculated separately.

We have combined the potential identified in these two studies, taking a conservative estimate by reducing the solar generation potential in the 2024 study by 50%, and added the potential for roof-top solar[19]. We then compared the 2011 estimates with government information as to what had been commissioned up until 2022. Only biomass production from wood fuel and animal waste and anaerobic digestion from sewage and food waste have been included in this summary of current energy generation. In addition to the exclusions to **Table 3.1** above, future potential for agricultural residues and waste wood has not been included as changes in the use and volumes of these are anticipated. Thus, the potential additional capacity for renewable electricity generation in each district by technology is shown in **Table 3.3**.

Table 3.3 Potential additional onshore renewable generation installed capacity across Yorkshire and Humber (2024)

Council Area	Renewable Energy Generation Potential Capacity (MW)					
	Onshore wind	Solar PV (land)	Solar PV (rooftop)	Hydro	Anaerobic digestion	Total
Kingston upon Hull		5.1	154.5		4.3	163.9
East Riding of Yorkshire	2278.3	2455.1	145.5			2764.5
North East Lincolnshire	61.3	161.6	81.4			304.3
North Lincolnshire	706.0	541.6	74.4			920.3
North Yorkshire	2751.1	4456.0	49.1	8.8	46.1	7311.1
York	1.9	6.2	103.3		0.3	111.7
Barnsley	1.2	3.7	92.2	0.2	1.7	99
Doncaster	135.4	343.0	142.0	0.3	0.0	620.7
Rotherham		2.2	110.3	0.9	2.4	115.8
Sheffield			303.2	1.0	2.1	306.3
Bradford	8.4	14.7	234.5	4.0	0.7	262.3
Calderdale	53.7	178.7	111.2	2.3	2.3	349.2
Kirklees	4.2	6.7	200.4	2.3	3.3	216.9
Leeds	5.6	4.6	460.0	2.5	6.3	479
Wakefield			168.2	1.4	5.0	174.6
Total	**6007.1**	**8178.9**	**2430.1**	**23.5**	**80.4**	**14199.6**

Notes: Biomass based renewable-energy generation has been excluded as it is hard to distinguish large-scale biomass which has significant environmental impacts from government estimates. Anaerobic digestion includes from sewage

Considering just onshore wind and solar alone, the combined total of current generation and the above identified generation potential totals over 31 GWh (see **Table 3.4**).

Table 3.4 Future onshore wind and solar generation potential across Yorkshire and the Humber

Council Area	Renewable Energy Generation (GWh/year)	
	Onshore wind	Solar PV (land)
Kingston upon Hull	0.1	35.1
East Riding of Yorkshire	5739.6	5142.7
North East Lincolnshire	137.5	318.9
North Lincolnshire	1851.7	1330.9
North Yorkshire	6131.4	8128.4
York	4.3	23.8
Barnsley	55.9	97.3
Doncaster	389.2	784.1
Rotherham	46.4	66.3
Sheffield	59.4	26.0
Bradford	54.0	51.6
Calderdale	153.2	639.9
Kirklees	48.8	40.5
Leeds	65.8	79.3
Wakefield	32.8	29.4
Total	**14770.0**	**16794.2**

Note: Inclusion of solar PV on rooftops (see below) will also add to the scale of solar PV generation.

In addition to this additional renewable energy onshore there is capacity for further development of offshore wind, and potentially tidal power. The North Sea currently has around 50% of the UK's offshore wind, which accounts for around half the UK's current installed wind power, and 24% of global offshore capacity (2022)[20][21][22]. The scope for new offshore wind projects (see Appendix 2) far exceeds the current projects in planning or construction. This could increase further with increased funding of £1.5 billion announced for UK Government's next renewable energy auction[23]. The Hull tidal lagoon plan is mainly to reduce flood risk in Hull but could include power generation from the tide[24]. We do not know how viable these proposals are. While this could build on studies in the 1980s estimating that a barrage on the

Humber could generate 1650 GWh/year[25], Hull's declaration as a centre for tidal power research has since faltered with the plant abandoned and the research company going into liquidation[26][27].

Increasing renewable-powered electricity, reducing overall energy demand

Getting to zero carbon requires significant reduction in overall energy use alongside the development of new renewable generating capacity. We cannot simply replace fossil fuels with renewables, we also need to reduce our energy demand, which will require more *electricity* generation but less overall *energy* use. Electricity demand is predicted to increase significantly, even as overall energy use falls, because both heating and transport need to be switched from fossil fuels to electricity.

Getting to net zero is likely to require a doubling of electricity generation – which would amount to around 42 GWh (twice the figure for 2022 as in Figure 3.1)[28]. However, Table 1.5 shows that onshore solar and wind alone could provide around three quarters of this amount of electricity from onshore renewables, before any offshore renewables (or indeed anaerobic digestion) are considered, which would make Yorkshire and the Humber into a renewable energy Powerhouse – providing a substantial contribution to national demand. To do this though will require both an upgrading of the local grid to enable the connection of new generation capacity as well as provision of local storage and balancing, for example the 50 MW battery storage park granted planning permission outside York in 2019[29] and the installation of batteries with solar PV systems in domestic and other properties[30].

Research by the Intergovernmental Panel on Climate Change (IPCC) working group in 2022 found that changing how we live can have far more impact on energy use than technological changes alone, for example in transport and in the temperature control of buildings. The research concluded that behaviour change could reduce energy demand by an estimated 5% to over 70%[31]. This requires changes in the way we live to be combined with infrastructure changes such as improvement to the energy efficiency of buildings (by investing in street-by-street retrofit of homes, as well as other buildings) and shifting journeys to walking and cycling, buses, trams and trains. Experts refer to this as changing 'systems of provision' or 'daily practices'[32]. This could mean:

» Provision of local public services (e.g. local GP and dentists and wider health and social care provision, community hubs and local shops etc.) will reduce the need to travel, as will the provision of employment opportunities within communities, rather than travelling to central locations distant from their homes, such as Drax.

» Similarly, changing how buildings are used needs to sit alongside retrofit, to ensure the changes to the fabric of the building are amplified by changes in building use, such as wearing different clothes and heating and cooling buildings differently in different seasons. For example, just wearing a suit and tie in the office in winter, but short sleeved shirts and no tie in the summer can have a profound effect[33].

By reducing overall energy demand, the time it will take to decarbonise society will be reduced and less up-front expenditure will be needed – not just in energy supply but across all sectors. For example, fewer EV charging points will be required if more people travel locally using active and/or public transport and less renewable power will be needed if overall energy demand across society falls, rather than continuing to rise. Thus, the transition across other sectors (transport, buildings, waste and resource use, food production etc.) will enable a wider transition to sustainable living, that defines the scale of energy (primarily electricity) supply needed, and hence the speed of transition.

Jobs from onshore renewable electricity generation

We have estimated the jobs involved in installation and maintenance of onshore renewables: onshore wind, solar rooftop and farms and hydropower, shown in **Table 3.3**.

To avoid double counting, and as the location of these jobs depends on government support and investment decisions, the job numbers in this report do not include those in the manufacturing supply chain, although there is clearly potential to develop this further in Yorkshire and the Humber, including for offshore wind. Transition Economics (2022) recently highlighted that UK job creation in offshore wind "has not met expectations due to achieving less local construction and manufacturing content than anticipated, with nacelles, towers, foundations, cables and substations largely manufactured overseas and imported, so there is greater potential for these supply chains to be developed in the UK[34]."

Yet the UK already has a competitive edge in much of these technologies, so expanding domestic demand could be all that is needed to make the commercial case for this investment, including in Yorkshire and the Humber[35].

This will also require investment in new jobs to facilitate this amount of renewable energy generation, specifically large-scale transition grid reinforcement[36], and investment in demand management and energy storage. The jobs estimates have also excluded jobs from anaerobic digestion in future renewable energy generation potential for the following reasons:

» Jobs associated with food waste collection are included under waste and recycling, so excluded to avoid any double counting and jobs associated with converting existing sewage works to capture biomass are minimal.

The assumption is that installation takes place over the 10-year transition period. Long-term jobs are jobs in operation and maintenance of this renewable energy capacity. These are summarised for different local authority areas in **Table 3.5**.

Table 3.5 Net increase in renewable energy generation jobs by local authority area

Council Area	Renewable Energy Generation Jobs		
	Year 2	Year 10	Long-Term
Kingston upon Hull	70	70	1
East Riding of Yorkshire	2,668	3,083	1,037
North East Lincolnshire	140	157	43
North Lincolnshire	761	876	288
North Yorkshire	3,749	4,347	1,493
York	39	39	2
Barnsley	41	42	1
Doncaster	283	320	92
Rotherham	52	53	2
Sheffield	155	156	1
Bradford	141	145	10
Calderdale	167	185	46
Kirklees	104	106	5
Leeds	248	250	6
Wakefield	81	82	2
Total	**8,699**	**9,910**	**3,028**

Note. Includes only onshore wind, ground and roof-mounted solar, and hydropower.

As already noted above, these jobs are just the direct jobs which would be generated on-site based on conservative assumptions of the amount of onshore renewable energy that could be delivered. Plans to develop offshore wind are already progressing and there is also potential to develop floating turbines and tidal power in the future. All of this new generation capacity, both onshore and offshore, will require a huge array of supply chain jobs to produce the components needed. For example, figures from the industry body, International Renewable Energy Agency (IRENA) reported that UK employment in wind power reached 75,000 in 2022 (including indirect jobs). This included 17,400 direct jobs supporting offshore wind, of which 2,850 were in Yorkshire and the Humber[37]. Committing to the on-site investment in new renewables across the region would strengthen the case for investment to strengthen these industrial supply chains in the region too.

[1] This follows the scenario set out in the Zero Carbon Britain reports, see Centre for Alternative Technology (2019) Zero Carbon Britain; Rising to the Climate Emergency

[2] Association for Renewable Energy and Clean Technology (REA) (2023) REview23. https://www.r-e-a.net/resources/review23/.

[3] DESNZ (2024) Regional and local authority electricity consumption statistics. https://www.gov.uk/government/statistics/regional-and-local-authority-electricity-consumption-statistics.

[4] Across the UK, REA note that a further 5GW is under construction with 45GW potential to be operational by 2030. RenewableUK (2024) UK can secure record number of offshore wind farms in this year's auction for new projects. https://www.renewableuk.com/news/665698/UK-can-secure-record-number-of-offshore-wind-farms-in-this-years-auction-for-new-projects.htm

[5] SeAH Wind Ltd received government funding towards a new £117 million monopile foundation factory in the Humber in 2021. BEIS (2021) Huge jobs windfall for the North East and Yorkshire. https://www.gov.uk/government/news/huge-green-jobs-windfall-for-the-north-east-and-yorkshire

[6] A wind turbine blade factory in Hull is to be doubled in size after the government confirmed it would provide financial support for the expansion. BBC (2021) UK renewable energy: Major expansion confirmed on Humber. BBC News, 9 August 2021. https://www.bbc.co.uk/news/uk-england-humber-58143027

[7] Edwards, R (2024) Plan to upgrade harbour could create offshore jobs. BBC News, 4 August 2024. https://www.bbc.co.uk/news/articles/c3gelq25yyzo

[8] Hawkes, T (2020) A Just Transition (webpage published by CAT, 9 December 2020).. https://cat.org.uk/a-just-transition/

[9] MHCLG (2024) Enterprise Zones. https://enterprisezones.communities.gov.uk/enterprise-zone-finder/humber-enterprise-zone/

[10] AECOM (2011) Low carbon and renewable energy capacity in Yorkshire and Humber – Final Report, March 2011. https://www.kirklees.gov.uk/beta/planning-policy/pdf/supportingDocuments/climateChange/Low-Carbon-Renewable-Energy-Capacity-Yorkshire-Humber.pdf

[11] Harley Stoddart and David Turley (2012) Review of approaches adopted in regional renewable energy capacity assessments when following the Regional Renewable and Low Carbon Energy Capacity Methodology, NNFCC Project 11-030. https://assets.publishing.service.gov.uk/media/5a75736840f0b6397f35e862/5827-review-approaches-adopted-regional-renewable.pdf

[12] Exeter University, Centre for Doctoral Training in Environmental Intelligence (2024)

How England can produce more onshore renewable energy fast. Published by Friends of the Earth, UK. https://policy.friendsoftheearth.uk/insight/how-england-can-produce-more-onshore-renewable-energy-fast

[13] Clapin, L. and Longden, T. (2022) Waiting to generate: an analysis of wind and solar project development lead-times in Australia's National Electricity Market Zero-Carbon Energy for the Asia-Pacific ZCEAP Working Paper ZCWP07-22

https://iceds.anu.edu.au/files/ZCEAP_CCEP_WP_Lead%20times%20solar%20wind.pdf

[14] Hakimian, R (2024) Government removes ban on onshore wind development in England. https://www.newcivilengineer.com/latest/government-removes-ban-on-onshore-wind-development-in-england-08-07-2024/
#:~:text=The%20revision%20to%20the%20planning,way%20as%20other%20energy%20development.

[15] Fichtner (undated, web page accessed September 2024) Projects: Overden Moor and Royd Moor Onshore Wind Farms. https://fichtner.co.uk/projects/ovenden-moor-royd-moor-onshore-wind-farms/ Fichtner (undated, web page accessed September 2024) Projects: Overden Moor and Royd Moor Onshore Wind Farms. https://fichtner.co.uk/projects/ovenden-moor-royd-moor-onshore-wind-farms/

[16] Richard, C (2018) Repowereing boosted UK projects' capacity by 171%. Wind Power Monthly. https://www.windpowermonthly.com/article/1519033/repowering-boosted-uk-projects-capacity-171

[17] Ceraphi (undated, webpage accessed September 2024) KMA Study: Project - Gas-Well Repurposing Kirby Misperton. https://ceraphi.com/wp-content/uploads/2023/06/KMA-Study.pdf

[18] Cariaga, C (2024) Pickering, North Yorkshire awarded grant for geothermal investigation. www.thinkgeoenergy.com/pickering-north-yorkshire-awarded-grant-for-geothermal-investigation/

[19] For homes our estimate assumes installation of high performance PV panels (201 W/m2) on a roof area equivalent to 20% of domestic ground floor area. Deductions have been made for existing solar panels but not for listed buildings. For non-domestic buildings we assume a 20kWp array for each building (based on 100m2, this equates to around 13% of floor area). This is considered reasonable as it also equates to the estimated usable area of large warehouses in Yorkshire and Humber providing 12% of the UK's large warehouses, which are estimated to provide 75 million square metres of roof space.

Source: UK Warehousing Association (2022) Investment Case for Rooftop Solar Power in Warehousing. https://www.ukwa.org.uk/wp-content/uploads/2022/09/Investment-Case-for-Rootop-Solar-Power-in-Warehousing-August-2022.pdf. This is based on government published data on commercial floor area (https://www.gov.uk/government/collections/non-domestic-national-energy-efficiency-data-framework-nd-need) scaled to Yorkshire and Humber based on the region having 12% of warehouses over 100,000 sqft. (https://www.csrf.ac.uk/wp-content/uploads/2023/05/ENG-TR.033-SRF-Warehousing-in-the-UK-summary-slideset.pdf).

[20] Ukpanah, I (2024) The statistical landscape of wind farms in the UK. https://www.greenmatch.co.uk/green-energy/wind-farm.

[21] (undated, accessed September 2024) North Sea Offshore Wind Development https://www.gem.wiki/North_Sea_Offshore_Wind_Development#:~:text=Current%20Power%20Capacity%20Mix,-In%20the%20first&text=According%20to%20the%20January%202023,the%20national%20waters%20surrounding%20it.

[22] The Crown Estate (2023) Offshore Wind report 2022. https://www.thecrownestate.co.uk/media/4382/11720_owoperationalreport_2022_tp_020523plusaccessibility.pdf.

[23] DESNZ (July 2024) Record breaking funding for clean energy in Britain. https://www.gov.uk/government/news/record-breaking-funding-for-clean-energy-in-britain.

[24] (undated, accessed September 2024) Lagoon Hull. https://www.lagoonhull.co.uk/more-green.

[25] Department of Energy (DoE), Central Electricity Generating Board (CEGB) and Severn Tidal Power Group (STPG), 1989. The Severn Barrage Project: General Report, Energy Paper Number 57 (EP57), HMSO, London. Referenced in Burrows, Ruain & Walkington, I. & Yates, Nick & Hedges, Terry & Chen, Daoyi & Li, Ming & Zhou, J. & Wolf, Judith & Proctor, Roger & Holt, Jason & Prandle, David. (2009). Tapping the Tidal Power Potential of the Eastern Irish Sea. 10.13140/RG.2.2.35469.13285. https://www.researchgate.net/publication/313649808_Tapping_the_Tidal_Power_Potential_of_the_Eastern_Irish_Sea/link/58a1872ca6fdccf5e96eb650/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoicHVibGljYXRpb24ifX0. But this does not appear to have been investigated in detail, as opposed to other sites (For example, see Ferris, N (2022) THe Mystery of the UK's untapped Tidal Power. Energy Monitor. https://www.energymonitor.ai/tech/renewables/the-mystery-of-the-uks-untapped-tidal-power/?cf-view and Vandercruyssen D, Baker S, Howard D, Aggidis G (2023) Tidal range generation: combining the Lancaster zero-dimension generation and cost models. Energy Volume 177 Issue 2, April, 2024, pp. 49-62. https://doi.org/10.1680/jener.22.00077).

[26] News Humberside (2011) Humber Estuary becomes centre for tidal power research. BBC News, 14 December 2011. https://www.bbc.co.uk/news/uk-england-humber-16186209.

[27] BBC News (2014) Calls to remove disused Humber tidal plant. BBC News, 13 January 2014. https://www.bbc.co.uk/news/uk-england-humber-25715337.

[28] Climate Change Committee (2020) The Sixth Carbon Budget: The UK's path to Net Zero. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf. Figure 3.4a

[29] One plant has been approved by August 2024 (PWA Planning Group (undated, accessed September 2024) Planning for an energy storage scheme close to historic York. https://www.pwaplanning.co.uk/projects/energy-storage-scheme-close-to-historic-york/) and a further plants proposed, such as in Osbaldwick. Galloway S (2023) Large battery storage plan for Osbaldwick. Westfield Focus. https://

westfieldnewsfocus.wordpress.com/2023/08/31/large-battery-storage-plan-for-osbaldwick/.

[30] Battery storage is increasingly installed alongside PV panels – see for example Solar Together (2024) Is Battery Storage Worth it for UK Homeowners? An In-depth Look? https://solartogether.co.uk/blog/solar-battery-storage-is-it-worth-it/.

[31] Creutzig, F., and Roy, J. (2022) 'IPCC Sixth Assessment Report: Chapter 5, Demand, Services and Social Aspects of Mitigation'. IPCC. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

[32] See Shove, E, at al. (2012) The Dynamics of Social Practice: Everyday Life and How it Changes. Sage. https://uk.sagepub.com/en-gb/eur/the-dynamics-of-social-practice/book235021 and Bayliss, K, and Fine, B (2020) A Guide to Systems of provision: Who Gets What, How and Why. Palgrave Macmillan. https://www.researchgate.net/publication/348221549_A_Guide_to_the_Systems_of_Provision_Approach_Who_Gets_What_How_and_Why.

[33] Essex, J., Sims, P. and Storey, N. (2022) 'Rethinking Energy Demand'. Green House Think Tank, UK. https://www.greenhousethinktank.org/static/2022/Rethinking_Energy_Demand_Report_Oct2022_v2.pdf.

[34] Transition Economics (2022) Potential Clean Job Creation in Areas with High Oil & Gas Employment. Published by Platform London, UK https://platformlondon.org/resource/potential-clean-job-creation-in-regions-with-high-oil-gas-employment/.

[35] Pranesh Narayanan, George Dibb. Enrico Vanino, Simone Gasperin and Luke Murphy (2024) Manufacturing Matters: The Cornerstone of a Competitive Green Economy. IPPR Fair Transition Unit. https://ippr-org.files.svdcdn.com/production/Downloads/Manufacturing-matters-May-24_2024-05-15-131750_sldr.pdf.

[36] Martins L (2024) New connections, old delays: the grid connection 'farce'. https://www.solarpowerportal.co.uk/new-connections-old-delays-the-grid-delay-farce/.

[37] IRENA (2023) Renewable Energy and Jobs: Annual Review 2023. https://www.irena.org/Publications/2023/Sep/Renewable-energy-and-jobs-Annual-review-2023, page 54 and IRENA (2023) Renewable Energy Employment by Country (webpage). https://www.irena.org/Data/View-data-by-topic/Benefits/Renewable-Energy-Employment-by-Country.

Buildings and Heat

Vision: Buildings are energy efficient so require little heating or cooling. The heat they do need is provided primarily by heat pumps.

Over half of Yorkshire and Humber's territorial greenhouse gas emissions are from homes (28%) and public and commercial buildings (26%). These could be substantially reduced. The Zero Carbon Britain scenario considered that the energy used to heat buildings could be reduced by around 50% by building all new homes to Passivhaus standards (thus requiring very little energy to heat) and retrofitting existing buildings. Better roof, wall and floor insulation is needed to cut heat loss, reduce draughts and recover heat from building ventilation systems[1]. Further reductions in energy demand could be made by better heating controls and reducing internal temperatures (which have increased in recent decades)[2].

Heat pumps should replace all gas and oil heating systems. These pump heat energy from a source outside the building (ground, water or air) into a building, thereby raising the temperature inside the building. As dangerous heat waves become more common, heat pumps may also be used to *remove* heat from a building. A heat pump can use just a quarter of the energy used by a boiler or electric radiators, bringing immediate reductions in emissions. As the proportion of renewables used to generate electricity grows, the carbon intensity of the grid (the amount of carbon dioxide emitted for each unit of electricity consumed) reduces, so in future heat pumps will reduce carbon emissions even more. From 2025 new homes will not be allowed to have gas boilers installed[3], and gas boiler sales are to be phased out by 2035[4].

Heat pumps are best suited to well-insulated buildings, so should be part of a retrofit programme. An alternative to heat pumps could be district heating systems (e.g. for dense urban areas or new buildings). These could use waste heat from industry or pumped from underground (e.g. from former mine workings, geothermal energy as discussed above). There are also proposals to decarbonise the gas grid by substituting fossil gas with biomethane or hydrogen[5][6]. However, making *green* hydrogen (i.e. by using renewably-produced electricity to split water) is extremely energy intensive, whilst making hydrogen from fossil fuels has high greenhouse gas emissions even with carbon capture[7] and biomethane has limited availability[8]. These therefore need to be prioritised for other uses, such as the few industrial processes which cannot be electrified. Friends of the Earth argue that hydrogen should be reserved for these uses[9]. In a recent review of 54 independent studies comparing different forms of domestic heating, no evidence was found to support a significant role for hydrogen in space or water heating, with heat pumps and district heating being overwhelmingly the cheaper and greener options.

Current Renewable Heat in Yorkshire and the Humber

Information about the use of renewable heat in the region has been obtained from data on accreditations for the Renewable Heat Incentive (RHI). The RHI covers biomass boilers, heat pumps and solar thermal (water heating), and most of these are for domestic properties. The non-domestic RHI was introduced in 2011 and the domestic RHI in 2014. The number of accreditations per district and the breakdown between the technologies is shown in **Table 4.1**.

Even assuming all the applications are for domestic properties, the proportion of properties with low carbon heating systems is less than 1%, except in North Yorkshire (3.5%), York (1.5%), Sheffield (1.7%) and Calderdale (1.1%).

This partly reflects the high number of properties in more rural districts that are off the gas grid (25% in North Yorkshire, 3-1u3% elsewhere)[10], for whom other forms of heating, such as fuel oil, is very expensive.

Table 4.1 Number of Renewable Heat Incentive accredited installations by technology type and local authority area [11]

	Air source heat pump	Ground source heat pump	Biomass systems	Solar thermal	Total number of accredited installations
Kingston upon Hull	71	0	5*	5*	77
East Riding of Yorkshire	937	218	193	64	1,412
North East Lincolnshire	101	6	5*	5*	128
North Lincolnshire	364	35	56	17	472
North Yorkshire	7,267	1,460	1,169	528	10,424
York	948	218	193	65	1,424
Barnsley	104	6	5*	5*	131
Doncaster	371	35	56	18	480
Rotherham	218	34	23	24	299
Sheffield	2,755	750	591	188	4,284
Bradford	862	175	145	49	1,231
Calderdale	686	219	95	34	1,034
Kirklees	234	75	51	21	381
Leeds	300	117	120	39	576
Wakefield	201	60	74	19	354
Total	**15,419**	**3,408**	**2,781**	**1,081**	**22,707**

Note: Where indicated with a "*" a number of 5 has been assumed based on data withheld to prevent disclosure.

Over two-thirds of these installations are for air source heat pumps (68%), whereas there are similar proportions of ground-source heat pumps (15%) and biomass systems (12%). Solar thermal uptake is particularly low, making up 5% of installations, equivalent to 0.04% of homes. The usefulness of solar thermal for heating water is limited by the fact that many households now use dishwashers and washing machines that take a cold fill, and electric showers rather than baths. However, in houses that can accommodate a storage tank, they can make a significant contribution to heating. The electricity from a solar PV system can be exported to the grid, stored in a battery or used to heat water. The rate of installation of these technologies needs to be far more ambitious to address the very big chunk of UK carbon emissions not being dealt with in heating buildings. The National Audit noted that heat pump installations to meet government targets would require an eleven-fold increase by 2028[12].

However, whilst biomass systems are counted under the RHI, there are multiple climate, environmental and health concerns related to their operation; as with wood burning stoves. Sourcing material for wood pellets at scale threatens forests, biodiversity and carbon sequestration. The creation and combustion of wood pellets, or wood, emits dangerous and harmful air pollutants.

Improving energy efficiency and heating of buildings in Yorkshire and the Humber

The main challenge is the existing building stock. Information on the energy efficiency of homes across Yorkshire and the Humber has been obtained from the national database of Energy Performance Certificates (EPCs)[13]. EPCs were introduced in 2008 and rate properties from A to G on the basis of their construction, levels of insulation, heating systems, efficiency of lighting, etc. In theory a band D property will use about 4 times as much energy per m^2 as a band A, and band G properties will use at least six times as much[14]. EPCs are required when buildings are sold, rented out or apply for a feed-in tariff or RHI payments for renewable energy systems. Therefore, the homes in Yorkshire and Humber[15] with an EPC are likely to be more energy efficient, on average, than the properties for which an EPC has not been obtained, as they will include all the new ones and those with renewable energy systems.

The EPC rating of domestic and non-domestic properties in each district is shown in **Figures 4.1** and **4.2**. Only 0.3% of homes are rated A, 10.0% B and 31.1% C. Almost 60% are D or below. Of the non-domestic properties with an EPC (it is not known what proportion of the total stock of such properties this is) 7.4% of the building area is rated A, 21.4% B and 34% C with 37% of non-domestic properties with EPCs rated at band D or below.

Public buildings over 250m^2 are required to have a Display Energy Certificate (DEC), also rated A-G rating for the building, but it is based on actual energy use (heating fuel and electricity consumption) not just on inspection of the building. For Yorkshire and Humber just under 10% are A or B rated, with 67% D to G[16].

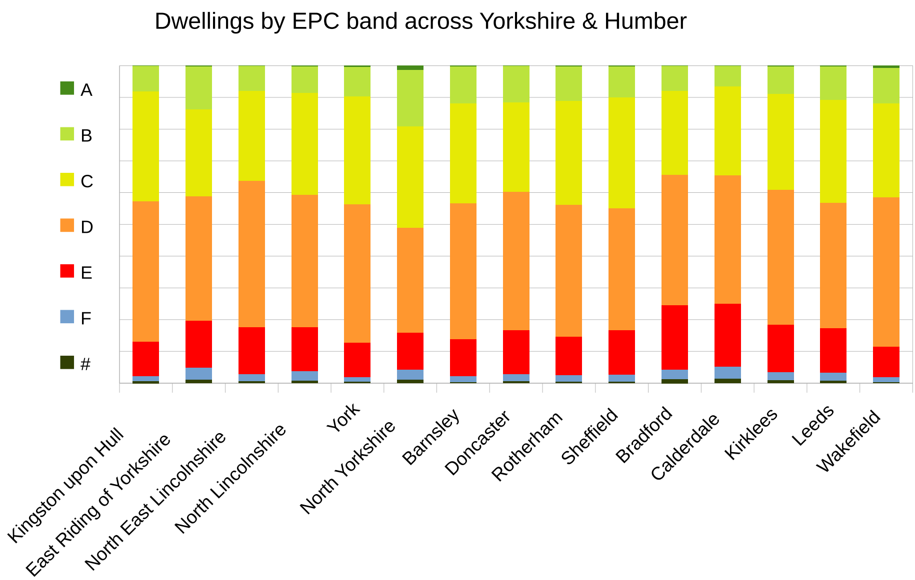


Figure 4.1 Current Range of Home Energy Efficiency (rated by EPC band) across Yorkshire and Humber

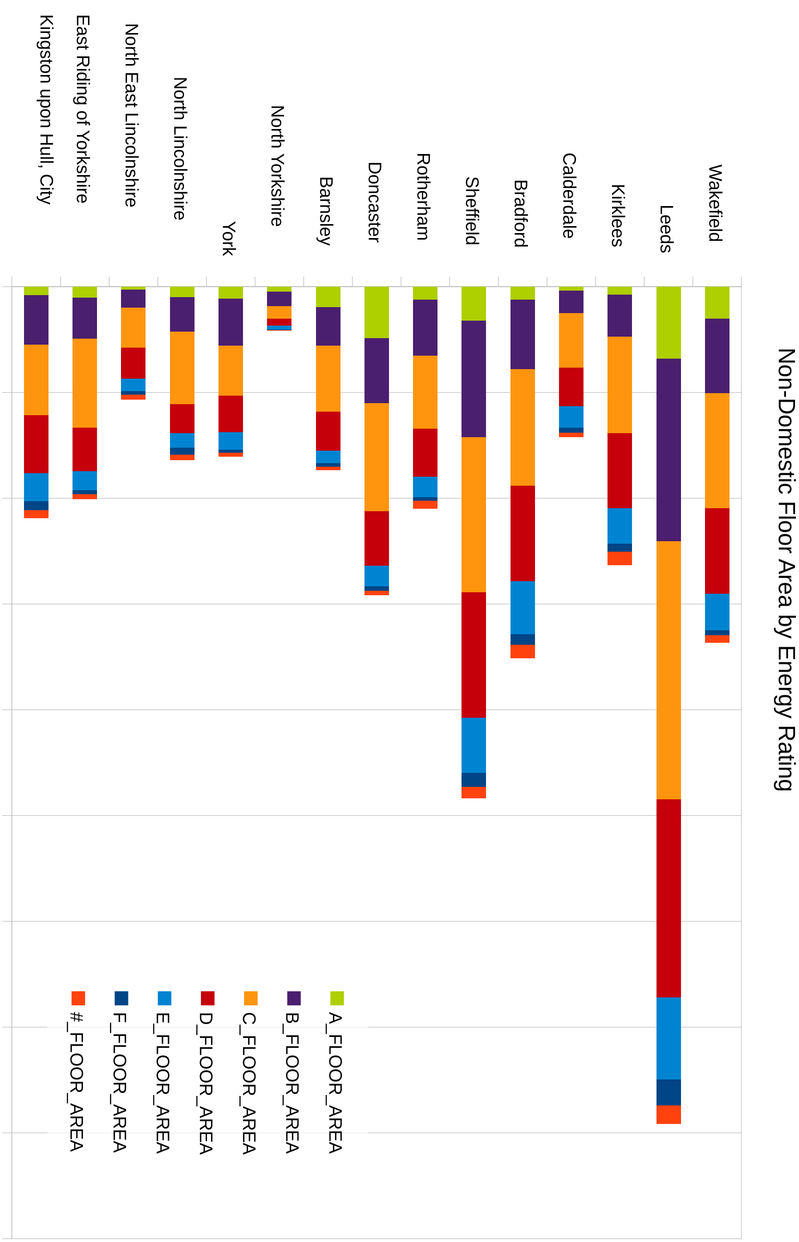


Figure 4.2 Current Range of Non-Domestic Building Energy Efficiency (rated by EPC band) across Yorkshire and Humber

The current government target is to upgrade houses to EPC band C by 2035 "where practical, cost-effective and affordable", and for all fuel-poor households, and as many rented homes as possible, to reach the same standard by 2030[17]. The UK's independent Climate Change Committee (CCC) commented that this is consistent with meeting carbon budgets at least cost, so long as the conditions of "practical" and "affordable" do not substantially restrict "cost-effective" uptake[18]. This is consistent with the level of ambition to deliver a 10-year transition plan set out in this report. This equates to upgrading 2,000 properties a week to band C or better across Yorkshire and the Humber.

This report targets a higher standard with most homes retrofitted to at least an EPC rating of B, with 75% retrofitted in total (all those D-G and around half of those currently EPC 'C'). This is consistent with the ambition being considered in London. A 2021 report by London Councils estimated that to retrofit all homes across London to an average rating of EPC band B would cost an average of £25,900 per home, where 97.5% of homes are EPC rating of band C or lower[19]. This included eliminating single glazing and gas boilers and upgrading the energy performance of homes by improving the building fabric energy efficiency, adding double/triple glazing and ventilation systems, changing heating systems to heat pumps and installing energy storage, smart energy controls and roof mounted solar panels.

Jobs in building retrofit and renewable heat

The jobs total is calculated using estimates for the extent of building retrofit required (see **Figure 4.1** and **4.2**), and the number of buildings still with fossil fuel powered heating. We have therefore calculated the jobs that would be created from retrofitting air source heat pumps to 90% of the housing built up to 2025 (when gas boilers will no longer be permitted in new homes). In addition, we have assumed provision of a limited amount of solar thermal installations[20]. These estimates are conservative as they only include jobs to retrofit and install heat systems in homes, not public buildings, other non-domestic buildings or industrial demand for heat. In practice some of these other buildings will have a higher priority due to their higher energy use and potential to foster wider behavioural change (e.g. higher occupancy and energy use of libraries, community centres and other public buildings; health and social care facilities; care homes).

The Renewable Heat Incentive (RHI) data (see **Table 4.1**) shows air source heat pumps are the most common form of low carbon domestic heating. Installing the alternatives, such as ground or water source heat pumps and heat networks, is likely to involve similar if not more work, so an estimate based on air source heat pumps gives a conservative baseline of the number of jobs created. These jobs would to some extent replace those that are currently involved in fitting and maintaining gas boilers and other existing heating systems. However, a great deal more work is involved in fitting a heat pump (3-8 working days – see table below) than replacing a gas boiler (which can take just 4-6 hours[21]), so heat pumps require an increase in the workforce fitting heating systems. There will also be a need to decarbonise heat in non-domestic buildings, so the job estimates here are a minimum of the amount of work involved.

Retrofit jobs are based on retrofitting whole streets at once, across different tenures (social housing, private rent, owner occupied), bringing 75% of homes up to a “B” EPC standard (although best measured in terms of CO_2e/m^2). Areas with high amounts of social housing and fuel poverty should be prioritised. Some properties will be expected to be improved again, ideally to Passivhaus standard, drawing on improved understanding and an increasingly skilled workforce. However, this does mean that the initial round of work needs to be based on a longer-term plan for the building, ensuring that initial work lays the right foundation for any deeper work to be done later. This future upgrade will increase the number of jobs in the long-term, which would then be significantly more than the numbers we have estimated here.

The total number of jobs, including jobs in training and upskilling, is estimated to be an average of 22,300 jobs over the 10-year transition phase.

Table 4.2 Breakdown of home retrofit and technology installation jobs by type

Retrofit and heating on-site retrofit jobs	Total transition work (job-years)
Heat pump installation (1)	37,682
Solar thermal installation	28,738
Fabric retrofit	149,778
Training and skills development	6,485
Total	**222,683**
Total/year for a 10-year transition period	**22,268**

Notes on Table 4.2

1. Working days for installation of heat pumps from Heat Pump Association, 2019: pre-2018 properties – 8 working days; 2018-2025 properties – 6 working days; replacements – 3 working days.

2. Solar PV installation included in energy generation jobs in Section 3.

The total estimated increase in building work is set out in **Table 4.3**.

The total estimated increase in building work is set out in Table 4.3.

Council Area	Domestic Retrofit Jobs		
	Year 2	Year 10	Long-Term
Kingston upon Hull	1,263	1,657	492
East Riding of Yorkshire	1,535	2,051	644
North East Lincolnshire	774	1,011	297
North Lincolnshire	745	990	306
North Yorkshire	2,603	3,555	1,190
York	746	1,039	366
Barnsley	1,067	1,430	454
Doncaster	1,361	1,812	564
Rotherham	1,145	1,528	478
Sheffield	2,707	3,527	1,025
Bradford	2,329	3,031	878
Calderdale	1,030	1,336	383
Kirklees	1,911	2,517	758
Leeds	3,927	5,098	1,463
Wakefield	1,602	2,120	647
Total	**24,746**	**32,701**	**9,944**

The jobs estimates above set out the scale of the challenge to transform Yorkshire and Humber's housing stock, to at least be average-good (SAP rating B-C). However, the overall retrofit challenge will also include public buildings (requiring public-investment plans for schools, hospitals and all councils and government buildings), community and privately owned buildings. Developing this expertise to scale up delivery of retrofit (area-based, or street-by-street) will enable deeper retrofit of buildings to remove the need for heating and increasingly cooling (referred to as Passivhaus), which will continue to require employment to further improvements to building stock after this initial transition to achieve a minimum standard for all homes. Therefore, the total amount of work required to retrofit buildings across the region is far greater than that set out here, and will continue into the future.

[1] CAT (Centre for Alternative Technology) (2019) Zero Carbon Britain; Rising to the Climate Emergency. Page 42.

[2] Essex, J., Sims, P. and Storey, N. (2023) 'Rethinking Energy Demand: Heating and Cooling of Buildings – Policy Briefing'. Green House think tank, UK. Essex J, Sims P and Storey N (2022) Rethinking Energy Demand. Green House think tank, UK. https://www.greenhousethinktank.org/static/2023/Heating_and_Cooling_of_Buildings-Policy_Breifing_Jan2023_v1.pdf

[3] HM Treasury (2019) Spring Statement 2019: Philip Hammond's Speech. https://www.gov.uk/government/speeches/spring-statement-2019-philip-hammonds-speech.

[4] Although the new Labour government says it may not keep this target. George S (2024) Ed Mililband: Labour would scrap Tories' 2035 boiler ban. Edie news, 24 June 2024. https://www.edie.net/ed-miliband-labour-would-scrap-tories-2035-gas-boiler-ban/

[5] Harwood T, Danter M, Oxley R, Matthews S, Spriggs C, Allason D, Acton M and Flyon F (2021) The H21 Leeds City Gate project looked at converting the grid and boilers to hydrogen. H21 Phase 1 Technical Summary Report. https://www.northerngasnetworks.co.uk/wp-content/uploads/2024/03/H21-Phase-1-Technical-Summary-Report-WEBSITE.pdf.

[6] The Committee on Climate Change points out that hydrogen made from fossil fuels is not zero carbon, even when the carbon dioxide is captured and stored. Making hydrogen from fossil (natural) gas further increases emissions. CCC (2018) Hydrogen in a Low Carbon Economy. https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf

[7] Baxter T (2020) Hydrogen isn't the key to Britain's Green Recovery - here's why. https://theconversation.com/hydrogen-isnt-the-key-to-britains-green-recovery-heres-why-143059?utm.

[8] For example, the Committee on Climate Change estimated that the available biomass resource is 20 TWh, against an estimated 2030 gas demand (from industry, buildings and power) of 700 TWh (CCC, 2016) Technical Note: Biomethane. https://www.theccc.org.uk/wp[1]content/uploads/2016/12/2016-PR-Biomethane-Technical-Note.pdf p.3).

[9] Childs, M. (2020) The Role of Hydrogen in our Low-carbon Transition, Friends of the Earth. https://policy.friendsoftheearth.uk/insight/role-hydrogen-our-low-carbon-transition.

[10] Rosenow, J (2023) A meta-review of 54 studies on hydrogen heating, https://www.sciencedirect.com/science/article/pii/S2949790623000101 and DESNZ (2023) Sub-national estimates of properties not connected to the gas network.

https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network.

[11] Department for Energy Security and Net Zero (2023) Renewable Heat Incentive (RHI) and Renewable Heat Premium Payments (RHPP) monthly deployment data, www.data.gov.uk. Available at: https://www.data.gov.uk/dataset/28d823ff-310b-4620-8ba2-58dbd1d0c7c5/renewable-heat-incentive-rhi-and-renewable-heat-premium-payments-rhpp-monthly-deployment-data.

[12] NAO (2024) Low heat pump uptake is slowing progress on decarbonising home heating. https://www.nao.org.uk/press-releases/low-heat-pump-uptake-slowing-progress-on-decarbonising-home-heating/.

[13] EPC Open Data (2024) Energy Performance of Buildings Data: England and Wales. https://epc.opendatacommunities.org.

[14] Anne Chapman, Jonathan Essex, Andy Gouldson, Andrew Sudmant, Karen Mitchell (2021) The potential for green jobs in Cumbria. Cumbria Action for Sustainability. https://cafs.org.uk/wp-content/uploads/2021/03/The-potential-for-green-jobs-in-Cumbria-v4.pdf.

[15] The total number of domestic properties in Yorkshire and the Humber was obtained from VOA (2023) Council tax: stock of properties, 2023. https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2023.

[16] MHCLG (2024) Live tables on Energy Performance of Buildings Certificates. https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates.

[17] UK Government (2017) The Clean Growth Strategy: Leading the way to a low carbon future. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf.

[18] Climate Change Committee (2018) An independent assessment of the UK's Clean Growth Strategy From ambition to action, p.58. https://www.theccc.org.uk/wp-content/uploads/2018/01/CCC-Independent-Assessment-of-UKs-Clean-Growth-Strategy-2018.pdf.

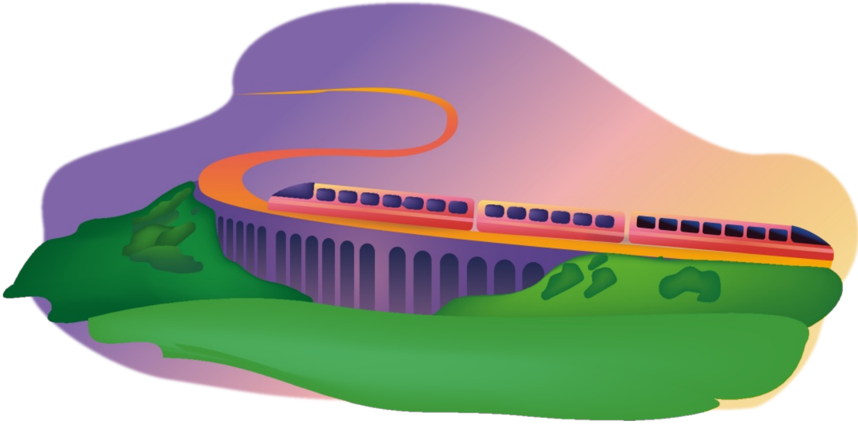
[19] London Councils (2021) Retrofit London Housing Action Plan.

https://democracy.cityoflondon.gov.uk/documents/s158853/Appendix%203%20Retrofit%20London%20Housing%20Action%20Plan.pdf, page 73 (2021 prices).

[20] Assumed to take around 2% of domestic roof area.

[21] (undated, last accessed September 2024) How long does it take to fit a boiler? https://idealheating.com/tips-and-advice/how-long-does-it-take-to-fit-a-boiler.

Transport



Vision: There is less need to travel and more of the journeys that are made are by walking, cycling and public transport rather than by private car. Buses and trains have good disabled access and are within easy reach of where people live. Most vehicles with internal combustion engines (ICE) are replaced by electric vehicles (EVs). The railways are electrified, use green hydrogen or batteries.

Transport currently accounts for around 28% of Yorkshire and Humber's territorial emissions, most of which are due to road transport. Transport across Yorkshire and the Humber varies significantly across different local council areas. For example, the numbers travelling by private motorised vehicle to work vary substantially, from 57% in York to 82% in North Lincolnshire. Similarly, use of public transport varies hugely, from 20% in Sheffield to just 3% in North East Lincolnshire. The data for 2011 commuting across Yorkshire and the Humber is included in **Table 5.1**.

Table 5.1 Method of Travel to Work (2011)[1]

	Car/van/ motorbike	Bus	Train/ Tram etc.	Bicycle	On foot	Other
Kingston upon Hull	64.6%	13.4%	0.7%	8.3%	12.2%	0.8%
East Riding of Yorkshire	79.0%	3.0%	1.6%	4.0%	11.4%	0.9%
North East Lincolnshire	74.6%	6.3%	0.6%	5.6%	12.0%	0.9%
North Lincolnshire	81.8%	2.5%	0.5%	4.0%	10.4%	0.7%
North Yorkshire	74.3%	3.2%	2.3%	2.5%	16.7%	1.0%
York	57.5%	7.6%	2.8%	12.1%	19.5%	0.6%
Barnsley	79.7%	6.6%	2.2%	0.7%	10.3%	0.5%
Doncaster	76.3%	7.8%	2.4%	2.6%	10.4%	0.5%
Rotherham	79.9%	8.9%	1.6%	0.9%	8.3%	0.4%
Sheffield	64.5%	14.7%	5.3%	1.9%	13.1%	0.6%
Bradford	71.7%	9.5%	5.5%	0.8%	11.8%	0.7%
Calderdale	74.6%	9.0%	3.6%	1.0%	11.4%	0.5%
Kirklees	76.8%	8.2%	3.0%	1.0%	10.4%	0.5%
Leeds	66.9%	14.8%	3.6%	1.9%	12.4%	0.5%
Wakefield	77.7%	7.3%	2.8%	1.3%	10.4%	0.4%
Total	**72.4%**	**8.9%**	**3.0%**	**2.7%**	**12.3%**	**0.6%**

There is a wide disparity of current bus and train use across the region, as reflected in the above data, but the amount of distance travelled by these modes is not separately reported by local council areas. Therefore, our modelling work has used estimated total miles travelled per person using data broken down on a regional basis[2]. **Table 5.2** presents this breakdown of distance travelled by mode for Yorkshire and Humber residents.

Table 5.2 Travel by different modes by Yorkshire and Humber residents in 2019

	Yorkshire and Humber distance travelled [i]	
	distance travelled km/person/year	**% of distance**
Car/Van/Taxi	8,040	82.4%
Motorcycle	33.6	0.3%
Bus and Coaches	478	4.9%
Trains/Trams [ii]	611	6.3%
Walking	502	5.1%
Cycling	81.6	0.8%
Total	**9,747**	

Notes:

[i] All data is for 2019, as pre-Covid data is still used as the benchmark for Bus Service Improvement Plans and other transport comparisons.

[ii] Excludes Light Rail as not reported separately by the government.

Proposed changes in how we travel

We have followed the scenario set out in *Zero Carbon Britain*[3] which involves reducing the distance travelled, a shift from private vehicles to public transport (that uses zero-emissions technology) and to some extent cycling, with the remaining private vehicle travel using electric vehicles. This modal shift is a target, not something that will happen without active policies to encourage it. Electric vehicles (EVs) are more energy efficient than internal combustion engine vehicles and can use electricity generated from renewable sources. These modal shift targets are set out in **Table 5.3**.

Table 5.3 Assumed changes in modes of transport and vehicle occupancy

	Occupancy (passenger km/vehicle km)		Current distance travelled per person km/person/ year	Proposed distance travelled per person km/person/ year	Total increase in distance travelled by vehicles km/person/ year
	Current	Proposed			
Car- EV [i]	64.6%	13.4%	0.7%	8.3%	12.2%
Car – ICE [ii]	79.0%	3.0%	1.6%	4.0%	11.4%
Bus (urban) [iii]	74.6%	6.3%	0.6%	5.6%	12.0%
Bus (rural) [iv]	81.8%	2.5%	0.5%	4.0%	10.4%
Train	74.3%	3.2%	2.3%	2.5%	16.7%

Notes.

[1] EV = electric vehicle. CTEC Electric Vehicle Survey 2022. 2% EV and 50% of miles of 2% Plug in Hybrid in the UK in 2022. Assume overall 3% electricity powered vehicles currently in the UK (based on plug-in-hybrid using a combination of electricity and fuels) are EVs.

[2] ICE = internal combustion engine (i.e. petrol or diesel). New car sales of ICE and hybrids will be banned in the UK by 2035. This model assumes 10% of passenger kms will be by ICEs by 2035.

[3] The following council areas in Yorkshire and Humber are assumed urban for bus passenger assumptions: Kingston upon Hull, York, Barnsley, Doncaster, Rotherham, Sheffield, Bradford, Leeds and Wakefield

[4] The following council areas in Yorkshire and Humber are assumed rural for bus passenger assumptions: East Riding, North and Northeast Lincolnshire, North Yorkshire, Calderdale and Kirklees.

The transition to this new transport system will require a massive programme of installation of electric vehicle charging points. It will also require upgrading of the railway lines, rolling stock and services on the railway lines other than the East Coast Mainline so they use zero emission trains (either electric or hydrogen-powered) and are of more use for everyday travel, including by commuters, as well as being more attractive to visitors. Better local rail services and faster inter-urban area bus/coach services would help facilitate visitor access to the National Park areas, reducing visitor reliance on private cars. Bus services should be integrated with the train services and made more affordable, including to provide a reasonable service on bus routes in rural areas, alongside community bus services. They will also need to be electric, use hydrogen, or combination of both (however, batteries are far more energy efficient;

see also comments on hydrogen in the Appendix).

This will include extending the hours of bus routes, increasing frequency and introducing new routes, such as indicated through demand levels for demand responsive transport[4]. Bus patronage has doubled elsewhere already, notably through investment in new routes, extending service hours and establishing bus priority[5].

Finally, while we have not estimated a modal shift, increased walking and cycling clearly has a key role to play in a zero carbon future, not least because of the benefits to health of active travel. In many places increasing walking and cycling is likely to require improved facilities, such as segregated cycling and walking routes. However, reducing the number of cars on the road is itself key to making cycling and walking more palatable.

In summary, to achieve zero carbon transport, a significant modal shift and cultural change is required. This requires an ambitious scaling-up of buses and wider public transport provision (train, community transport, tram) such that, instead of accompanying continued growth in car travel, it displaces it. It would also be supported by increased provision of local services, and better provision of active and public transport for education, health and social care. This could lead to housing development utilising car parks and other brownfield sites, aided by a shift to public transport etc., and enable green spaces in urban areas to be retained for other uses (see Food and Farming section below), improving wellbeing and community cohesion. (See **Figure 5.1**).

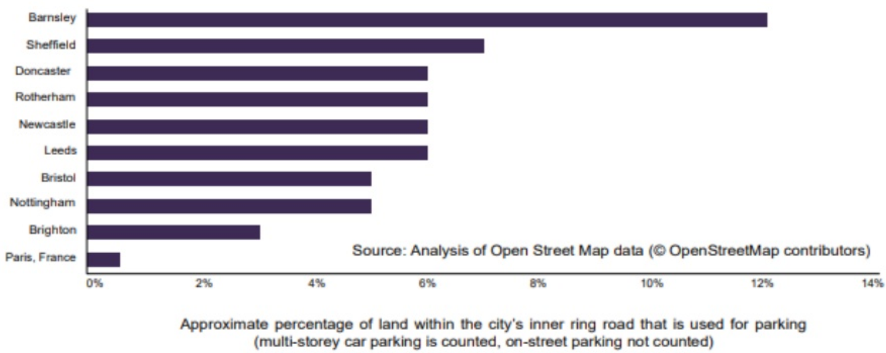


Figure 5.1 Approximate Percentage of Land used for Parking within an Urban Area's 'Inner Ring Road'[6]

Estimated Transport Jobs

This report quantifies the main changes in transport employment as:

1) Increase in bus and train drivers with increased amount of public transport; and
2) Reduction in jobs in vehicle maintenance as EVs require less maintenance than internal combustion engine vehicles.

There will also be changes in construction (from road building to rail improvements, road safety and junction improvements, bus prioritisation/lanes, cycle lanes, pedestrianisation and public realm improvements but these have not been quantified in this report.

The new long-term jobs estimated in this area are primarily in the provision of public transport (supply-chain manufacturing jobs have not been estimated, as discussed separately). As electric vehicles require less maintenance than petrol/diesel cars, there will be a net loss of jobs in vehicle maintenance, which we have subtracted from the new jobs. The metrics used, of jobs per bus or train mile are included in **Appendix 3** and the estimated numbers are shown in **Table 5.4**. For vehicle maintenance jobs the number in each council area are proportional to the population. Bus jobs are based on the modal shift for the region as a whole, then split between the districts where there are bus stations or train stations. Overall, we estimate a significant gain in employment with this shift to public transport, although this is expected to vary across the region.

Table 5.4 Net increase in transport jobs by local authority area

Council Area	Net change in transport jobs	
	Year 2	Year 10+
Kingston upon Hull	78	390
East Riding of Yorkshire	151	756
North East Lincolnshire	68	339
North Lincolnshire	75	376
North Yorkshire	273	1,365
York	64	321
Barnsley	79	396
Doncaster	98	489
Rotherham	84	418
Sheffield	187	34
Bradford	165	827
Calderdale	91	457
Kirklees	194	970
Leeds	246	1.231
Wakefield	117	586
Total	**1,971**	**9,855**

The shift to more active travel and public travel set out here will also help to strengthen community cohesion and build stronger and more resilient local economies across the region. In addition, as noted above with respect to energy, expanding public transport across this and other regions in the UK will support the case for greater investment in supply chains to support these jobs, such as to support an increase in bus manufacturing, such as by AD Dennis in Scarborough[7].

[1] From Table QS701EW, Method of Travel to Work, Local Authorities in England and Wales, ONS, 2011 Census. 2011 referenced as 2021 census survey affected by working from home during Covid lockdowns.

[2] DoT (2023) Statistical Data Set: Mode of Travel. NTS9904a: Average distance travelled by mode and region of residence. https://www.gov.uk/government/statistical-data-sets/nts03-modal-comparisons.

[3] See p51 of CAT (Centre for Alternative Technology) (2019) Zero Carbon Britain; Rising to the Climate Emergency. https://cat.org.uk/info-resources/zero-carbon-britain/research-reports/zero-carbon-britain-rising-to-the-climate-emergency/.

[4] North Yorkshire Council (undated, accessed September 2024) Demand responsive transport. https://www.northyorks.gov.uk/roads-parking-and-travel/public-transport/demand-responsive-transport.

[5] For example see Ryan S (2013) Hopping on a bus is just the ticket in Brighton and Hove. Argus news, 14th June 2013. www.theargus.co.uk/news/10490187.hopping-on-a-bus-is-just-the-ticket-in-brighton-and-hove/.

[6] South Yorkshire Mayoral Combined Authority (2021) Bus Service Improvement Plan. www.southyorkshire-ca.gov.uk/SheffieldCityRegion/media/PDF-library/Transport%20pdfs/37770_Bus-Service-Improvement-Plan_FINAL.pdf.

[7] Alexander Dennis (undated, accessed September 2024) Company Facilities. https://www.alexander-dennis.com/company/facilities/.

Reuse and Recycling of Waste

Vision: A society where products last longer, are repaired and reused much more, with far less packaging, which reduces the amount of waste produced. Most of what remains as waste is recycled with new industries making use of that recycled material in the UK, reducing imports of raw materials and exports of waste.

Available information

The amount of waste generated and managed across Yorkshire and the Humber has been obtained from the waste estimates reported quarterly to the government[1]. The volumes of construction and demolition and commercial and industrial waste have been scaled based on the final adjusted projections for these types of waste in the West Yorkshire Combined Authority Waste Needs Assessment Capacity Gap Analysis[2]. The overall waste arisings for Yorkshire and the Humber for 2022 are presented in **Table 6.1**.

Local Authority Collected Waste is all waste collected through councils' kerbside collections as well as that taken to council-run recycling centres and bring sites (e.g. bottle banks). As well as waste from households, it includes waste from small businesses that choose to use the waste collection service provided by their local council plus street sweepings and collections from litter bins. The amount separated for recycling, food waste and composting (together called recycling) is recorded as well as the remaining residual waste that requires disposal (generally through landfill and/or incineration). In 2022 41% of the region's LACW was recycled which varied from 34% in Sheffield to 58 in East Riding. However, what matters most is reducing the total amount of waste that is still thrown away, which is called residual waste, which is what will generate more jobs. Household recycling rates should increase as all councils are required to improve recycling provision[3].

We have assumed the same current recycling rates for commercial and industrial waste (as no recycling rates are published either for Yorkshire and the Humber, or for England as a whole) and a 70% recycling rate for the construction sector. UK statistics on waste suggest that 92% of construction and demolition waste in England was 'recovered' in 2016[4]. However, this includes 'downcycling', in which demolition reduces buildings to rubble and then turns it into lower quality materials. For example,

Table 6.1 Estimated Waste arisings in Yorkshire and the Humber (2022)

Type of waste	Tonnes
Local Authority Collected Waste (LACW)	2,166,576
Commercial and Industrial Waste	3,788,294
Construction and Demolition Waste (C&D)	878,236

brickwork and blockwork are reduced to aggregate and then buried as land raising on a construction site or in an inert landfill. Similarly, 'recycling' at construction sites tends to involve depositing items in skips and then mechanically sorting these at material recycling facilities/transfer stations, where apart from recovery of metal for scrap, materials tend to be disposed of. Instead of a recovery-led approach to recycling where most items are *downcycled* we need a reuse-led approach to construction and demolition where the value of materials is maximised[5]. Transforming the recycling of scrap steel through better separation of waste (e.g. car scrappage) will improve the quality of recyclate, enabling it to be recycled back into a higher grade of steel in electric arc furnaces, whilst also recovering materials like copper from electrical wiring. Copper is one of the most destructive materials to mine, and substantial quantities are required for extensive electrification of the energy system, so full separation and reuse of this material is vital. These complementarities require an integrated strategy that extends beyond the change from blast furnaces that burn coal, to invest in a whole new supply chain and use of the product as envisaged by the Use Less Group in response to Tata's plans for Port Talbot[6].

Currently Yorkshire and the Humber imports and exports waste from and to surrounding regions. However, the potential for job creation has been based on the amounts of waste arising within the region itself.

In 2015 Green Alliance and WRAP modelled the potential for job creation in the delivery of a circular economy in England and considered that a transformational shift equated to an 85% recycling rate[7]. We propose that a 90% recycling rate for all types of waste would align with a zero carbon future. Research by Zero Waste Europe[8] has found that some local authorities are already achieving recycling rates of around 80%[9]. Considering the economy-wide transformation required to bring about a zero carbon economy, and best practice being demonstrated already in Europe, a 90% potential recycling rate is considered a reasonable target.

Job creation potential

To estimate the jobs just from collection and sorting of waste for recycling we used recent research that has reviewed job intensity across the waste sector worldwide[10]. This, like earlier reports[11] explores the jobs that could be created in the waste and resources sector through increased reuse and recycling. This review for GAIA provides average figures for the job intensity of mechanical recycling, incineration and landfill of waste and suggests that increased (reuse and) recycling could increase the number of jobs 10-fold over landfill and incineration.

Our estimates of the number of jobs that could be created are based on increasing the rate of recycling to 90%. We have subtracted the number of landfill and incineration jobs lost to avoid overestimating the number of new jobs. The jobs created by recycling (and increased reuse, repurposing, refurbishment, repurposing etc. which would actually be reflected in an overall reduction of 'waste') is shown in **Table 6.2**. This shift to reuse is expected to increase as recycling rates increase, which we have assumed will be achieved over the same 10-year transition as for the other sectors.

Table 6.2 Waste and resources changes in jobs by local authority area

Council area	Current domestic recycling rate (%)	Current domestic waste volume (tonnes)	Waste and Resources Jobs	
			Year 2	Year 10+
Kingston upon Hull	47%	117,636	44	222
East Riding of Yorkshire	58%	185,937	53	263
North East Lincolnshire	39%	70,154	31	154
North Lincolnshire	49%	87,510	31	156
North Yorkshire	42%	305,555	125	626
York	41%	88,541	37	186
Barnsley	43%	110,003	45	223
Doncaster	44%	148,023	58	292
Rotherham	45%	108,327	42	210
Sheffield	34%	190,223	91	454
Bradford	38%	217,778	96	480
Calderdale	47%	79,896	30	148
Kirklees	24%	180,936	100	499
Leeds	36%	323,059	149	744
Wakefield	45%	167,499	65324	324
		Total	**996**	**4,981**

Higher recycling rates should lead to an increasing focus on the quality of recycling, which requires better waste separation and enables more of this to be used again to create high quality products. Together with reuse and resource reduction this will enable a shift in the overall culture of society from a consumer focused ‘take, make, break, throw-away’ economy to local circular economies. This should help build stronger communities through a more sharing economy (e.g. car clubs, reuse organisations, community spaces and so on) as well as repair, remanufacturing providing the foundation for a new, green, industrial strategy for the region as mentioned with respect to steel above. Thus, creating the new enterprises and community structures will not just create more jobs and strengthen the region’s economy, it will provide the basis upon which a better quality of life for all might flourish.

[1] Defra (2024) Local authority collected waste management - annual results. https://www.gov.uk/government/statistics/local-authority-collected-waste-management-annual-results.

[2] 4 Resources Ltd (2017) West Yorkshire Combined Authority Waste Needs Assessment Capacity Gap Analysis. Final Report, September 2017. https://new.calderdale.gov.uk/sites/default/files/2023-06/Leeds-City-Region-Waste-Gap-Analysis.pdf.

[3] Defra (2023) Simpler recycling collections and tougher regulation to reform waste system. https://www.gov.uk/government/news/simpler-recycling-collections-and-tougher-regulation-to-reform-waste-system.

[4] Government Statistical Service (2020) UK Statistics on Waste. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918270/UK_Statistics_on_Waste_statistical_notice_March_2020_accessible_FINAL_updated_size_12.pdf.

[5] See for example Resource Futures (2011) Market Potential and Demand for Product Reuse. Product module construction and demolition. http://sciencesearch.defra.gov.uk/Document.aspx?Document=11824_MarketPotentialandDemandConstruction.pdf.

[6] llwood J (2016) A bright future for UK steel. University of Cambridge, UK. https://www.uselessgroup.org/files/a_bright_future_for_uk_steel.pdf

[7] Morgan, J. and Mitchell, J. (2015) Opportunities to tackle Britain's labour market challenges through growth in the circular economy. Published by Green Alliance and WRAP.

[8] Zero Waste Europe (undated, last accessed September 2024) Why a zero waste vision? https://zerowasteeurope.eu/about/principles-zw-europe/.

[9] For example, Treviso in Italy has achieved a recycling rate of 85%, with 53 kg per person per year of residual waste and had a target for no more than 10 kg/person of residual waste in 2022. Simon JM (2018) The Story of Contarina. Zero Waste Europe. https://zerowasteeurope.eu/wp-content/uploads/2019/10/zero_waste_europe_cs4_contarina_en.pdf Similarly, the Sicilian municipality of Calatafimi Segesta achieved a 85% separate collection rate and generated just 88kgs of residual waste per person in 2022. Lo Sciuto P (2023) The Story of Calatafimi Segesta. Zero Waste Europe. https://zerowasteeurope.eu/library/the-story-of-calatafimi-segesta/.

[10] Ribeiro-Broomhead, J. & Tangri, N. (2021). ZeroWaste and Economic Recovery: The Job CreationPotential of Zero Waste Solutions. Global Alliance for Incinerator Alternatives.

www.doi.org/10.46556/GFWE6885.

[11] Friends of the Earth (2010) More Jobs Less Waste. https://www.foeeurope.org/sites/default/files/publications/foee_more_jobs_less_waste_0910.pdf.

Food and Farming

Vision: Fruit and vegetable growing has increased in both rural and urban settings to make best use of the land to provide healthy food for the local population. Farming practices are regenerative and agroecological rather than industrial, caring for the soil so that future generations can be fed.

With food production contributing up to a third of greenhouse gas emissions[1] changing how food is produced, processed and distributed is central to the green transition.

Yorkshire and Humber, with its proud tradition in food and farming, can take a lead in two key paths for transition: regenerative farming practices and food re-localisation. Both paths generate more jobs than a global industrialised food system and increase community resilience. Regional climate plans have already acknowledged the need for such shifts in principle, for example in the Yorkshire and Humber Climate Commission Sustainable Food Systems[2] report, in the York and North Yorkshire route map to Carbon Negative[3] and notably in the work in the region by Fix Our Food[4].

To achieve this, change needs to be fought for in terms of improved pay and conditions in the farming sector. Food growing is essential to our survival and needs to be given the respect it deserves. Much wider societal shifts are necessary to enable sufficient incomes from food growing that uses ethical and sustainable practices, in relation to both the land and workers. Ultimately food purchasing should represent a higher proportion of income than it currently does in the UK (where it is one of the lowest in the world[5]). However, this is only realistic if the crisis in housing affordability is also addressed so that a far smaller proportion of household income is spent on rents or mortgage repayments.

For the purposes of this report, other jobs on the land (such as forestry and flood defence) have been omitted on the basis that plans are already in place, at least to some extent, in these sectors.

The job numbers for Food and Farming have been developed in two main areas: horticulture and urban farming. Additional jobs are expected to be created by a re-localised food system.

Horticulture (fruit and vegetable growing)

There has been recognition in national plans[6] that horticulture should be increased in the UK to reduce the risk of over-reliance on imports of fruit and vegetables[7].

Only 1% of the area currently farmed in Yorkshire and Humber is used for horticulture (below the already low national average of 2%). However, 16% of land is designated as high-quality grades 1 and 2 (Excellent and Very Good)[8]. This is currently mainly used for arable farming – primarily for biofuels and animal feed. Converting some of this land to horticulture – using agroecological practices - would improve soil health, supply healthy food for the local community and provide jobs.

The job figures in this report are based on converting half the Grade 2 land to horticulture, a total of 84,000 hectares. Horticulture has a higher labour intensity than arable or general cropping (0.23 jobs per hectare compared to 0.05[9]). Due to varying seasonal requirements, it is assumed that half the jobs are part-time at 50% full time equivalent (FTE). This creates a total of 11,250 new FTE jobs. Keeping such farms to a relatively small-scale helps to create jobs that are much more varied and rewarding[10] than jobs on large monocrop farms although it should be acknowledged that pay in this sector must also improve.

In our figures, the jobs are allocated to each Local Authority area in line with their proportion of Grade 2 land (omitting those with minimal amounts within their boundary)[11]. Areas most benefiting from this would be those in the river valleys of North Lincolnshire, East Riding and parts of North Yorkshire. Councils can take a lead in the transition to agroecological horticulture. Whilst council farms (also called county farms) have seen significant decline across the UK over the last few decades[12], Guy Shrubsole has estimated that around 4,000 hectares remain in the region, mainly in the East Riding and North Yorkshire (with a small amount in York and North Lincolnshire[13]). Councils should protect this remaining resource and actively seek to grow their base of farms. Under council control, these farms could lead the way in shifting towards horticulture and endorsing agroecological approaches. The Campaign for the Protection of Rural England (CPRE) supports an increase in council farms and their use as a testbed for innovation and change, for bringing a new generation into farming and as a community asset[14].

Transition is also required for the remaining arable land in the region. The Yorkshire Grain Alliance 'envisages a future where the grains grown on our fields feed people rather than vehicles and intensive livestock production'[15]. Much of the wheat in the region is processed at Vivergo[16] for biofuel and animal feed. The transition envisaged by the movement entails switching to a regenerative approach to grain growing for human consumption, which improves the health of both soil and people. This includes approaches such as intercropping with legumes (beans, peas and lentils) to enable nitrogen fixing without chemical fertilisers. It is essential to shift away from the use of chemical fertilisers whose manufacture requires huge quantities of natural gas and is one of the hardest sectors to decarbonise. Adopting a natural approach using legumes also has the benefit of creating a supply of healthy plant protein. Some experimentation with this approach is already underway in the East Riding to assist with flood prevention[17]. Where there is no immediate local outlet for these crops, there are expanding national outlets for regeneratively grown grain and British pulses, such as the Wildfarmed network[18] and Hodmedod's[19]. A move towards a diversification of grain types being grown, including traditional rye, would support greater resilience in the face of current and future climate impacts. Including more diverse grains in the diet also offers benefits for human health.

No additional jobs have been assumed for arable farms themselves although there would be a wider impact by producing food for human consumption – more millers, bakers and local food distributors and retailers (see Additional Potential Jobs section below).

Urban Farming

Whilst rural areas of Grade 2 land offer the clearest opportunities to develop horticulture, studies have estimated the potential of urban environments to boost the supply of affordable fruit and vegetables to local communities. Additional benefits of such projects are helping people to recover from poor mental health, community cohesion and green objectives such as increasing biodiversity. In terms of jobs, urban farming can offer a mix of voluntary and paid positions, both full and part time.

Sheffield has been studied[20] for its potential in urban farming. The researchers' top-end estimates from this study and another in Leicester suggest the potential to meet an entire city's needs for fruit and vegetables. As a cautious estimate, they assume just 10% utilisation of the urban land available.

Using this assumption and the researchers' estimates of labour hours required, we have extrapolated from Sheffield to the other urban centres in the region (omitting those where horticulture jobs have already been allocated to avoid potential double counting). This generates a total of 11,000 full-time jobs in urban farming across the region's cities. Since most of the jobs are expected to be either voluntary or supported by social care funding as a form of rehabilitation, we have included only 10% of jobs as being salaried at Year 2, growing to 25% by Year 10. These jobs are expected to be at a managerial level, responsible for coordinating the activities of those supported. However, we use this approach only to be cautious in the job estimates. In parallel with developing urban farming, initially on a partially voluntary basis, campaigns need to be directed towards the government to treat this sector as a serious opportunity for supporting paid jobs, which could substantially increase the amount of employment (and food production) that could be supported. Ultimately the sector needs to be able to offer viable livelihoods for most people engaged in it.

Table 7.1 Food and farming job creation by local authority area

Council area	Area (km^2)	Horticulture Jobs		Urban Agriculture Jobs		Total	
		Year 2	Year 10+	Year 2	Year 10+	Year 2	Year 10+
Kingston upon Hull	71	0	0	36	91	36	91
East Riding of Yorkshire	2,403	832.5	4163	0	0	833	4,163
North East Lincolnshire	192	0	0	0	0	0	0
North Lincolnshire	845	270	1350	0	0	270	1,350
North Yorkshire	8,038	810	4050	0	0	810	4,050
York	272	67.5	338	0	0	68	338
Barnsley	329	0	0	168	418	168	418
Doncaster	569	112.5	563	0	0	113	563
Rotherham	287	0	0	146	364	146	364
Sheffield	367	0	0	187	466	187	466
Bradford	367	0	0	187	465	187	465
Calderdale	364	0	0	0	0	0	0
Kirklees	409	0	0	208	519	208	519
Leeds	552	67.5	338	0	0	68	338
Wakefield	339	0	0	172	430	172	430
Total	**15,404**	**2,160**	**10,800**	**1,105**	**2,752**	**3,265**	**13,552**

Anchor institutions and re-localising the food supply chain

To create the transition in agriculture set out above would require government (local, regional, national) support, including capital investment and revenue support, to scale-up new farming practices and food production. In exploring routes for implementation of these high-level strategies, the Fix Our Food research programme[21] (working in partnership with the Yorkshire and Humber Climate Commission) has made the case for schools in Yorkshire to procure their fruit and vegetables locally[22]. The idea of anchor institutions providing a guaranteed market for crops is a widely recognised approach (popularised by the Community Wealth Building movement[23]) to develop local community resilience and, in this context, supporting new or converted farms to become established and mitigate the risk of change. However, Fix Our Food have also recognised that the process of tendering for such contracts can be daunting for small businesses. In Scotland, the Supplier Development Programme[24] was set up for the purpose of supporting small businesses through such processes. A similar office could be set up within the Yorkshire and Humber region and would support around 6 office-based jobs for individuals with the appropriate skills (additional to our job numbers). Fix Our Food's recommendations include contracts being split to make it easier for Small and Medium Sized Businesses (SME's) to bid for quantities they are in a position to supply.

Re-localising the food system has the potential to create a wide variety of additional jobs beyond agriculture, notably in food processing and production, distribution and retail. These have been excluded from the green job numbers in this report but afford additional job opportunities if a local food economy can be stimulated. There is also a body of research showing how money spent in the local food economy stays within the region and builds community wealth[25].

A Sustain 2021 report on 'The Case for Local Food' found that smaller food outlets create three times the number of jobs as supermarket chains. Using Sustain's estimates, a shift of just 10% of retail market share to local food outlets could create 16,000 additional jobs in Yorkshire and the Humber[26].

Local jobs in food processing could include millers and bakers linked to a more regenerative arable sector; producers of foods other than bread made from grain (for example pasta) and from legumes grown alongside grain crops; packers and distributors of veg box schemes linked to a renewed horticulture sector; local cafes and restaurants; local retailers and market stalls (expanding the work of Real Markets[27] for example).

[1] Crippa, M. et al. (2021) 'Food systems are responsible for a third of global anthropogenic GHG emissions'. Nature Food. 2, pp. 198-209. https://www.ed.ac.uk/files/atoms/files/food_systems_are_responsible_for_a_third_of_global.pdf.

[2] Herbert, S. (2023) Sustainable Food Systems. Report. Insight Paper (1). University of Leeds on behalf of Yorkshire and Humber Climate Commission. https://yorksandhumberclimate.org.uk/sustainable-food-systems.

[3] North Yorkshire Combined Authority (undated, last accessed September 2024) York and North Yorkshire's Routemap to Carbon Negative. https://yorknorthyorks-ca.gov.uk/growing-our-economy/economic-framework/green-economy/routemap-to-carbon-negative/

[4] FixOurFood (2022) Transforming to a regenerative farming system in Yorkshire: Summary report of the co-creative Three Horizons process. FixOurFood, York. https://fixourfood.org/wp-content/uploads/2022/12/Transforming-to-a-regenerative-farming-system-in-Yorkshire.pdf.

[5] World Economic Forum (2016) 'Which countries spend the most on food? This map will show you' https://www.weforum.org/agenda/2016/12/this-map-shows-how-much-each-country-spends-on-food/.

[6] Department for Environment, Food and Rural Affairs (2024) 'Government unveils major package of farming and food sector support' https://www.gov.uk/government/news/government-unveils-major-package-of-farming-and-food-sector-support; Sustain (2024) 'Home-grown: A roadmap to resilient fruit and vegetable production in England' https://www.sustainweb.org/assets/home-grown-report-1718965792.pdf.

[7] UK self-sufficiency is 55% for vegetables and 17% for fruit. Department for Environment, Food and Rural Affairs (2024) 'UK Food Security Index 2024' https://www.gov.uk/government/publications/uk-food-security-index-2024/uk-food-security-index-2024.

[8] Farm Business Survey (2009) 'Commentary on Yorkshire and Humber Government Office Region'. https://www.farmbusinesssurvey.co.uk/regional/commentary/2009/yorkshirehumber.pdf.

[9] Devlin, S. (2016) 'Agricultural Labour in the UK' New Economics Foundation. https://foodresearch.org.uk/wp-content/uploads/sites/8/2016/07/Agricultural-labour-briefing-FINAL-4-July-2016.pdf.

[10] Laughton, R. (2017) 'A Matter of Scale: A study of the productivity, financial viability and multifunctional benefits of small farms (20 ha and less)'. Landworkers Alliance. https://staging.landworkersalliance.org.uk/wp-content/uploads/2018/10/matterofscale.pdf.

[11] Natural England (2024) 'Provisional Agricultural Land Classification'

https://www.data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc.

[12] Graham, K., Shrubsole, G., Wheatley, H. and Swade, K. (2019) 'Reviving County Farms. A report for CPRE, the countryside charity, by the New Economics Foundation, Shared Assets and Who Owns England?' https://www.cpre.org.uk/wp-content/uploads/2019/12/December-2019_Reviving-county-farms.pdf.

[13] Shrubsole, G. (2020) 'What land is owned by councils?' Who Owns England. https://whoownsengland.org/2020/05/04/what-land-is-owned-by-councils/.

[14] Willis, G. (2021) 'Council farms: what are they, and why are they so special' CPRE: The Countryside Charity. https://www.cpre.org.uk/explainer/county-farms-explainer/.

[15] Yorkshire Grain Alliance (undated, last accessed September 2024). https://fixourfood.org/yorkshire-grain-alliance/.

[16] Vivergo is based in the East Riding and employs 120 people. (undated, last accessed September 2024). https://vivergofuels.com/.

[17] Yorkshire Water (2023) 'Twenty innovative East Riding farmers using 'pop-up rainforests' to improve soil quality and reduce flooding' https://www.yorkshirewater.com/news-media/news-articles/2023/twenty-innovative-east-riding-farmers-using-pop-up-rainforests-to-improve-soil-quality-and-reduce-flooding/.

[18] Wildfarmed (undated, last accessed September 2024). 'Regenerative Farming with Wildfarmed'. https://wildfarmed.com/pages/farming.

[19] (undated, last accessed September 2024).https://hodmedods.co.uk/.

[20] Edmondson, J.L., Cunningham, H., Densley Tingley, D.O. et al. (2020) The hidden potential of urban horticulture. Nat Food 1, 155–159 (2020). https://doi.org/10.1038/s43016-020-0045-6.

[21] Fix Our Food (undated, last accessed September 2024). https://fixourfood.org/.

[22] Fix Our Food (2022) 'Public Sector Food Procurement Supply Chains leading to School Meals: The Case of Yorkshire'. https://fixourfood.org/wp-content/uploads/2023/01/Public-Sector-Food-Procurement-Supply-Chains-Leading-to-School-Meals.pdf.

[23] CLES (undated, last accessed September 2024). The national organisation for local economies 'What is Community Wealth Building'? https://cles.org.uk/community-wealth-building/what-is-community-wealth-building/.

[24] Supplier Development Programme. https://www.sdpscotland.co.uk/.

[25] Campaign to Protect Rural England (2019) 'From field to fork: the value of England's local food webs' https://www.cpre.org.uk/wp-content/uploads/2019/11/From_field_to_fork___The_value_of_Englands_local_food_webs_interactive.pdf; New Economics Foundation (2020) 'Growing Communities: Farmer-focused routes to market. An evaluation of social, environmental and economic contributions of growing communities.' https://www.nefconsulting.com/wp-content/uploads/2021/04/Farmer-focused-routes-to-markets-an-evaluation-of-growing-communities-April-2021.pdf.

[26] Sustain and RSPB (2021) 'The Case for Local Food: building better local food systems to benefit society and nature' https://www.sustainweb.org/secure/The-Case-for-Local-Food.pdf.

[27] Real Markets (undated, last accessed September 2024). Yorkshire. https://realmarkets.co.uk/.

Health and Care

Vision: There is a sufficient workforce in the health and care sector to look after the needs of the region's population. These jobs are valued and well-paid in recognition of their importance in a healthy, sustainable society.

A green transition entails a focus on living healthier lives as indicated by more active travel, well insulated homes and better diets from local food systems as well as a more convivial approach to community which supports mental wellness.

The need for care will remain for when people are sick, live with disability or need support as people age. Jobs in the health and care sectors should be seen as green jobs in a future where health and care are prioritised and should be recognised as foundational in our society.

Jobs in this sector have not been included in the job number totals because most of these jobs already exist as vacancies. Therefore, these represent additional jobs that should be filled.

The health and care sectors run under pressure from a high vacancy rate, making the jobs more stressful than they should be. This is the case across the UK with Yorkshire and Humber being no exception.

The job numbers below have been estimated across three key sectors: the NHS, adult social care and children's services:

» **NHS Vacancies.** At March 2024, the NHS reports vacancies totalling 12,752 in the NHS region of North East and Yorkshire[1]. The number has been pro-rated for Yorkshire and Humber in line with the region's share of population within the NHS region. These vacancies have then been apportioned to each Local Authority in line with population figures.

» **Adult Social Care.** Adult social care vacancies for 2022/23 across the region total 12,650[2]. These are provided in the data at Local Authority level.

» **Children's Services.** The data for vacancies in children's services is available at the national (England) level. Vacancies total 7,700 with 25.6% of these remaining unfilled by agency staff, which equates to 1,971 real vacancies. Pro-rating this for the population in Yorkshire and Humber gives a figure of 190 vacancies across the region and this has been apportioned by Local Authority in line with population to give an approximate estimate of local vacancies.

Across the three sectors, the assumption has been made that, with a concerted focus, 80% of the jobs could be filled by Year 2 and 100% by Year 10. These jobs would then remain filled over the long term. No increase has been assumed although population growth and extended lifespans could imply a need for more jobs in these sectors. However, this might be partially counterbalanced by healthier lifestyles reducing the need for healthcare, at least until much later in life.

Table 8.1. Health and Social Care Job Vacancies by Local Authority Area (2024)

Council area	NHS	Adult Social Care	Children's Services Social Workers
Kingston upon Hull	400	650	9
East Riding of Yorkshire	516	1000	12
North East Lincolnshire	235	400	5
North Lincolnshire	253	225	6
North Yorkshire	928	1700	21
York	305	600	7
Barnsley	367	500	8
Doncaster	463	650	11
Rotherham	400	475	9
Sheffield	843	1600	19
Bradford	823	1100	19
Calderdale	309	300	7
Kirklees	652	750	15
Leeds	1225	1900	28
Wakefield	533	800	12
Total	**8251**	**12650**	**190**

Childcare Jobs

Childcare is another sector where jobs are foundational to the local economy and need to be more highly valued and paid accordingly. An increase in jobs is already anticipated on the back of the previous government's expansion of free childcare places for the under fives. Early Years provision currently employs 24,000 individuals in Yorkshire and the Humber[3]. The Department for Education has estimated that the plan will create an extra 40,000 jobs nationally[4]. Based on population, this would mean around 2,750 additional jobs in Yorkshire and the Humber. However, these estimates reflect the government relaxing staff-to-child ratios in 2023, despite overwhelming opposition. Higher (rather than lower) care ratios as well as far better pay are needed in this highly gendered sector (government statistics show that up to 98% of workers are female). Ensuring adequate childcare provision is not only a matter of employing more childcare professionals, but also of ensuring that parents and other caregivers are in a realistic position to give children the care they need, and that informal childcare (i.e. in the domestic sector) can be shared amongst more adults.

These additional jobs in the health and care sectors have not been included in the job numbers for this report as they are mainly existing vacancies that need to be filled. However, their inclusion highlights the significant potential for more employment in this sector as part of a transition which is not only green but puts people's wellbeing at its heart. Measures such as reducing the length of the working week, more flexible parental leave and doing more to collectivise financial support for caregiving in the home are all essential to increase the value that is placed in the health and care professions. It is vital that society better values these roles such that the vacant positions are filled as part of a shift to a healthier, more equal society.

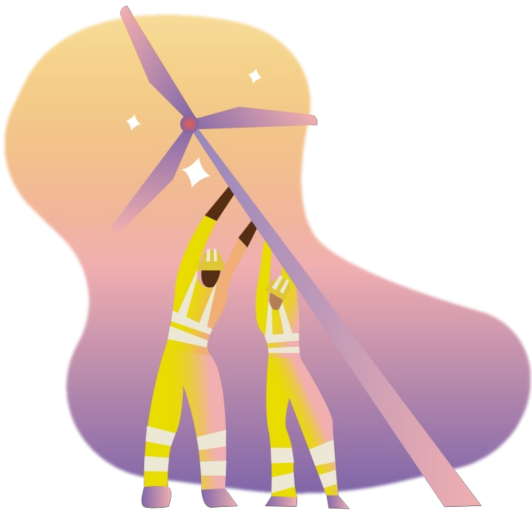
[1] NHS England Digital (2024) 'NHS Vacancy Statistics England, April 2015 - March 2024, Experimental Statistics' https://digital.nhs.uk/data-and-information/publications/statistical/nhs-vacancies-survey/april-2015---march-2024-experimental-statistics.

[2] Skills for Care (2023) 'Local Area Comparison' https://www.skillsforcare.org.uk/Adult-Social-Care-Workforce-Data/Workforce-intelligence/publications/local-information/Local-area-comparison.aspx.

[3] Department for Education (2023) 'Childcare and Early Years Provider Survey' https://explore-education-statistics.service.gov.uk/find-statistics/childcare-and-early-years-provider-survey/2023.

[4] Department for Education (2024) 'Spring Budget 2023 Childcare Expansion' https://assets.publishing.service.gov.uk/media/66221ba8252f0d71cf757d2b/Spring_budget_2023_childcare_expansion_costing_note_information.pdf.

Training and Skills



Skills to bring about a zero carbon transition for the UK must be developed across the country, and that requires the training to be carried out in all regions. Yorkshire and Humber has historically been one of the heartlands for the high-carbon areas of industrial production that underpin the UK economy. Creating local demand, for onshore as well as offshore wind, increasing the region's circular economy through a scaling up of reuse and recycling, programmes of retrofit of buildings and transformation of farming and wider productive land use will require skills from leadership through to on-the-ground delivery.

Different types of skills and training will be needed. This will include short course to provide pathways for existing trades (e.g. 'boot camps' for plumbers to become air source heat pump installers); more extensive training for new roles (e.g. architects to become retrofit assessors) as well as an overall increase in carbon literacy to embed awareness into existing jobs, and provide project manager, analyst, communications and other 'soft skills' around the trades.

The scale of this training need is huge. For example, Arup (2024) recently identified the skills gap to retrofit all social housing in London would need a further 1,200 retrofit coordinators trained to PAS 2035 standard (around a 70-fold increase)[1] and a London Office for Retrofit to provide support and coordination. Similar leadership is needed across the Yorkshire and Humber region.

The success of this is likely to generate win-win outcomes, helping to reverse the current graduate drift to London and other regions, through sustaining more work within the region, whilst giving confidence to colleges and other educational providers to invest in supporting these skills and training. Colleges have an important role not only in teaching skills, but in influencing attitudes, aspirations and perceptions of work that promotes sustainability; however they can ultimately only offer courses that they can fill, which in turn depends on the (real or perceived) market for those skills. This is one reason for the important role of local authority programmes in areas like housing retrofit, or agro-ecology, to initiate a virtuous cycle of training and secure job prospects for trainees.

There is an important role for universities and colleges in the region to develop the skills needed in regenerative agriculture and horticulture. Universities and colleges should be treated as anchor institutions for the procurement of local food, alongside schools and hospitals. A few courses in sustainable forms of agriculture and agro-ecology are currently offered (for example an MSc in Sustainable Agriculture and Food Production at University of Leeds[2]) but the offer needs to be expanded to meet the skills requirements of a green transition. Food and farming should also be embedded in the region's skills strategies, where they do not currently typically feature.

We estimate this training and skills development as requiring around 3% uplift in the overall work. In addition, committing to this upskilling in delivering a just transition to a sustainable Yorkshire and Humber would also strengthen the attractiveness of the region to new supply chain enterprises, justified by the combination of a strong local market and skills.

[1] Arup (2024) A retrofit delivery model for London. https://www.londoncouncils.gov.uk/sites/default/files/202405/retrofit_delivery_plan_for_london_full_report.pdf. For details of PAS 2035 see https://retrofitacademy.org/knowledge/pas-2035/.

[2] Sustainable Agriculture and Food Production MSc offered by the University of Leeds. (undated, last accessed September 2024). https://courses.leeds.ac.uk/j644/sustainable-agriculture-and-food-production-msc

Summary: Making it Happen

In 2023, whilst the UK economy grew by 1%, the Confederation of British Industry (CBI) reported that the green economy grew by 9%[1]. This is what investing in retrofitting homes, transforming transport, creating a circular economy within Yorkshire and Humber, construction of renewables within the region and transforming its food production could deliver. The total number of jobs needed in order to transition to a sustainable Yorkshire and the Humber is estimated to peak at 1.5% of the total population, and then be sustained at around 1% in the long-term. They are desired work to deliver the changes needed to bring about a different future. The total number of jobs created by local authority is set out in **Table 8.1**.

Table 8.1 Overall Creation of Green Jobs by Local Authority Area (transition and long-term)

Council Area	**Total Job Creation (Buildings, Renewables, Food and Farming, Waste and Resources, Transport, Training and Skills)**		
	Year 2	**Year 10**	**Long-Term**
Kingston upon Hull	1,537	2,502	1,230
East Riding of Yorkshire	5,397	10,626	7,070
North East Lincolnshire	1,043	1,711	857
North Lincolnshire	1,939	3,861	2550
North Yorkshire	7,787	14,360	8,985
York	982	1,981	1,249
Barnsley	1,442	2,584	1,537
Doncaster	1,970	3,579	2,059
Rotherham	1,513	2,649	1,515
Sheffield	3,427	5,702	2,966
Bradford	3,005	5,096	2,740
Calderdale	1,358	2,191	1,065
Kirklees	2,592	4,750	2,834
Leeds	4,777	7,890	3,895
Wakefield	2,099	3,648	2,049
Total	**40,868**	**73,130**	**42,601**

Note: Excludes health and social care (and other existing) job vacancies

Redirecting Drax subsidies

Estimates for the cost to invest in the jobs needed to deliver a green transition vary depending upon timescales and the scope of activities included. However, the UK Climate Change Committee's widely quoted numbers are £30-£50 billion per year for the UK from 2025[2]. Only 10-20% of this is expected to be publicly funded. However, the IPPR recommends a minimum public investment of £30 billion per year at least until 2030 (report published 2021)[3].

Based on the IPPR estimate and weighting the transition cost to the Yorkshire and Humber region by population would imply around £3 billion per year from the public finances. However, weighting this by GDP this would equate to less, just over £2 billion/year suggesting that greater public sector investment is needed to drive the green transition in this region[4]. Clearly Drax's £539 million subsidy in 2023[5] (higher in 2022) would go some way to fill the government subsidy gap needed to drive the green transition across different sectors.

The government support required will vary significantly across the sectors set out in this report:

Training and a new job guarantee. In most areas there is a need to support institutions to offer and individuals to undertake training in new skills for different types of work. This should be enabled, such as through a government funded jobs guarantee[6], rather than leave an existing worker required to forego current employment and fund the training and upskilling needed.

- *Example 1: Drax's subsidy could instead provide the subsidy needed for training between 12,700 and 21,800 16-25-year olds over five years across Yorkshire and the Humber[7].*

Initial capital investment and initial revenue funding to scale-up demand. This is needed to subsidise supply before demand levels rise. Such subsidy levels are lower now for capital investment in renewable energy. However, they are needed in other areas too – such as to invest in new waste collection systems and vehicles, to invest in new buses and bus priority routes and signalling – as well as subsidising the subsequent bus services until patronage levels rise[8]. This requires publicly funded capital investment and initial revenue funding.

- *Example 2. The 2023 level of Drax subsidy could fund the 10,000 new bus drivers envisaged across Yorkshire and Humber together with an equal amount to fund investment in bus priority and road safety[9].*

Universal public services. In some cases public funding should be viewed as part of a basic service such as retrofitting council homes or those with limited income or other savings, and provision of local transport accessible to all. The level of subsidy will vary depending on the minimum service level, level of fees and charges, and levels of deprivation.

- *Example 3. Retrofitting homes at scale across the region (based on the cost estimates from London Councils, 2021) the 2023 Drax subsidy would fund the full cost to retrofit 208,000 homes over 10 years.*

Subsidies will also be needed to drive wider societal changes that may take years to embed. For example, making recycling cheaper and more convenient than waste disposal, providing an incentive to make buildings more energy efficient, and the transition to agro-ecological farming practices and fair pay for farmers is such a sector. The UK population needs to be enabled to afford to spend a higher proportion of income on energy and food but this, in turn, requires major changes to the cost of housing as well as living incomes in other sectors[10].

[1] CBI (undated, last accessed September 2024). https://www.cbi.org.uk/our-campaigns/driving-green-growth-and-the-transition-to-net-zero/#:~:text=Last%20year%2C%20our%20green%20economy,share%20and%20creating%20skilled%20jobs.

[2] Climate Change Committee (2020) 'The Sixth Carbon Budget: The UK's path to Net Zero' https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf.

[3] Institute for Public Policy Research (2021) 'Fairness and Opportunity: A People-Powered Plan for the Green Transition' https://ippr-org.files.svdcdn.com/production/Downloads/Fairness_and_opportunity_final_report_July21_web.pdf.

[4] In 2022 the GDP of Yorkshire and Humber was £153 billion compared to £2,249 billion for the UK. (undated, last accessed September 2024). https://www.statista.com/statistics/1004135/uk-gdp-by-region/.

[5] As referenced earlier in this report.

[6] TUC (2020) A new plan for jobs - Why we need a new jobs guarantee. https://www.tuc.org.uk/sites/default/files/2020-06/JobsguaranteeReport2.pdf

[7] Friends of the Earth (2021) 'An emergency plan on green jobs for young people' https://policy.friendsoftheearth.uk/sites/default/files/documents/2021-03/EMERGENCY_PLAN_GREEN_JOBS_FEB_2021.pdf Cost £25-43k/trainee.

[8] In many cases services will become self-funding as passenger numbers rise but some areas, such as with higher deprivation or more rural areas, may need ongoing subsidy.

[9] Median salary for a bus driver in 2024 is noted as £24,185 (£12.40/hour) across the UK (https://uk.talent.com/salary?job=bus+driver -undated, last accessed September 2024) and £23,972 (http://www.mysalary.co.uk/average-salary/Bus_Driver_366 - undated, last accessed September 2024). A total employee cost of £27,000 (based on 2024 prices) is considered here (https://www.icalculator.com/united-kingdom/salary-example/24000.html - undated, last accessed September 2024).

[10] Currently housing accounts forms a disproportionate (and non-negotiable) amount of household expenditure. A combination of factors has led to inflation in housing, including the financialisation of the market, landlordism, second homes and AirBnB (particularly in areas of high tourism) and the failure by councils to maintain a sufficient supply of genuinely affordable housing.

Conclusion

As set out above, the jobs that have been quantified are those which necessarily occur within the Yorkshire and Humber region, and represent the minimum we consider to be needed, forming the essential foundation of a low-carbon local economy. From renewable energy generation, to insulating our homes and growing our food we have quantified over 70,000 jobs needed in Yorkshire and the Humber over the next ten years. To make these jobs, and the many more jobs needed in supply chains, training and skills, a reality we need a cross-sectoral approach that recognises the interconnected nature of our society.

Organisations like the Campaign Against Climate Change Trade Union Group[1], the Public and Commercial Service Union (PCS)[2] and others, have long advocated the setting up of a National Climate Service to plan and oversee this transition, alongside extensive public ownership of energy and other key services. Following the TUC conference in September, is now formal TUC policy to campaign for these demands, as well as for unions "to co-operate in negotiating industrial strategies for decarbonisation, including the building of combines within and across sectors, at the level of branches as well as nationally and globally, and engagement with community groups"[3]. These developments, we hope, will support an accelerated push for a decarbonised economy and society that offers good work and is fairer to everyone.

Transitioning to a greener, fairer society is a necessity. In order to do this in a way that guarantees decent jobs, a process is needed that brings everyone together, joining the dots between sectors, between the different requirements for a good quality of life, and between workers, communities, campaigners and progressive policy makers. Too often in the past these groups have existed in silos, with the goals and interests of these different groups often assumed to be in conflict. To realise the transformation set out in this report, an approach is needed that is inclusive and collaborative, enabling a genuine sense of common purpose, unity, and a shared belief that the change we need is both necessary and achievable.

[1] Campaign Against Climate Change Trade Union Group (2021) Climate Jobs: Building a Workforce for the Climate Emergency https://www.cacctu.org.uk/climatejobs

[2] See for example, https://www.pcs.org.uk/campaigns/focus-why-climate-change-trade-union-issue/focus-why-climate-change-union-issue

[3] TUC (2024) C18 Climate emergency the next steps. Available at: https://congress.tuc.org.uk/c18-climate-emergency-the-next-steps/

Glossary

Biomass - In this context, biomass is matter from recently living organisms used for bioenergy production. Examples include wood, wood residues, energy crops, agricultural residues including straw, and organic waste from industry and households.

Agroecology - Agroecology is sustainable farming that works with nature. It is the application of ecological concepts and principals in farming. Agroecology promotes farming practices that work with wildlife and mitigate climate change - reducing emissions, recycling resources and prioritising local supply chains (Source: https://www.soilassociation.org/).

Arable - Land used or suitable for growing crops. In the UK, this typically means the growing of grains (such as wheat, oats, barley) or potatoes. This is distinct from horticulture (see definition below).

CO_2e - Abbreviation for carbon dioxide equivalent - a unit of measurement used to standardise the climate impact of various greenhouse gases by quantifying total emissions in terms of the amount of CO2 which would be required to have the same impact.

GHG - Greenhouse gas - a gas which traps heat by reflecting back infra red radiation leaving the earth. It is the increase in greenhouse gases in the atmosphere over the last 150 years that is causing the earth to become warmer.

GWP - Abbreviation for Global Warming Potential - a measure of how much heat a greenhouse gas traps in the atmosphere, weight for weight, over a specific time period (usually 100) years), relative to carbon dioxide.

Horticulture - In farming, this is defined as a branch of agriculture that relates to the production, cultivation and management of edible fruits and vegetables, and ornamental plants (Source: Horticultural Sector Committee report: 'Sowing the seeds: A blooming English horticultural sector' - House of Lords Library

(parliament.uk)

Hydrogen - hydrogen is classified according to the way it is produced. For our purposes the main types are “grey”, “blue” and “green” hydrogen.

Grey hydrogen - produced by splitting (or “reforming”) methane (the main component of natural gas) into hydrogen (H_2) and carbon dioxide (CO_2), with the CO_2 released into the atmosphere.

Blue hydrogen - produced in the same way as grey hydrogen but with the carbon dioxide captured and stored. The capture and storage process has never yet reached a high level of efficiency.

Green hydrogen - produced by electrolysis of water using renewable generated electricity. This produces no greenhouse gas emissions, but is very energy intensive.

Jobs - In projections of jobs numbers, the jobs are classified as “direct”, “indirect” or “induced”.

Direct jobs - jobs supported from direct project expenditure, or from the supply of items used on site

Indirect jobs - jobs which are supported from spending in the wider supply chain, for example when the manufacturer of an item used on site purchases items needed for its manufacture.

Induced jobs - jobs which are supported from spending in the local economy by employees on site or in the supply chain.

Appendix 1 Overview of Methodology

Our model combines:

» **A zero carbon vision** and how this would impact on each sector in practical terms;

» **Published data** about the geographic area of interest, such as land area, population, waste generation, renewable energy potential etc.; and

» **Job metrics** – hours of work required and hence numbers of jobs per activity, derived from published sources.

These were combined, using the low end of estimates to be prudent, to quantify the number of jobs in each sector during a 10-year transition period (notionally 2025-2035) and in the longer term. The transition and long-term jobs are estimated separately as in some cases they are different activities (e.g. installing and then maintaining renewable energy systems). Overall, we believe there will be an upside to these estimates. In calculating the number of transition period jobs, we have assumed that the activities required to bring about the transition, such as installing renewable energy systems or insulating homes, are spread equally throughout the 10-year period. In practice, the different roles will vary in terms of the time required to train people and build up the workforce required. Therefore, the actual number of jobs will be lower in the first year and significantly higher towards the end of the transition period, and in some cases will continue for far longer as opportunities to make further improvements within different sectors will continue. This means that, in practice, either more people will be required than is indicated by the average number of full-time equivalent jobs, or the roles will continue for a longer transition period.

In parallel to this, long-term jobs will not just start from the end of the transition period but will grow as the transition is implemented. We have assumed a linear build in these jobs through the ten-year transition period.

Many of the jobs created by a transition to zero carbon in Yorkshire and Humber will not necessarily be located within the region: for example, jobs manufacturing low carbon heating systems or solar photovoltaic panels could be elsewhere in the country or abroad. These jobs have not been included in our estimates. However, such industries and the jobs they support can be encouraged to locate themselves in Yorkshire and Humber by driving a strong transition in this region. This would create more jobs over and above those quantified in this report. Rather than focusing on connectivity with other regions, notably in the South of England, the recommended approach is to support local industry that will help to balance the regional economy relative to other regions and notably London.

However, rather than focusing on these supply chain jobs we have estimated the jobs that must occur in Yorkshire and Humber, for example installing but not manufacturing heat pumps or solar panels; in driving and maintaining buses but not the manufacture of electric buses. We consider this to be the new foundation, anchor points for the new green economy, embedded in the region's communities. We have allocated these jobs to the council areas where the work will take place. This does not mean that the jobs will necessarily be based there as companies may set up elsewhere and travel to do the work.

The sectors included in this report are:

» Renewable electricity generation

» Buildings and heat

» Transport

» Reuse and recycling of waste

» Food and farming

» Health and Social Care (included in the report but not in the job numbers).

An overview of this methodology is presented in **Figure A1.1**.

This report updates the metrics and approach used previously in each of these sectors. There will be additional areas of potential new employment such as in forestry and flood prevention, energy storage and electricity grid upgrading that have not been quantified here but would follow naturally from the core activities included in this report[1].

This report focuses on jobs onshore. We have not quantified changes in the North Sea (displacement of fossil fuel offshore gas extraction with offshore wind) as this is already documented elsewhere.

Where information is available, we have subtracted the jobs that will be lost in current fossil fuel-dependent activities, such as in the maintenance of internal combustion engine vehicles or landfill and incineration. Many people will need training or support of some kind to take up the new jobs, so we have included an estimate for such 'support jobs', calculated from the total number of jobs.

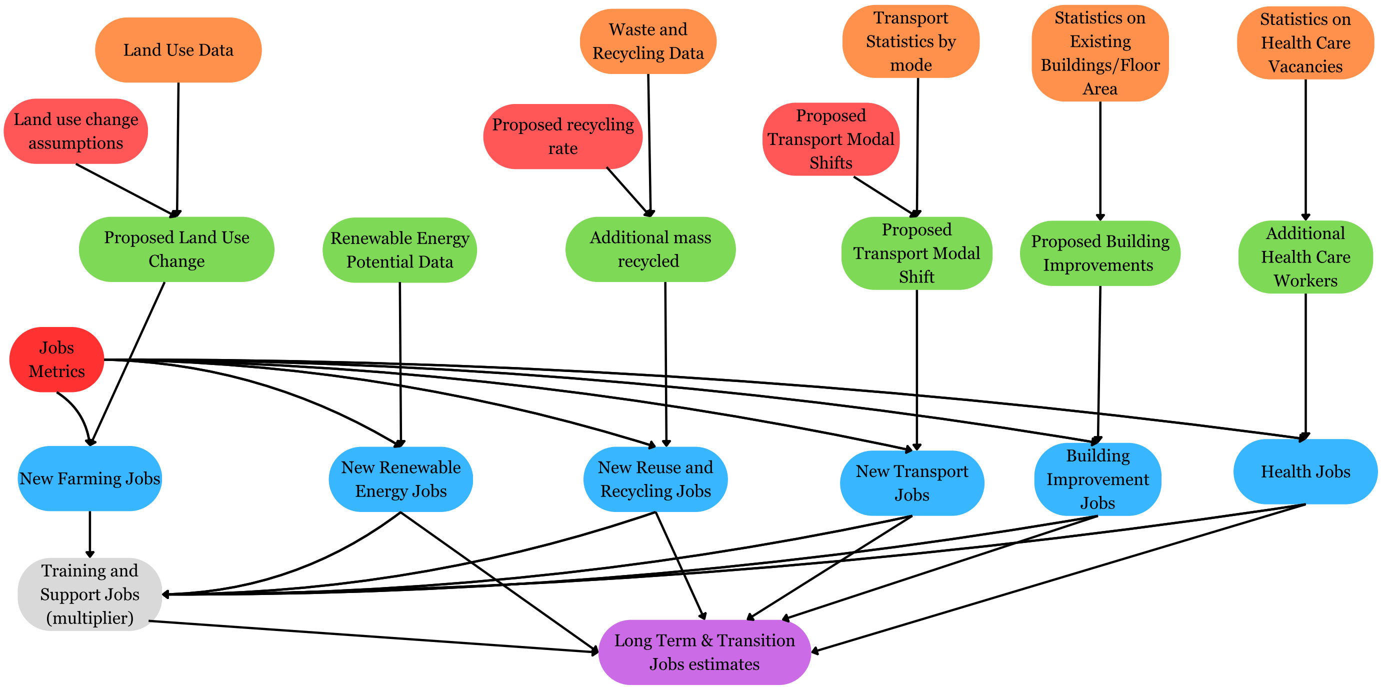


Figure A1.1 Overview of methodology

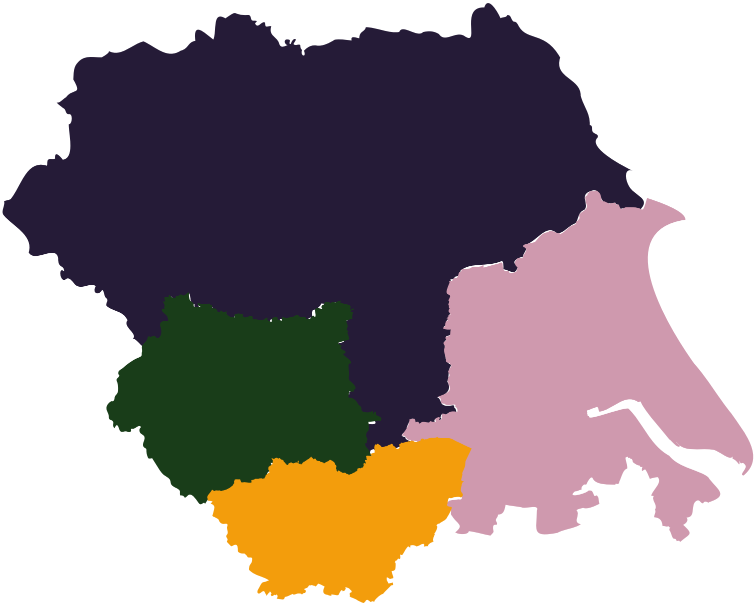
An overview of the region's population and land area is shown in Table A1.1. Yorkshire and the Humber comprises 15 council areas grouped under four sub-regions. Some jobs have been calculated based on data available at a local council level while others, such as public transport, are calculated at the sub-regional level as they reflect the responsibility of combined authorities as set out in **Figure A1.2** and **Table A1.2**.

Table A1.1 Yorkshire and Humber population & land area

Council area	Area	Population (2022)	Population (2033)	Current population density (people per km)
Kingston upon Hull	71	268,852	261,373	3,770
East Riding of Yorkshire	2,403	346,309	354,473	144
North East Lincolnshire	192	157,754	158,902	820
North Lincolnshire	845	170,042	176,491	201
North Yorkshire	8,038	623,501	639,830	78
York	272	204,551	215,595	752
Barnsley	329	246,482	265,868	748
Doncaster	569	311,027	327,747	547
Rotherham	287	268,354	280,173	936
Sheffield	367	566,242	626,487	1,542
Bradford	367	552,644	554,689	1,507
Calderdale	364	207,699	214,303	570
Kirklees	409	437,593	454,870	1,071
Leeds	552	822,483	826,139	1,490
Wakefield	339	357,729	393,468	1,056

Notes:
[1] ONS mid 2022-mid 2023 population estimates
[2] ONS 2018-based population projections (published March 2020)

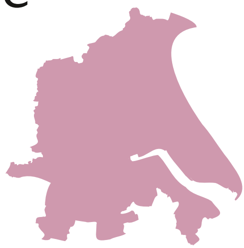
Figure A1.2 Yorkshire and the Humber



North Yorkshire Combined Authority

City of York, North Yorkshire (formed from the areas of Craven, Hambleton, Harrogate, Richmondshire, Ryedale, Scarborough and Selby in 2023)

The Humber (part of two future authorities)[2]



East Riding, Hull City,

North East Lincolnshire

and North Lincolnshire

South Yorkshire Combined Authority

Barnsley, Doncaster, Rotherham and Sheffield City (together the South Yorkshire combined authority)

West Yorkshire Combined Authority

Bradford, Calderdale, Kirklees, Leeds and Wakefield (together the West Yorkshire combined authority)

[1] For example, the CCC (2023) estimates that increasing forest cover in line with the 'balanced pathway' to decarbonise the UK economy could create 6,600 to 39,000 jobs across the UK by 2030.

Climate Change Committee (May 2023) A Net Zero Workforce. https://www.theccc.org.uk/publication/a-net-zero-workforce/ .

[2] Hull and East Riding will form a combined authority and North and North East Lincolnshire form a combined authority with Lincolnshire County Council following devolution deals agreed in late 2023. But they all remain within the Yorkshire and Humber group of councils.

Appendix 2 Current and Potential Areas for Offshore Wind Farms in the North Sea

As can been seen from the figure and table below the current wind farms commissioned in the North Sea off Yorkshire and Humber total 2905 MW, around 30% of current UK offshore wind capacity[1] yet only take up a small part of the potential generation area.

Figure A2.1 Current Offshore Wind installed in the North Sea off Yorkshire and Humber

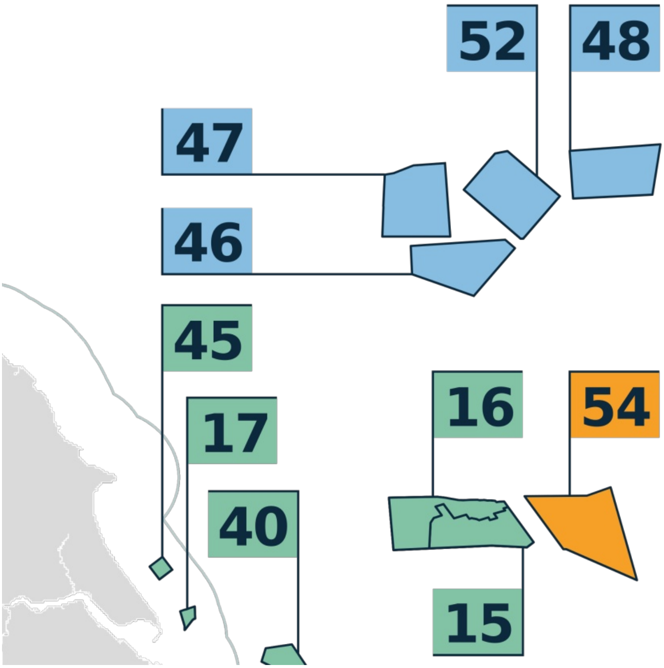


Figure A2.2: Potential areas for new turbines (right)[2] .

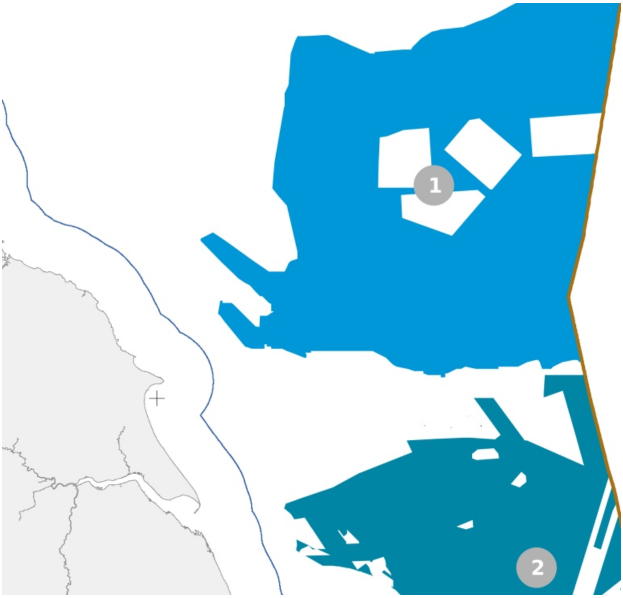


Table A2.1 Current and proposed Wind Farms off the coast of Yorkshire and Humber

Reference	Name	Status	MW
15, 16	Hornsea 1 & 2	Fully operational	2,602
17	Triton Knoll	Fully operational	857
45	Westermount Rough	Fully operational	210
46 - 48	Doggerbank A-C	Under construction	3,670
52	Sofia	Under construction	1,400
York56	Hornsea 3	Government support on offer	3,000
		Barnsley	3,669
		Doncaster	8,070
		Rotherham	**11,739**

[1] Crown Estate (2024) Offshore wind operational report 2023. This notes that the UK had 14.7 GW of offshore capacity fully commissioned as of December 2023 and a further 13.5 GW under construction or with government support under offer.

[2] Sources: Crown Estate (2024) Offshore wind operational report 2023. https://www.datocms-assets.com/136653/1720789954-11964_offshorewindreport_2023_final300424.pdf and Crown Estate (2019) Offshore Wind Leasing Round 4: Regions Refinement Report https://www.thecrownestate.co.uk/media/3330/tce-r4-regions-refinement-report.pdf, part of Figure 20 on page 35).

Appendix 3 Metrics used in Calculation of Job Estimates

Job type	Scaling metric	Notes	Source
Onshore wind construction	7 job years per MW	2030 value for direct jobs of 11 job years/MW from EWEA (2009) scaled down by 63.5% as this is the proportion of direct construction jobs that Kahouli and Martin (2018), in their study of wind energy jobs in Brittany, consider are local to the site of construction.	European Wind Energy Association, 2009 and Kahouli and Martin, 2018.
Onshore wind maintenance	0.29 jobs per MW	2030 value for operation and maintenance jobs from source.	European Wind Energy Association, 2009
Offshore wind construction	10.5 job years per MW	Uplift of 1.5x compared with onshore wind based on predicted cost difference by 2030.	European Wind Energy Association, 2009
Offshore wind maintenance	0.43 jobs per MW	Uplift of 1.5x compared with onshore wind based on predicted cost difference by 2030	European Wind Energy Association, 2009
Solar PV - Domestic Installation	0.038 job years per installation	50 hrs installation plus 7 hours quote, invoicing etc for 3.5 kWp system.	Personal communication from a local installer.
Solar PV Domestic Installation	26.6 FTE per 1000 per year installation	Assume it takes 30.75 hours to install 1kW of PV, and 2KWp installed per dwelling.	Birmingham City Council, 2009
Solar PV – Domestic Maintenance	0.002 jobs per installation	assume inspected every 5 years, half a day per visit	
Solar PV - Commercial roof mounted Installation	2.93 Job years per MW	220 hours for a 50 kWp system, including admin, scaffolding etc.	Personal communication from a local installer
Solar PV - Commercial roof mounted Installation	3.19 job years per MW	Bold scenario, 20 GW in 2030 (p.32) direct employment 63,800 FTE years	Cebr,2014
Solar PV - Commercial roof mounted installation	3.09 jobs per MW	Estimate used in report - Powering Green Jobs Growth with Electrical Contractors	EuropeOn (2021) https://europe-on.org/wp-content/uploads/2021/07/EuropeOn_Job-Potential-Study-2021_Members-version.pdf

Job type	Scaling metric	Notes	Source
Solar PV – commercial maintenance	0.07669 jobs per MW	600-700 people employed in 2016 when there was 8475.7 MW	Solar Trade Association, 2016 and https://www.gov.uk/government/statistics/solar-photovoltaics-deployment.
Hydro Installation (low head: run of river schemes)	48.5 job years per MW installed	From data for <100KW projects	Forrest and Wallace, 2009.
Hydro Maintenance (low head: run of river schemes)	1.3 jobs per MW	From data for <100KW projects	Forrest and Wallace, 2009.
Horticulture using 50% of Grade 2 land	0.23 jobs per hectare (less 0.05 typical for general cropping)	84,000 ha x (0.23-0.05) = 15,120. Assuming ½ the jobs are part-time at 50% of full-time hours = 11,250 FTE jobs.	Devlin for NEF (2016) 'Agricultural Labour in the UK'
Urban farming		Extrapolated from Sheffield case study (authors say are typical of UK cities in terms of urban green space). 1,866 FTE jobs (at 35 hours per week) for Sheffield based on 10% of population gardening for 60 hours per year. Pro-rated for other cities based on land area.	Edmondson et al (2020) 'The hidden potential of urban horticulture'

Transport Sector jobs

Job type	Scaling metric	Notes	Source
Driving buses	0.313 FTE jobs per 10,000 bus km/year	600 Bus drivers employed by Stagecoach Cumbria and North Lancashire and 19.15 million km travelled.	Stagecoach Cumbria and North Lancashire, 2019.
Maintaining buses	00881 FTE jobs per 10,000 bus miles/year	106 maintenance staff and cleaners and 63 supervisors and managers employed by Stagecoach Cumbria and North Lancashire and 19.15 million km travelled. Existing maintenance intensity assumed to apply to Trolley/EV/hydrogen buses.	Stagecoach Cumbria and North Lancashire, 2019.
Railways - Operation and maintenance	4.1 FTE jobs per 10,000 train miles/ year	Total UK rail industry staff divided by total train-km (Includes supply chain),	Rail Delivery Group Annual Report 2016 and Office for Rail and Road, 2016 /17 statistics.http:// orr.gov.uk/__data/ assets/pdf_file/ 0019/24832/ passenger-rail-usage-2016-17-q4.pdf
Maintaining private internal combustion engine vehicles (ICE)	0.5 FTE jobs per 1,000,000 private vehicle miles/ year	Based on 233,000 FTE jobs supporting 316.7 billion vehicle miles.	ONS, Table TRA8901 and Table EMP04, All in Employment by Occupation, Apr-June 2016.
Maintaining private electric vehicles (EVs)	0.3 FTE jobs per 1,000,000 private vehicle miles/ year	Based on EVs requiring approximately 2/3 of the maintenance of ICE vehicles.	Van den Bulk, 2009.

Waste Sector jobs

Job type	Scaling metric	Notes	Source
Recycling of waste	1.7 jobs per 1000 tonnes of waste recycled	Includes for collection, sorting and cleaning of recycling.	GAIA, 2021
Waste disposal	0.175 jobs per 1000 tonnes of waste	Average job intensity of landfill (0.17 jobs/1000 tonnes/year) and incineration (0.18 jobs/1000 tonnes/year). Note that these two ways of disposing of waste employ roughly a 10th of the numbers used for recycling.	GAIA, 2021

Building Sector jobs

Job type	Scaling metric	Notes	Source
Improving energy efficiency of dwellings	81.5 jobs per 1000 dwellings/year	Direct labour only. 134 hours on site per house and 3 hours survey (see source)	Birmingham City Council, 2009
Adding Solar Thermal to dwellings	34.5 jobs per 1000 dwellings/year	Source has 1 FTE (direct and indirect) per 100m2 installed. Assume out of 2900 FTE jobs 400 are direct. Also assumed 4m^2 per dwelling.	Batisti, et al. 2007
Installing Ground Source Heat Pumps in houses	208 jobs for 1000 dwellings per year	Assume 8kW heat pump for 2 bed houses. For capital costs in source, assume 40% cost is labour and wage of £26,000 per year.	www.gshp.org.uk and https://www.kensaheatpumps.com/wp-content/uploads/2015/06/Retrofit-blueprint-document-120916.pdf
Dwelling Maintenance	3.1 jobs per 1000 dwellings	Additional maintenance as a result of retrofit and to maintain energy efficiency standards.	Birmingham City Council, 2009
Maintaining private electric vehicles (EVs)	0.3 FTE jobs per 1,000,000 private vehicle miles/year	Based on EVs requiring approximately 2/3 of the maintenance of ICE vehicles.	Van den Bulk, 2009.

APPENDIX 4 - More about carbon capture and storage

History of carbon capture

The majority of experience with carbon capture so far has not been for the purpose of emissions reduction, but to produce CO_2 as a commodity for oil companies, for enhanced oil recovery. Some of the injected CO_2 remains in the oil reservoir while some returns to the surface with the oil[1]. Nevertheless, because some carbon (perhaps 50%) remains in the ground, it has allowed some to claim that this technique helps to reduce emissions[2].

This argument implies that the oil substitutes for oil extracted by conventional means. The reality is that making it easier and cheaper to get it out of the ground has the effect of *increasing* global production and usage, including by increasing the financial viability[3] of extracting hard-to-reach oil from dwindling reserves, so delaying the move to renewables. The emissions stored in EOR are only a fraction of the emissions caused by burning the oil.

Much of the CO_2 historically used in this process comes from natural underground sources, and experience of capturing it from industry or power stations is far more limited. Without the financial incentive of EOR, it is also likely to require major long-term public subsidies; however, the bulk of industrial emissions can be eliminated through demand reduction, reuse of materials, and electrification with renewable energy, and this is where research and funding needs to be directed[4].

The energy penalty

In Chapter One it was noted that the additional energy required to run carbon capture means more fuel burned for each unit of electricity produced, meaning more methane emissions, or more trees burned depending on the fuel source.

The same problem applies to producing hydrogen from natural gas (so-called “blue hydrogen”). Even the most successful project of this kind (Quest in Canada) has reached only a 68% CO_2 capture rate, when the additional gas burned to power the carbon capture is included[5]. When you add in the additional methane emissions too, the total greenhouse gas emissions from producing this hydrogen can be worse than just burning gas without carbon capture[6].

Both new gas power stations and blue hydrogen plants would depend on huge imports of Liquified Natural Gas, with a particularly high CO_2e footprint due to the sourcing of the gas (ie mainly shale gas from the USA, known to have high methane emissions in the extraction process), and the emissions from compression and transportation of the gas[7]. Going ahead with these projects would seriously undermine UK emissions reduction targets.

But even if the carbon capture is powered by renewable sourced electricity, it is more efficient to use this clean electricity directly to heat homes[8], power industry[9] and run a clean public transport system[10], rather than wasting it on a technology that at best can only partially clean up a fossil fuel or a biomass based system and, crucially, serves to prolong the use of these dirty fuels. (The same applies to producing hydrogen from water (so-called "green" hydrogen) which, unless reserved for essential applications where no other low carbon alternatives exist[11], wastes huge amounts of renewably produced electricity that could be used to directly decarbonise industry and the wider grid.

It's also worth noting that hydrogen itself - claimed to be emissions-free when burned - is in fact an indirect greenhouse gas with a Global Warming Potential of approximately 12 over a 100-year period (that is, 12 times the GWP of CO_2, weight for weight) and approximately 35–40 over the crucial 20-year period[12]. Both methane and hydrogen, when burned in air, cause nitrous oxides to be formed, which are not only greenhouse gases but also contribute to lung diseases[13].

CO_2 transportation and storage

As noted, there is limited engineering experience with CO_2 pipelines, and feeding in CO_2 from multiple industrial sources will make it more complex to monitor and control pressures inside and levels of contaminants inside the pipeline, which may increase the risk of corrosion and a consequent leak[14]. Engineering work offshore is more complex than on land, with increased risk of corrosion of pipelines due to ingress of water during construction.

When CO_2 is injected into saline aquifers (layers of porous rock filled with salt water, as in the Northern Endurance field), not only is there a risk of leaks contributing to ocean acidification, but the salty water from the aquifer can be pushed out into the surrounding areas, harming creatures in sea-bed habitats[15].

High pressures can even crack the rocks capping the layer holding the CO_2. Recent experimental work shows that monitoring and detecting unintended CO_2 leaks is technologically feasible[16], but this provides no assurance that such leaks will be preventable or can necessarily be stopped if they do occur - especially when CO_2 injection is at the vast scale being proposed.

The Sleipner and Snohvit sites each have a maximum CO_2 injection rate of one million tonnes of CO_2 a year, and as we have seen even this has proved problematic. Yet Drax is proposing to capture and store up to *8 million* tonnes of CO_2 a year[17], and it is claimed that by 2035 the East Coast Cluster as a whole will store up to 23 million tonnes a year on average[18]. and the Viking Field aims for 10 million tonnes a year. Clearly any suggestion that there is precedent for this is untrue[19].

A note on jobs predictions

Jobs "Created and supported" is a highly ambiguous term used by Drax and cluster proponents in presenting their exaggerated jobs claims. What it really means is that many of the projected jobs in the East Coast Cluster (leaving aside the temporary ones created in the construction phase of new plants) are in existing industries faced with challenges of decarbonisation if they are to remain competitive.

But the reality is that for many (not all) industrial applications, direct electrification is becoming a feasible - and far cleaner - option which may well be "market ready" within the time it takes to build out CCS infrastructure[20].

Some industries will indeed contract, due to automation, reduction in demand or the need to move to cleaner production methods. The best way to protect jobs is not by defending polluting technologies that ultimately harm all of us, but to ensure properly planned and supported pathways[21] into the many expanding sectors like renewables, rather than leaving the markets to dump workers onto the scrap heap even whilst skills shortages mount in essential new sectors[22].

[1] Furbank, L. (2023) Carbon Capture and Storage (CCS): Frequently Asked Questions, Center for International Environmental Law. Available at: https://www.ciel.org/carbon-capture-and-storage-ccs-frequently-asked-questions/.

[2] Davoodi, S. et al. (2024) 'Carbon dioxide sequestration through enhanced oil recovery: A review of storage mechanisms and technological applications', Fuel, 366, pp. 131313–131313. Available at: https://doi.org/10.1016/j.fuel.2024.131313

[3] Davoodi, S. et al. (2024) 'Carbon dioxide sequestration through enhanced oil recovery: A review of storage mechanisms and technological applications', Fuel, 366, pp. 131313–131313. Available at: https://doi.org/10.1016/j.fuel.2024.131313

[4] Furbank, L. (2023) Carbon Capture and Storage (CCS): Frequently Asked Questions, Center for International Environmental Law. Available at: https://www.ciel.org/carbon-capture-and-storage-ccs-frequently-asked-questions/.

[5] Institute for Energy Economics and Financial Analysis. Carbon Capture and Storage: An Unproven Technology, ieefa.org. Available at: https://ieefa.org/ccs (Accessed: September 2024).

[6] Howarth, R.W. and Jacobson, M.Z. (2021) 'How green is blue hydrogen?', Energy Science & Engineering, 9(10). Available at: https://doi.org/10.1002/ese3.956.

[7] Sani, L. (2024) Kind of Blue - Carbon Tracker Initiative, Carbon Tracker Initiative. Available at: https://carbontracker.org/reports/kind-of-blue/.

[8] Gabbatiss, J. (2022) Heat pumps are the 'central technology' for low-carbon heating, concludes IEA, Carbon Brief. Available at: https://www.carbonbrief.org/heat-pumps-are-the-central-technology-for-low-carbon-heating-concludes-iea/.

[9] Joris van Niel and Somers, K. (2024) Net-zero electrical heat: A turning point in feasibility, McKinsey & Company. McKinsey & Company. Available at: https://www.mckinsey.com/capabilities/sustainability/our-insights/net-zero-electrical-heat-a-turning-point-in-feasibility.

[10] Transfinder (2024) Battery Electric vs. Hydrogen Fuel Cell Buses: Efficiency Comparison, Transfinder. Available at: https://www.transfinder.com/resources/battery-electric-vs-hydrogen-fuel-cell-buses (Accessed: 25 September 2024).

[11] Global Hydrogen Hub (2023) Clean Hydrogen Ladder – version 5.0 | Global Hydrogen Hub, Global Hydrogen Hub | Online platform aggregating analysis and information on global and regional hydrogen market developments. Available at: https://globalhydrogenhub.com/report-presentation/clean-hydrogen-ladder-version-5-0 (Accessed: 25 September 2024).

[12] Ocko, I.B. and Hamburg, S.P. (2022) 'Climate consequences of hydrogen emissions', Atmospheric Chemistry and Physics, 22(14), pp. 9349–9368. Available at: https://doi.org/10.5194/acp-22-9349-2022

[13] Mullendore, S., Milford, L. and Ramanan, A.R. (2020) Hydrogen Hype in the Air, Clean Energy Group. Available at: https://www.cleanegroup.org/hydrogen-hype-in-the-air/

[14] Fendt, L., Reisch, N. and Feit, S. (2024) Deep Trouble The Risks of Offshore Carbon Capture and Storage CENTER for INTERNATIONAL ENVIRONMENTAL LAW. Available at: https://www.ciel.org/wp-content/uploads/2023/11/Deep-Trouble-The-Risks-of-Offshore-Carbon-Capture-and-Storage.pdf.

[15] Fendt, L., Reisch, N. and Feit, S. (2024) Deep Trouble The Risks of Offshore Carbon Capture and Storage CENTER for INTERNATIONAL ENVIRONMENTAL LAW. Available at: https://www.ciel.org/wp-content/uploads/2023/11/Deep-Trouble-The-Risks-of-Offshore-Carbon-Capture-and-Storage.pdf.

[16] Stemm-CCS. STEMM-CCS Science briefs. Available at: http://projects.noc.ac.uk/stemm-ccs/sites/stemm-ccs/files/documents/STEMM-CCS_Monitoring.pdf (Accessed: 25 September 2024).

[17] Stemm-CCS. STEMM-CCS Science briefs. Available at: http://projects.noc.ac.uk/stemm-ccs/sites/stemm-ccs/files/documents/STEMM-CCS_Monitoring.pdf (Accessed: 25 September 2024).

[18] East Coast Cluster. https://eastcoastcluster.co.uk/. Accessed 25 September 2024.

[19] Viking CCS. https://www.vikingccs.co.uk/about. Accessed 25 September 2024.

[20] Fraunhofer ISI (2024): Direct electrification of industrial process heat. An assessment of technologies, potentials and future prospects for the EU. Study on behalf of Agora Industry. Available at: https://www.agora-industry.org/publications/direct-electrification-of-industrial-process-heat

[21] Campaign Against Climate Change Trade Union Group. (2024) Blogs. Available at: https://www.cacctu.org.uk/blog?page=1 (Accessed: 25 September 2024).

[22] Ambrose, J. (2024) '"We're facing a critical shortage": why UK's green revolution urgently needs skilled workers', The Observer, 20 January. Available at: https://www.theguardian.com/environment/2024/jan/20/were-facing-a-critical-shortage-why-uks-green-revolution-urgently-needs-skilled-workers.