



Centre for Alternative Technology
Canolfan y Dechnoleg Amgen

ZERO CARBON BRITAIN

RIISING TO THE CLIMATE EMERGENCY

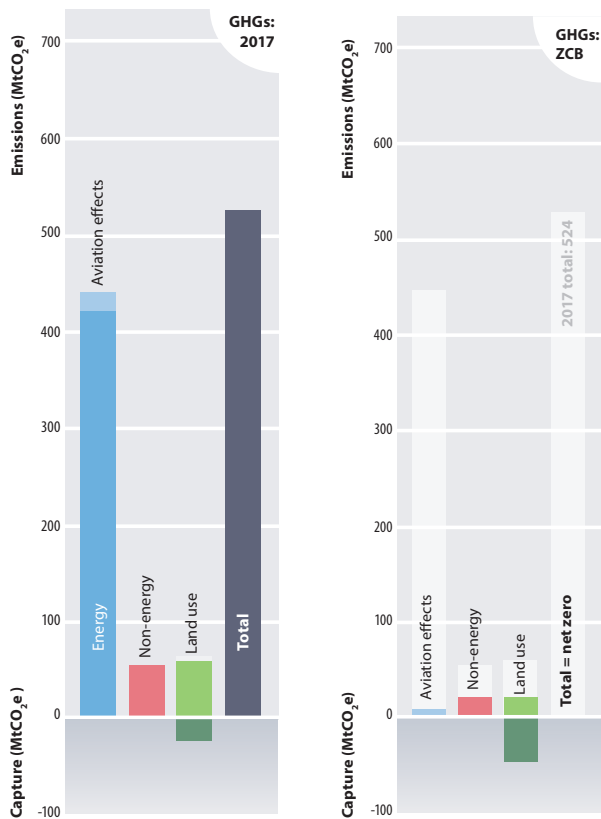
EXECUTIVE SUMMARY

Zero Carbon Britain: Rising to the Climate Emergency models a technically robust endpoint where we have achieved net zero greenhouse gas emissions – let's call this 'zero carbon'. Our work clearly demonstrates that we already have the tools and technology needed to efficiently power the UK with 100% renewable energy, to feed ourselves sustainably and so to play our part in leaving a safe and habitable climate for our children and future generations.

Addressing climate breakdown

People all over the world are feeling the effects of climate breakdown, from unprecedented heatwaves, droughts and massive wildfires to some of the most damaging floods and storms ever seen. The warnings from the scientific community are now becoming real life experiences.

The current UK greenhouse gas emissions reduction target of net zero by 2050, though ambitious in comparison to some other countries, does not offer rapid enough reductions to provide a good chance of avoiding extremely dangerous climate breakdown. Neither does it adhere to what might be termed the UK's 'fair share' of the remaining global carbon budget.



UK greenhouse gas emissions in 2017 (left) compared to our Zero Carbon Britain scenario (right), including carbon captured, international aviation and shipping, and the enhanced effect of emissions from aviation.

Net zero starts now

Zero Carbon Britain: Rising to the Climate Emergency explores how we can do what we know is necessary, clearly demonstrating that we already have all the technologies we need to achieve net zero.

By making changes to our buildings, transport systems, land use and behaviour, and by investing in a variety of renewable energy technologies, we can achieve a zero carbon transition while building in a wide range of additional benefits.

The report provides a blueprint to open new conversations around the scale and speed of change we need to deliver if we are to rise to the climate emergency.

It can be used as a template to help citizens and local and national policymakers develop and deliver zero carbon action plans.

By using energy more efficiently we can power down demand by 60%.

How can we reach net zero?

By using energy more efficiently we can power down demand by 60%. At the same time, we can power up the UK's renewable energy resources to replace fossil fuels. And by making changes to our agricultural

systems we could then balance out the remaining 8% of emissions from non-energy processes (such as cement production or methane from livestock) by removing greenhouse gases from the atmosphere through natural carbon capture from forests and restored peatlands. This would take us to net zero emissions overall.

Powering down our energy demand

We can reduce energy demand for heating by around 50%.

Reducing how much we travel and changing our modes of travel could cut energy demand for transport by 78%.

Our current lifestyles use far more energy than we actually need. CAT's Zero Carbon Britain research shows that we could reduce our energy demand by around 60%, with particularly large savings in heating buildings and in transport.

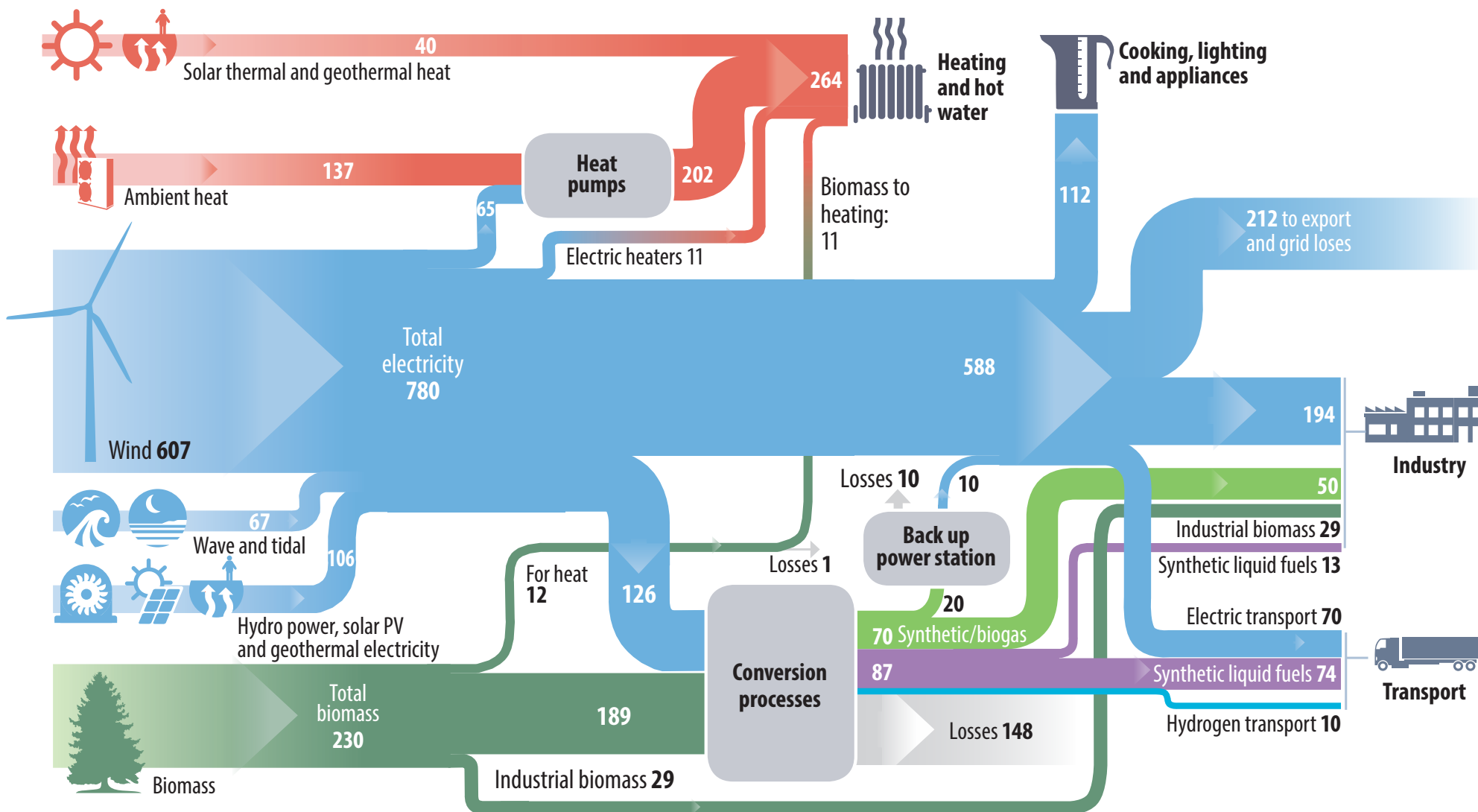
- **Buildings:** having high 'Passivhaus' standards for new buildings, retrofitting all existing buildings, and improving internal temperature control would reduce energy demand for heating by around 50%.
- **Transport:** reducing how much we travel, and changing how we travel – with more use of public transport, walking, cycling, switching to efficient electric vehicles and two thirds less flying – would reduce energy demand for transport by 78%.

We can supply 100% of the UK's 'powered-down' energy demand with renewable and carbon neutral energy sources.

Powering up renewable energy

It is possible to supply 100% of the UK's 'powered-down' energy demand with renewable and carbon neutral energy sources, without fossil fuels and without nuclear. In the Zero Carbon Britain energy scenario:

- Many different renewable energy sources suited to the UK – solar, geothermal, hydro, tidal and others – are used to produce electricity and heat.
- Wind energy – both offshore and onshore – plays a central role, providing around half of the energy supply.
- Most of the energy in this scenario (around 66%) is produced in the form of electricity.
- Carbon neutral synthetic fuels play an important role where it is not possible to use electricity – for example, in some areas of industry and transport, and as back up for our energy system.

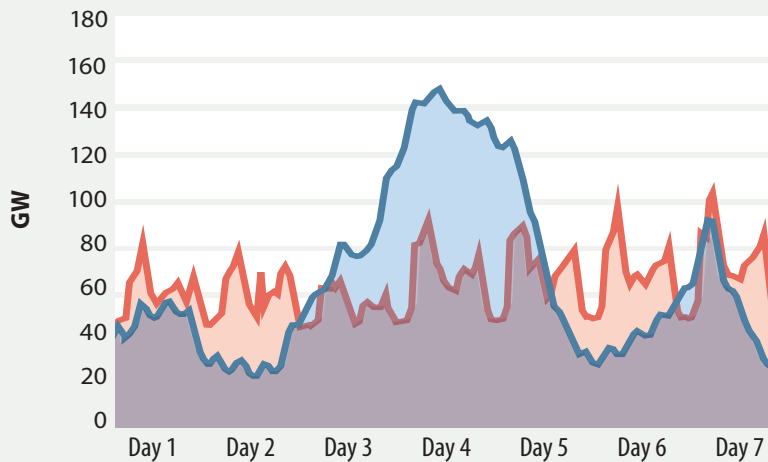


Energy flows in our scenario – from supply to demand (figures are in TWh/yr)

Hourly energy model

The Zero Carbon Britain energy model is one of the most detailed studies to date on balancing demand and supply in a renewable energy system. It uses hourly weather data (sunlight, wind speeds,

temperatures, etc.) from over the ten-year period of 2002 to the end of 2011 – a total of almost 88,000 hours – to test renewable energy mixes under real life conditions



Total demand
Total supply
Direct match
Surplus
Shortfall

Example of seven days (13th – 19th December 2010) from the hourly energy model, showing electricity demand and supply in gigawatts (GW), highlighting times of surplus and times of shortfall before measures to manage variability are implemented.

Smart appliances and short- and long-term storage mean a 100% renewable energy system can provide power 24 hours a day, all year round.

The important question for a 100% renewable energy system is not if we can produce enough energy but whether we can produce enough energy at all times – even when the wind isn't blowing, the sun isn't shining and our energy demand is high.

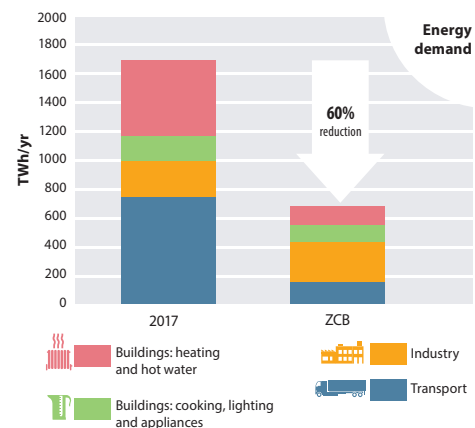
Hourly modelling of the renewables mix in the Zero Carbon Britain scenario shows a surplus of energy 74% of the time. We ensure there is enough energy at other times by:

- Shifting energy demand using 'smart' appliances and using batteries, pumped storage, heat storage and hydrogen for short-term energy storage over hours or days.
- Using carbon neutral synthetic gas (which can be dispatched quickly into the electricity grid when we need it) for long-term energy storage over weeks or months.

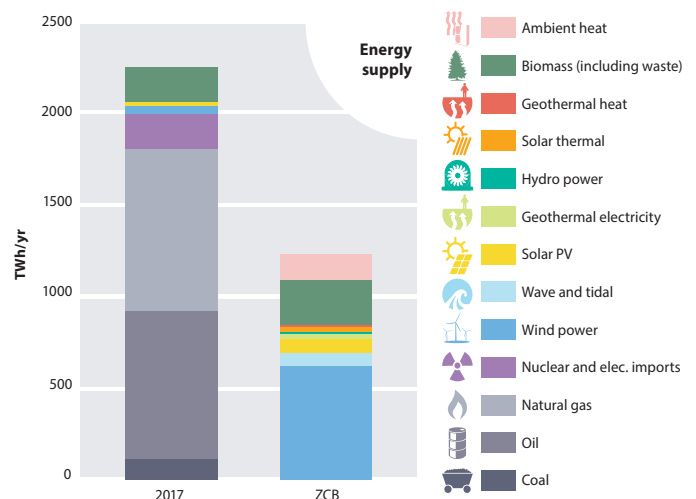
This research suggests 'baseload' power that provides a continuous supply of electricity but can only respond slowly (nuclear, for example) doesn't work well with a highly variable renewable energy system, as it leads to further overproduction when renewables already exceed demand.

Carbon neutral synthetic fuels

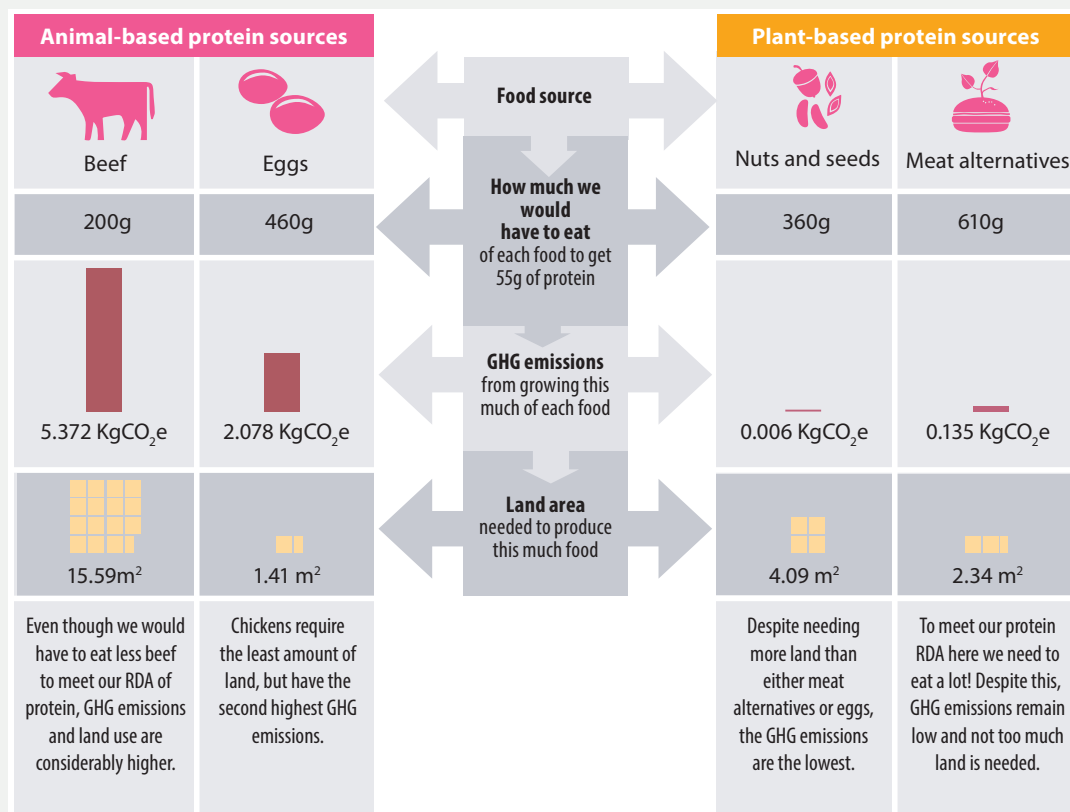
Synthetic fuels have the same chemical make up as fossil fuel oil and gas but can be created by combining hydrogen (produced by electrolysis using surplus renewable electricity) with carbon from sustainable UK grown biomass, making them carbon neutral.



Total annual energy demand by sector in the UK in 2017 and in our scenario in terawatt-hours per year (TWh/yr)



Energy mix in our scenario – the amount of energy supplied by each renewable source.



Comparison of four different high protein food sources: how much would need to be eaten to meet the recommended daily amount (RDA), the associated GHG emissions and land used.

Food and diets model

The Zero Carbon Britain food and diets model combines data describing the nutritional qualities of the foods we eat, their land requirements and the greenhouse gases emitted in producing them. This model can then be used to assess the impacts of dietary change.

Land use

Through 'powering down' demand and 'powering up' renewable supply, the UK's emissions can be significantly reduced save a few industrial and waste management processes that still emit residual greenhouse gases. However, there are also emissions associated with food production, land use changes and land management practices – this accounts for around 10% of current UK emissions.

Agricultural systems are threatened with reduced productivity due to a decline in the numbers and variety of plants and animals in farmland and the surrounding environment. This variety of life is necessary for efficient food production. Therefore, our land management practice must include restoring essential biodiversity.

Our model explores how we can achieve this whilst also reducing agricultural emissions, providing a healthier mix of foods, reducing unnecessary food imports, producing building materials, providing UK sourced biomass, and increasing natural carbon capture to 'balance' our residual emissions. In doing this, the UK will become more self-reliant and can clean up its

own mess within its own territory. This is a vital piece in the net zero carbon jigsaw. The use of land explored in the Zero Carbon Britain model will offer a healthier mix of food, plus backup energy supply, and will provide natural carbon capture, which allows the UK to be truly net zero carbon.

Through dietary change, food waste reduction and improved agricultural practices we could provide a healthy, sustainable diet for the whole UK population.

A healthy low carbon diet

Through dietary change, food waste reduction and improved agricultural practices we could provide a healthy, sustainable diet for the whole UK population. These changes would mean that:

- Greenhouse gas emissions from agriculture would be reduced by 57% from 2017 levels. This represents only emissions produced 'on the farm', as food processing and distribution are taken into account in 'powering down' and 'powering up'.

- The UK could become more self-reliant in food, reducing imports from 42% to 17%, and so reducing the impacts of food production for our consumption elsewhere in the world.
- Our health would be improved by eating a better and more balanced diet.
- 75% of the land currently used for grazing livestock could be repurposed, freeing up space for a range of other uses, which could also offer new income streams to farmers.

The modelled dietary change contains significantly less protein from meat and dairy (which have high emissions and use a lot of land) and more from plant-based sources like beans, nuts, cereals and vegetables.

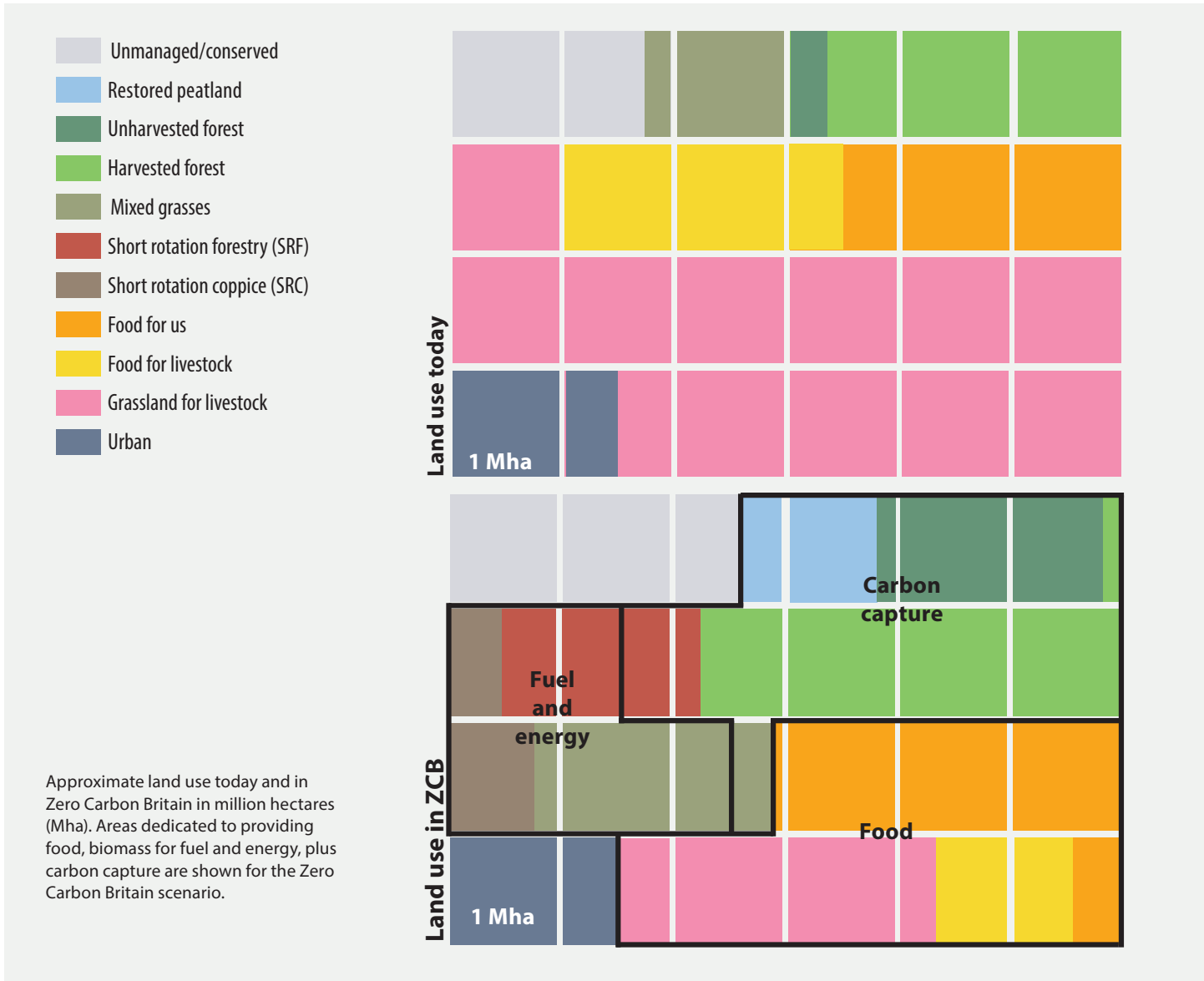
We can double UK forest area and restore 50% of UK peatlands.

Making these changes would mean that we have enough land in the UK not only for producing food but to offer new potential income streams.

As well as being used directly as a fuel, UK sourced biomass can be combined with hydrogen from surplus renewables to make carbon neutral synthetic gas and liquid fuels, which increases the amount of fuel produced per acre of land. These are 'carbon neutral' as the greenhouse gases they contain were initially captured by the biomass as it grew, resulting in no net increase in the atmosphere.

Forest area is doubled to 24% of the land area of the UK – roughly one third is unharvested and two-thirds harvested for timber. These forests, the wood products they produce and the restoration of 50% of UK peatlands, results in the capture of around 47 MtCO₂e on average every year. This is required to balance the residual emissions in the scenario and so make the UK net zero carbon.

The changes would also provide more room for biodiversity in wild, restored, conserved or protected areas.



Using this report

A great many people and organisations across the UK are working alongside their local governments to explore zero carbon transitions in transport, energy, buildings, food, land use and waste. Not only can we deliver this through collective action plans, we can also make the individual changes which directly reduce our own emissions, and so transform how we relate to climate breakdown personally.

How you use the report will depend on scale, location and circumstance, but here are some common approaches:

- Get informed and get skilled
- Get connected – join or start a local zero carbon group
- Map out key collaborators
- Make an action plan
- Minimise energy demand and rethink renewable supply
- Use the savings to help fund new projects
- Learn by doing
- Share your experiences

Rising to the climate emergency

While the impacts of individual changes are, of course, relatively small, as more and more of us scale these up they normalise emission reduction behaviours, empower people, help change social and political norms and so increase ambition for policy shifts.

Sharing Zero Carbon Britain can inform ambitious practical actions and policy shifts by clearly demonstrating:

- All the technologies needed to power down demand and power up clean energy are ready and waiting.
- Changes in land use, reduced food imports and healthier diets are a key part of the plan.
- Action on climate change can provide many additional benefits, including improved health and wellbeing, better housing and enhanced biodiversity.

Clearly, there is no single technology, policy or action that can prevent climate breakdown. It will require many people, from all walks of life, working together to bring about the change we need to see. So let's come together at individual, local, national and international levels – and collectively rise to the climate emergency!



Zero Carbon Britain at the Centre for Alternative Technology



Download the full *Zero Carbon Britain: Rising to the Climate Emergency* report or buy a printed copy on the CAT website at www.cat.org.uk/zcb

Radical action is needed now to avoid dangerous climate breakdown. The Centre for Alternative Technology (CAT) offers practical solutions and hands-on learning to help create a zero carbon future.

Since 2007, CAT's Zero Carbon Britain research has opened new conversations around how the UK can reach net zero greenhouse gas emissions using only proven technologies.

Exploring the technological, economic, social and cultural changes needed to reach net zero, CAT's research provides policymakers, industry and active citizens with the evidence and inspiration to begin building a better world.

All of our reports are free to download at www.cat.org.uk/zcb

Join the change

There are many ways to get involved with and support CAT's work.

- From 2020, a new Zero Carbon Britain Hub and Innovation Lab at CAT provides support for local authorities and community groups to develop and implement Zero Carbon Action Plans that will help address the climate emergency.
- CAT offers postgraduate degrees in a wide range of subjects, including renewable energy, sustainable architecture, food, ecology and behaviour change. With over 1,500 graduates working across all sectors of society, CAT's Graduate School is a growing movement for change.
- Our two-day Zero Carbon Britain course provides an overview of our research and explores ways that it can be used to inspire, inform and enable people to work together to create change. Other short courses provide skills and knowledge in environmental solutions from green building and renovation to introductions to renewable energy.
- Every year CAT's visitor centre welcomes thousands of people keen to learn more about environmental solutions – from school visits to family explorations. Come and visit us!
- CAT is an educational environmental charity – becoming a member is a great way to stay in touch whilst supporting our vital research and education work and joining a community of changemakers determined to rise to the climate challenge.



Visit our website or get in touch to find out more and join the change.

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