Towards Net Zero Carbon Emissions by 2030

Prepared by members of the
Thatcham Town Council Environmental Working Party

Adopted by the Recreation and Amenities Committee
on 11th January 2021

CONTENTS

1. INTRODUCTION

Thatcham Town Council recognises the urgency associated with the Climate Emergency and voted in June 2019 in support of a motion that seeks to 'support and promote a wider programme of activities to help Thatcham as a whole become more sustainable with the ambition of achieving carbon neutrality by 2030'.

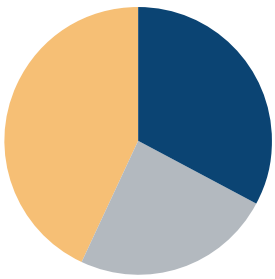
This document is a response to this motion and sets out initial recommendations from the Environmental Working Party of Thatcham Town Council.

The document is written, and shared, as a working document and is expected to develop further following feedback.

An Action Plan for Carbon Reduction

Since the 1990s scientists have been calling for an 80% reduction in the levels of carbon dioxide (CO_2) emissions in 1990 by 2050 by western nations in order to contain the rise in global temperatures to 2˚C. The 2˚ target changed in October 2018 to 1.5˚ following the publishing of an IPCC report 'Global Warming of 1.5˚C' requiring a faster and greater reduction. The target now is to achieve net zero emissions.

What does this mean to someone living in Thatcham? The average UK emissions in 1990 were approximately 10 tonnes of CO_2 per person. This is known as an individual's carbon footprint. The average UK carbon footprint has reduced slightly since then due to such things as the reduction in the amount of electricity produced by burning coal. Carbon footprints now need to be reduced to close to zero.



The Information Annex in this document sets out figures to show how an individual's carbon footprint is made up and should be referred to complement the following sections (see pie chart).

From the outset, this plan has been developed on the recognition that it is impossible for any single entity (Individuals, Town Councils, District Councils, or Government) to deliver a net-zero carbon transition alone: it is incumbent on all to work together.

The plan that follows draws attention to those where Town and District Council should focus priority, but also highlights actions that individuals can take and points to shortfalls in Government policy which urgently need to be changed.

In Thatcham[1] and West Berkshire, per capita CO_2 emissions arise from:

1. Industry and commercial: 1.9 tonnes per person and 33% of emissions
2. Domestic heating and electricity: 1.6 tonnes per person and 28% of emissions
3. Transport: 2.3 tonnes per person and 39% of emissions

Together these three categories account for 5.8 tonnes of CO_2 per capita. With a population in Thatcham of 26,000 this is a total equivalent emissions of 151,000 tonnes of CO_2.

What is Zero Carbon?

Zero carbon is a term used to denote a state of carbon neutrality in the sense that the amount of carbon extracted from the earth and delivered to the atmosphere as a greenhouse gas (not good) is balanced by the amount recovered from the atmosphere and returned to the earth (good). There is a good definition on Wikipedia of carbon neutrality[2]. Zero carbon can be achieved by a combination of reducing the amount of greenhouse gases, especially CO_2, that are emitted, and offsetting what is emitted through carbon capture techniques which may be natural or man-made.

1. INTRODUCTION

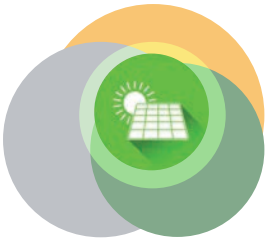
Why is Zero Carbon important?

The debate about man-made global warming, its causes and the mitigation actions required to keep it in control has been going on for over fifty years, but it has intensified recently, and 'global warming' is now a term generally understood by the public. There can be little doubt about the science, the extent to which humans cause global warming, its effects on the planet and the natural world including humans, and the actions needed to mitigate it. Indeed, there is very little doubt among scientists. 97% of actively-publishing scientists recognise that climate-warming trends over the past century are extremely likely to be due to human activities[3].

The actions required to control global warming have to be taken by all communities across the globe if success is to be achieved. A series of international conferences in the past thirty years has sought to bring consensus for action between as many governments as possible. The most recent, in Paris in December 2015, was signed by almost 200 governments including the UK government, of which 195 had ratified the agreement by March 2019. They agreed to take actions necessary to limit global warming to well below 2°C by 2050, (from pre-industrial revolution levels), and to strive further to keep to a limit of an increase of 1.5°C[4].

The difference between 1.5°C and 2.0°C of warming may not seem important but it matters hugely. The figure is an average across the planet, and in October 2018 the International Panel on Climate Change (IPCC) issued a report which stated that 20%-40% of the world's population lives in regions where, even if the average global rise is limited to 1.5°C, the rise in the location where they live would be 2°C or more[5] and that could be disastrous to them. So an increase of 1.5°C must be the limit, but even then the report "finds that limiting global warming to 1.5°C would require 'rapid and far-reaching' transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO_2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO_2 from the air".

1. *Emissions are not broken down to Town or Parish level and so it will be assumed that the Thatcham per capita emissions will be similar to West Berkshire as a whole*
2. *https://en.wikipedia.org/wiki/Carbon_neutrality*
3. *https://climate.nasa.gov/scientific-consensus/*
4. *https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement*
5. *https://www.ipcc.ch/sr15/*



2. ENERGY USE AND ENERGY SAVINGS PLANNING

At 5.8 tonnes of CO_2 per capita per year in West Berkshire and with an average occupancy of 2.6 people per house, the average household creates 14.8 tonnes of CO_2 per year. The domestic contribution due to heating, hot water, and electricity accounts for 4.1 tonnes pa split between electricity accounting for 1.3 tonnes, and heating fuels such as gas and oil accounting for 2.7 tonnes of CO_2.

The focus in this plan is more on domestic and transport which Thatcham Town Council can influence and less on commercial activity which is mostly outside its area of influence. The plan also identifies opportunities for Thatcham to exploit renewable energy solutions.

The plan builds on initial proposals contained within 'Zero Carbon West Berkshire' (West Berkshire Green Exchange) and 'Clean Growth: Technologies for meeting the UK's emissions reductions targets' (House of Commons Science and Technology Committee) as well as drawing in research from other reports including the Committee on Climate Change.

This plan is supported by an Information Annexe that provides an introduction to the relationship between energy use and carbon dioxide emissions, references and glossary.

Building Design

Across West Berkshire 68% of domestic carbon emissions are associated with the use of gas and oil, mostly for air and water heating. In the transition towards net-zero carbon it is essential that new buildings are specified that have insulation, airtightness, and low-carbon heating solutions central to their design.

New buildings must be built to the highest levels of building regulations and alignment should be sought with West Berkshire Council on an agreed definition (e.g. PassivHaus, AECB Gold Standards, Code for Sustainable Buildings, Zero Carbon Buildings).

Alternatively the Building Compliance Body (BCB) of West Berkshire should set values for the Dwelling Emission Rate (DER) in Part L 1A that substantially exceeds minimum requirements and that are consistent with the Council's net-zero carbon approach.

The BCB should set targets for the number of new developments that include high efficiency alternative systems as defined in Building Regulations Part L1A Regulation 25A. The number of achieved targets should be available for public review.

New developments should be designed that maximise the potential for buildings to support solar photovoltaic and solar heating panels to reduce the demand for electricity and heating. This will require consideration of the orientation of buildings, and that shadowing from adjacent properties is minimised.

Where developers are unable to demonstrate that buildings in their development are able to be net-zero carbon, then the developer should indicate alternative carbon offsetting through support of other renewable energy schemes. Heating for new buildings must transition from gas/oil to electricity using air source or ground source heat pumps. Recommendations from the Committee on Climate Change that no new homes should be connected to the gas grid by 2025 should be embraced. New builds should be designed to support thermal stores, and have a heating design suitable for low distribution temperatures. Where multiple options exist control strategies should give priority to the least carbon intensive solution.

The Building Inspector with the support of an Energy Assessor should ensure that buildings are built to the highest standards and that air tightness is achieved.

Existing buildings should bring up their level of insulation and airtightness to the highest levels within the constraints of the existing building fabric.

When building adaptations are made, a building should have an energy assessment and be brought up to levels consistent with equivalent DER ratings of new buildings.

A service should be made available with Council support that enables residents to have energy

assessments of their property. Ideally, this would include thermal testing and airtightness (air permeability). As such tests can be expensive, there is an opportunity for Energy Assessors to propose a service to multiple properties to lower the cost.

Commercial developments

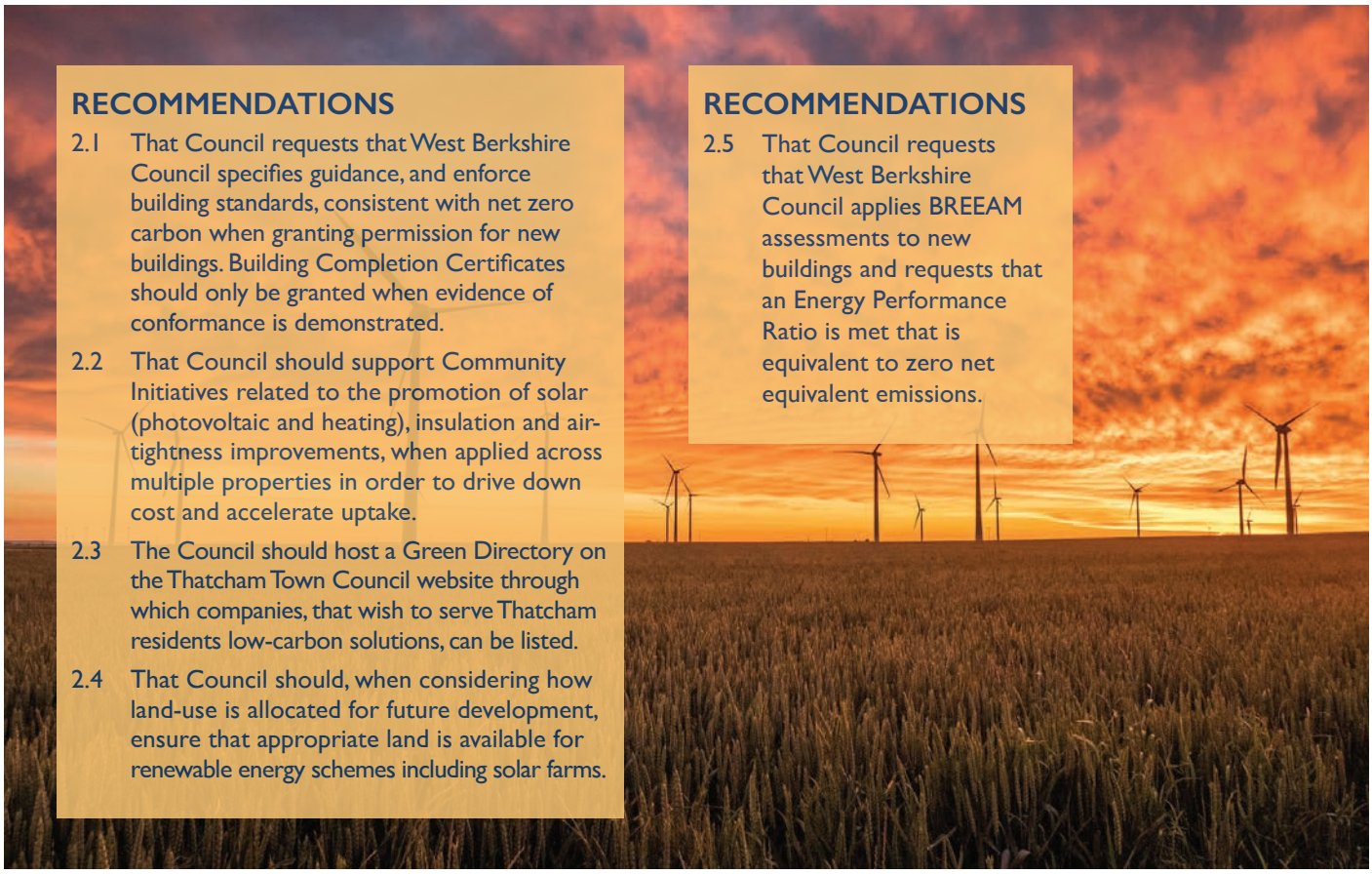
Any new commercial office space should follow similar guidelines for residential properties in order to reduce the carbon impact for heating, water and electricity.

In addition:

New commercial buildings should be BREEAM (Building Research Establishment Environmental Assessment Method) registered and assessed against the 'fully-fitted out' category. Outstanding Ratings should be sought with an Energy Performance Ratio for New Construction of 0.9 consistent with zero net regulated CO_2 emissions.

Where a developer is unable to demonstrate the appropriate BREEAM zero net emissions, an equivalent offset in energy use through investment in renewable energy schemes should be sought.

Where there is mixed residential and commercial development consideration should be given to heat distribution systems such that excess heat (from industrial processes) can be used to preheat water for residential or office use.



RECOMMENDATIONS

2.1 That Council requests that West Berkshire Council specifies guidance, and enforce building standards, consistent with net zero carbon when granting permission for new buildings. Building Completion Certificates should only be granted when evidence of conformance is demonstrated.

2.2 That Council should support Community Initiatives related to the promotion of solar (photovoltaic and heating), insulation and air-tightness improvements, when applied across multiple properties in order to drive down cost and accelerate uptake.

2.3 The Council should host a Green Directory on the Thatcham Town Council website through which companies, that wish to serve Thatcham residents low-carbon solutions, can be listed.

2.4 That Council should, when considering how land-use is allocated for future development, ensure that appropriate land is available for renewable energy schemes including solar farms.

RECOMMENDATIONS

2.5 That Council requests that West Berkshire Council applies BREEAM assessments to new buildings and requests that an Energy Performance Ratio is met that is equivalent to zero net equivalent emissions.

3. TRANSPORTATION

The transport sector (excluding aviation) is the largest emitting-sector of the UK economy. In West Berkshire the emissions over a 5-year period, classed as being under the scope of influence of Local Authorities after excluding Motorway traffic, shows an upwards trend accounting for 39% of all emissions and about 2.3 tonnes of CO_2 per person.

Actions that this Council should take must be aligned with a longer-term policy as recognised by the Science and Technology Select Committee [August2019] that has the aim to reduce the number of private vehicles required, for example by promoting and improving public transport; reducing its cost relative to private transport; encouraging vehicle usership in place of ownership; and encouraging and supporting increased levels of walking and cycling.

The train service between Thatcham and London, recently electrified, provides a low carbon transport alternative to private vehicle use. An analysis of vehicle traffic flow in the region, including parking and access to/from the train station, should be undertaken as part of a broader review.

Identified steps and recommendations include the following:

RECOMMENDATIONS

3.1 That Council seeks grant support for the introduction of electric charging points in Council controlled car parks.

3.2 That Council supports increased levels of walking and cycling and where appropriate prioritises both over vehicles in new transport schemes.

3.3 That Council reviews cycle routes, including the canal bridle path between Newbury and Thatcham, to determine if new recreational routes can be developed or improved.

3.4 That Council reviews bus routes and seeks feedback from the public on alternative routing that may increase usage and improve access to the train station.

3.5 That Council requests a traffic flow assessment in the area around the rail crossing to assess access to the public car parks for the train station.

3.6 That Council requests that public car parks, commuter hubs, and retail centres have provision for secure cycle parking and electric charging when new developments come before the Planning and Highways Committee.

3.7 That Council requests new commercial developments to have a transport policy that promotes low carbon travel, including car sharing.

3.8 That Council supports community initiatives that encourage a migration from vehicle ownership to vehicle sharing.

3.9 That Council promotes 'switch-off-your-engine' with improved information signs at the approach to the rail crossing on Station Road.

4. PLANNING

National Level Initiatives

At a national level the Climate Change Act 2008 set a legally-binding commitment for the UK to reduce carbon emissions by 80%, compared to 1990, and recent legislation (June 2019) calls for an acceleration to net zero greenhouse gas emissions by 2050.

The Committee on Climate Change (CCC) report the performance relative to targets on a 5-year cycle and although headline figures suggest that emissions are reducing, the CCC have stated that it failed to meet all significant key indicators: "the surplus [in carbon reduction] is not due to policy but very largely due to accounting changes." The Science and Technology Select Committee, on reviewing Government analysis, indicates that under existing policies the carbon budget objectives will fail to be met.

There are therefore urgent initiatives that the Government needs to make. These include the reintroduction for incentives of solar, onshore wind, and low-emissions vehicles, and improved building regulations. Without such support it is unlikely that West Berkshire and Thatcham can unilaterally achieve net zero carbon emissions in the aspirational time period to 2030.

Where developers are unable to demonstrate that buildings in their development are able to be net-zero carbon, then the developer should indicate alternative carbon offsetting through support of other renewable energy schemes. Heating for new buildings must transition from gas/oil to electricity using air source or ground source heat pumps. Recommendations from the Committee on Climate Change that no new homes should be connected to the gas grid by 2025 should be embraced. New builds should be designed to support thermal stores, and have a heating design suitable for low distribution temperatures. Where multiple options exist control strategies should give priority to the least carbon intensive solution.

The Building Inspector with the support of an Energy Assessor should ensure that buildings are built to the highest standards and that air tightness is achieved.

District Level Initiatives

As a Town Council is only a consultee to planning applications and major developments, many of the recommendations outlined so far will require District Council support to enact. Further actions that should be encouraged at District level include the following.

Renewable Energy

Planning support must also be provided for the generation of renewable energy. The most cost-effective route for large scale renewable energy is onshore wind and solar power, and there should be a presumption towards acceptance of such planning applications.

Appropriate sites for on-shore wind turbines that have good wind resource, typically with an unobstructed view towards the South-West prevailing wind direction, should be identified as part of future West Berkshire development plans. Suitable sites within the AONB should not escape consideration.

A further energy resource available in West Berkshire is micro-hydroelectric low-head power schemes between the River Kennet and the Kennet and Avon Canal. It is recommended that a survey on the available energy resource and most productive sites should be conducted.

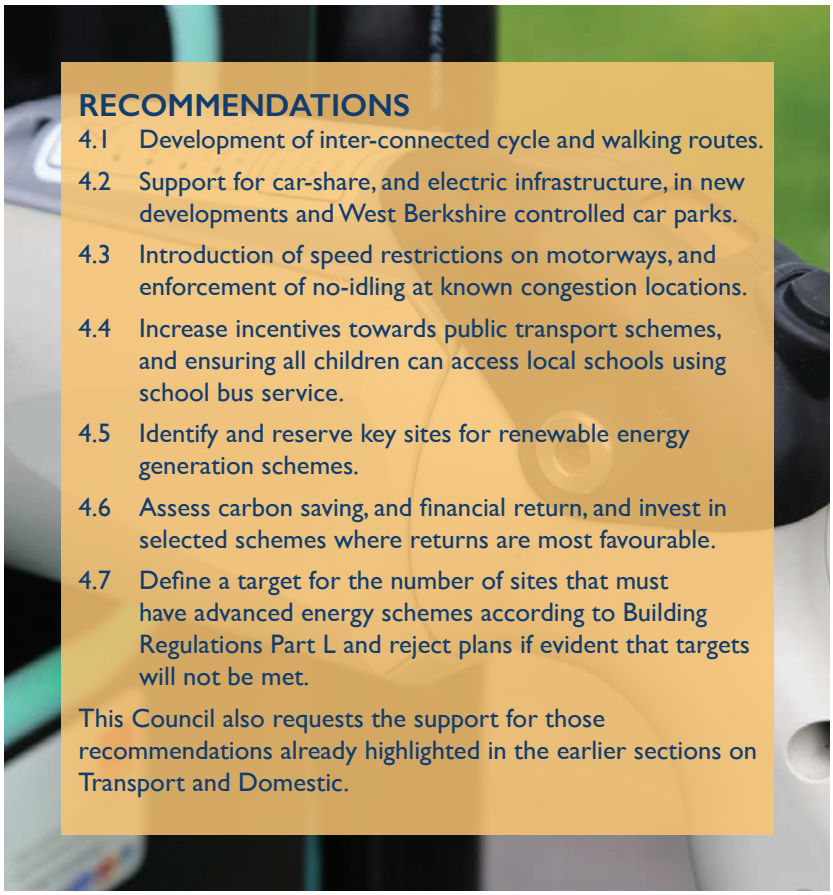
A number of Councils across the country have already taken the step to build and own solar farms directly to offset their own electricity consumption and generate profit. The District Council should explore the feasibility of the energy and financial return from such schemes using Public Works Loan Board that has fixed rates of less than 1.5% for 10 years, and invest directly in renewable energy schemes.

4. PLANNING

Transport

As the sector with the single largest carbon footprint, this should be given priority in District planning for a transition to net zero carbon. Future developments should always be taken in conjunction with a transport policy that has the objective to minimise the number of private car journeys taken using partially occupied petrol/ diesel vehicles.

Walking and cycling routes that are interconnected, public transport, car sharing initiatives, and an electric charging infrastructure must be central to future development plans.



RECOMMENDATIONS

4.1 Development of inter-connected cycle and walking routes.

4.2 Support for car-share, and electric infrastructure, in new developments and West Berkshire controlled car parks.

4.3 Introduction of speed restrictions on motorways, and enforcement of no-idling at known congestion locations.

4.4 Increase incentives towards public transport schemes, and ensuring all children can access local schools using school bus service.

4.5 Identify and reserve key sites for renewable energy generation schemes.

4.6 Assess carbon saving, and financial return, and invest in selected schemes where returns are most favourable.

4.7 Define a target for the number of sites that must have advanced energy schemes according to Building Regulations Part L and reject plans if evident that targets will not be met.

This Council also requests the support for those recommendations already highlighted in the earlier sections on Transport and Domestic.

Individual and Community Initiatives

The figure of 5.8 tonnes of CO_2 per person per year reported by West Berkshire does not take into account personal consumption of materials, food, or air travel, which taken together may double the CO_2 emissions. Therefore, individual choice has an enormous impact on carbon emissions and the more information people have, the better they are able to make choices regarding how to minimise their carbon footprint.

Some of the more significant areas of personal choice include the following:

Aviation

A single return flight (e.g. New York) can easily account for over 2 tonnes of CO_2 per person which is 1/3 of the reported total annual per-person emissions (of 5.8 tonnes) from all other sources in West Berkshire. Therefore, the most immediate way to reduce personal carbon emissions is **to reduce, and if possible avoid, air travel**.

Meat and Dairy

The carbon intensity of meat and dairy consumption is widely recognised as significant with estimates[6] indicating that a diet that includes a 75 gramme serving of beef 1-2 times a week could contribute to 600kg of CO_2 emissions in a year. A reduction of meat in the diet, and sourcing local food that is in season, is a sensible approach to minimise carbon impact.

Electrical Items

The greatest electricity consumption for many houses (that do not use electricity for heating) is related to the use of a tumble dryer for drying clothes. Where possible, drying clothes outside or in an airing cupboard can significantly reduce CO_2 and the electricity bill.

The transition to net zero carbon emissions is a serious challenge. In general, an approach of 'use less', 'waste less' and 'recycle more' is a start, whilst reducing household energy bills.

6. *Climate Change Food Calculator (BBC, 2019)*

5. BIODIVERSITY

Anyone who has watched David Attenborough's documentaries will appreciate how wonderfully diverse nature is. Equally, anyone who saw his 2020 film 'A Life on our Planet' will know how precarious is the existence of many of our natural species. We are in the middle of a mass extinction caused by humans. Climate change is just one of many destructive impacts on the natural world for which the human race is responsible. We need urgently to start to address all the causes. We need to act at many levels, one of which is in our own communities.

We face a huge uphill struggle, but not an impossible one. There are already some success stories. The otter, a mammal at the top of its food chain, was once hunted almost to extinction in England. Now it is evident on every river in the country, including our own River Kennet. The Red Kite, also once absent in England, has been successfully reintroduced, and is now plentiful in this area, as everyone living in Thatcham will know. But for these exciting species to thrive, their natural habitats need to be protected. We know that the bee, of which there are several varieties, is essential to our own survival through its pollinating of plants which would not be able to breed without such pollination. The bee is under threat because of our tendency to destroy the wild places where it thrives. 'Rewilding' is one policy that can protect natural habitats.

In Thatcham we are blessed with a variety of habitats, from reedbeds and lakes to streams, a major river and canal, woodland and heathland on Greenham and Crookham Commons as well as mixed farmland, open public areas and gardens. We are surrounded on most sides by downland that is designated an Area of Natural Beauty (AONB). Some of these areas are under threat from development and any development initiatives should value their existence, as should we.

THATCHAM TOWN COUNCIL WILL:

- 5.1 Map, visit and appraise the natural habitats under its control.
- 5.2 Put a vegetation policy in place.
- 5.3 Manage its natural assets for the benefit of all natural species.
- 5.4 Apply for Tree Preservation Orders on all important trees.
- 5.5 Ensure that the right of use is established for all regularly walked paths.
- 5.6 Involve the community, and in particular children, in understanding the need for nature recovery.
- 5.7 Communicate the need for the general public to respect natural habitats.
- 5.8 Continually review its contribution to biodiversity.

6. REDUCTION OF THATCHAM TOWN COUNCIL'S CARBON FOOTPRINT

In order to identify how Thatcham Town Council can improve its own carbon footprint an independent audit was commissioned and completed by Carbon Footprint Ltd. This audit covers the calendar year 2019 and provides a benchmark to measure future improvements against.

Source: Carbon Footprint Report, External Benchmarking (table 7)

Year/Element	2019
Turnover in £million	1.10
Total number of employees	12
Tonnes of CO_2e	15.05
Tonnes of CO_2e per £million	13.68
Tonnes of CO_2e per employee	1.25
Tonnes of CO_2e per thousand residents	0.50
Scope 1&2 Emissions	
Scope 1&2 of tonnes of CO_2e	13.98
Scope 1&2 of tonnes of CO_2e per employee	1.16
Scope 1&2 of tonnes of CO_2e per £million	12.71

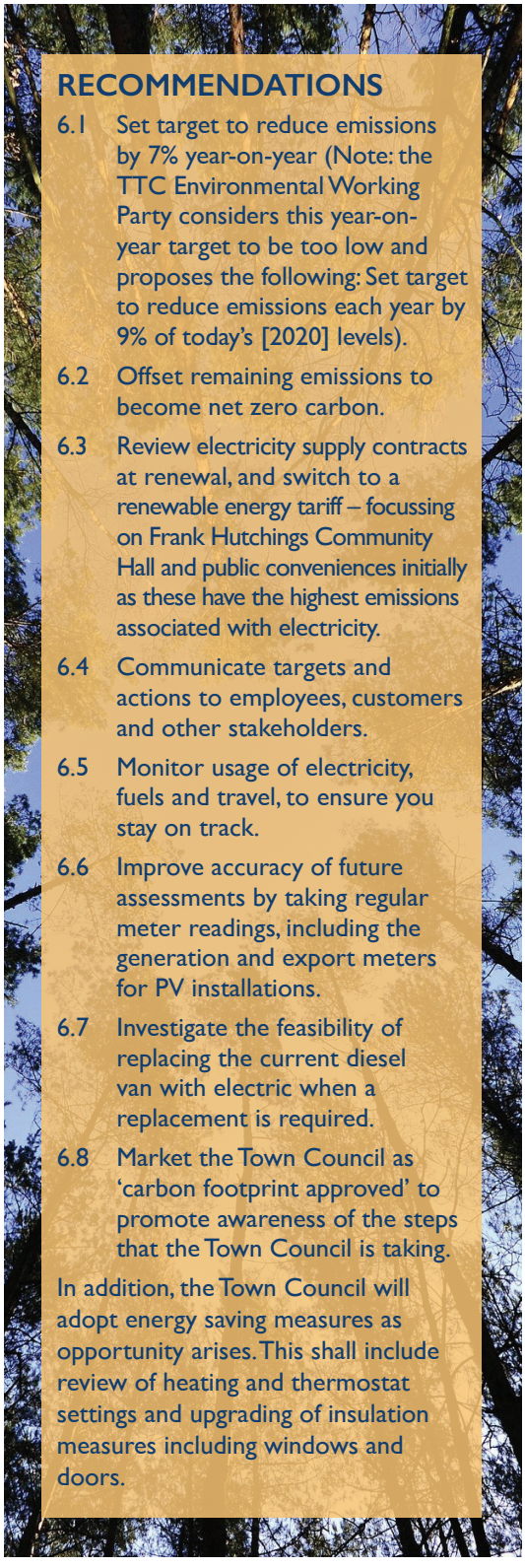
Scope 1 covers direct emissions from owned or controlled sources. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company.

The audit identified that Thatcham Town Council is responsible for approximately 15.05 tonnes of CO_2e of which 81% was associated with electricity consumption, 8% with gas, and 10% with company van travel. Company owned car travel makes up the remaining 1%.

Thatcham Town Council benefits from having an 8kW solar PV system at its Council office building, and a 4kW system at the Frank Hutchings Community Hall. Together it is estimated that they generated 12,140kWh of electricity and avoided 3.37 tonnes of CO_2e emissions.

As well as providing a benchmark, the audit provides a clear priority for the Council to reduce its emissions further. The priority should be on electricity which accounts for the greater share of consumption.

Thatcham Town Council will review and adopt the following recommendations in an appropriately timed manner (for example, electricity contracts will be reviewed when existing contracts expire).



RECOMMENDATIONS

6.1 Set target to reduce emissions by 7% year-on-year (Note: the TTC Environmental Working Party considers this year-on-year target to be too low and proposes the following: Set target to reduce emissions each year by 9% of today's [2020] levels).

6.2 Offset remaining emissions to become net zero carbon.

6.3 Review electricity supply contracts at renewal, and switch to a renewable energy tariff – focussing on Frank Hutchings Community Hall and public conveniences initially as these have the highest emissions associated with electricity.

6.4 Communicate targets and actions to employees, customers and other stakeholders.

6.5 Monitor usage of electricity, fuels and travel, to ensure you stay on track.

6.6 Improve accuracy of future assessments by taking regular meter readings, including the generation and export meters for PV installations.

6.7 Investigate the feasibility of replacing the current diesel van with electric when a replacement is required.

6.8 Market the Town Council as 'carbon footprint approved' to promote awareness of the steps that the Town Council is taking.

In addition, the Town Council will adopt energy saving measures as opportunity arises. This shall include review of heating and thermostat settings and upgrading of insulation measures including windows and doors.

7. COMMUNITY ENGAGEMENT

Most people, regardless of their political persuasion or opinions on many other matters, are concerned by the climate emergency and believe it to be an issue which needs urgent attention. One of the biggest obstacles is a widely shared sense of inability to have any impact on an individual level. The challenge, therefore, is for this action plan to bring local people together and create a sense of 'informed, collective effectiveness'. In order to achieve this, Thatcham Town Council will employ a range of strategies to provide relevant information, local action, and guidance on how every citizen can make their own contribution to a larger effort. A key feature of this plan is to create, communicate and build a sense of shared responsibility; an understanding that the solutions are in the choices of each of us, and all of us.

The Council will create the role of 'Community Climate Champion' to oversee, develop and promote the community engagement required for success.

Engagement

We will create a conversation where all voices can be heard, a sense of shared responsibility within a culture of individual action, connected to a community purpose.

This will include:

- Community consultation
- Public meetings
- Regular communication, specifically on climate issues
- Connecting with various groups and organisations within our community such as schools, local youth, sport, faith & other interest groups, and local businesses.

Information (7.1-7.4)

We recognise that there are two contrasting issues to be addressed. Firstly, the amount of information available (sometimes dubious in its validity and intent) is the cause of inaction for many people. Secondly, a significant lack of information of any kind is also a cause of inaction for many other people.

Action (7.5-7.8)

We believe our community is convinced of the need for action, but often confused or unsure about what individuals can do to contribute.

Thatcham Town Council will take a leading role.

Celebration (7.9-7.12)

It is important to recognise success in order to sustain the energy of existing participants as well as engaging with more people. Too much focus on the remaining challenges can be demoralising and create a feeling of being overwhelmed by the scale of the task and individual insignificance.

Thatcham Town Council will keep a positive focus on achievement alongside the persistent ambition for further and better action.

7.1 Curate accessible, credible information.

7.2 Use social media and the Town Council website to share ideas, events and other useful information.

7.3 Develop a clear focus on local issues.

7.4 Use posters and information on Council noticeboards and in other public places.

7.5 Providing community events.

7.6 Promoting the events of other organisations.

7.7 Supporting local people and organisations as they create events and opportunities for action.

7.8 Ensuring that local people are aware of actions they can take in their own homes and within the broader community.

7.9 Develop a local certification programme to recognise the efforts and contributions of individuals and organisations.

7.10 Explore ways to celebrate the actions of local businesses.

7.11 Promote 'open' events at successful green initiatives (homes, businesses, organisations).

7.12 Dedicate space within all communications to what has been achieved.

8. INFORMATION ANNEX

The purpose of this annex is to assist in education and communication by describing the relationship between energy consumption and CO_2 emissions, and offsets that can be achieved through the generation of renewable energy.

Energy use and its relationship with CO_2

We intuitively understand the meaning of 'energy' – it is what we consume to heat a house, drive a car, or to fulfill us when we are hungry. In physical terms, it refers to the transfer of a source such as electricity or a chemical fuel to create motion or heat.

A convenient way to measure energy is the power used for a given time period and the most common unit to describe it is the kilo-Watt-hour (kWh) which is equivalent to 1kW (or 1000 Watts) of power being used continuously for 1 hour. This is such a useful measure it is what forms the basis of both electricity and gas meter reading.

The kWh also provides a way to convert to CO_2 using readily available tables. For example, electricity from the national grid is generated from a combination of different sources such as coal, gas, nuclear, wind, solar, biomass; several of these sources consume fossil fuels that contain carbon and lead to the emission of carbon dioxide when burnt as fuel to create electricity. The national grid tracks the quantity of fossil fuels consumed and reports the level of CO_2 created for each kWh of useful electrical output.

Similarly, when natural gas is burnt in a gas-boiler at home, or a car consumes petrol or diesel, or coal is burnt for heating in the house or in a power station, CO_2 is generated, and the quantity can be obtained from readily available tables such as those provided by the UK government.

Table 1: Example conversion factors

Energy Source	Typical unit	Energy [kWh] per unit	CO_2 kg per kWh[7]
Electricity	kWh	1	0.25
Petrol	litre	9	0.25
Diesel	litre	10	0.27
Natural Gas	m^3	10	0.20
Coal	kg	7	0.35

[ref. Government Conversion Factors, 2019]

So what can be learnt from Table 1?

As an example, it indicates that using gas to heat a house creates 0.20kg of CO_2 for each 1kWh of heat assuming a fully efficient gas boiler, but electricity used directly to heat up a radiator would emit 0.25kg of CO_2 for each kWh of heat and therefore has higher emissions.

A much better use of electricity for heating is to power a heat-pump that extracts heat from the external environment and can create up to 3kWh of heat for every 1kWh of electric energy, so reducing the heating energy requirements and CO_2 emissions by about 1/3rd.

Another observation is that the CO_2 emission for a kWh of energy from electricity is the same as that for petrol and very similar to diesel. Therefore, for an electrical vehicle to deliver a lower CO_2 emission than a petrol or diesel vehicle per mile travelled, the efficiency of the electrical motor must exceed that of an internal combustion engine. In practice, this is always the case – a Nissan Leaf can travel 3 miles on 1kWh of energy, whilst a comparably sized VW Golf (1,0l, 46mpg) can only travel about 1 mile on 1kWh of energy; an electrical car whilst still not carbon neutral, contributes only 1/3 of the CO_2 emissions of a comparable petrol power vehicle.

What are typical values per individual and per household?

Whilst the previous section introduces the relationship between energy and CO_2 it does little to indicate the scale of energy consumption, e.g. what are the largest contributors to CO_2 emissions?

In this section, examples are provided that illustrate the scale of energy consumption, and related CO_2 emissions. The examples are chosen to give representative indications of their impacts on CO_2 emissions.

Table 2 illustrates the scale of some of the largest familiar contributors to CO_2. For most households the greatest contribution to CO_2 emission

7. *Referenced to Net Calorific Values and CO_2 equivalent emissions; energy per unit rounded to nearest integer or 2 significant figures*

[ref: Energy Consumption in the UK, Domestic and Sector, UK Govt 2019, and UK Conversion Factors, UK Govt 2019]

Table 2: Example contributions to CO_2 footprint

Description	Key assumptions	Energy per year [kWh]	CO_2 kg per kWh[7]
Electrical device left on standby	1W for 1 year	9	2
Washing machine usage[8]	Average of 270 cycles per year, 1kWh per cycle	270	69
Tumble drier[9]	Average of 148 cycles per year, 2.5kWh cycle	148	95
Bath[10]	110litres, 50°C gas heating, 1 per week, 5kWh per bath	260	52
Annual electricity consumption per house	Average over 28mil UK households	3800	980
Annual electric car[11]	Nissan Leaf, 3 miles per kWh, 10000 miles per year	3300	850
Annual petrol car usage[12]	46mpg, 10000 miles per year	9000	2300
Annual gas consumption per house	Average over 23.5mil UK households	14000	2800
One long-haul return flight	Average passenger, New York 5600km	8500	2200[13]

is related to space and water heating, followed by transportation use (petrol or diesel vehicles), and flying on holiday or business. Flying has a particularly adverse impact on the environment because the International Panel on Climate Change (IPCC) has estimated that aviation's total climate impact is some two to four times that of its direct CO_2 which means that a long-haul return flight can easily account for 2 tonnes of CO_2.

This table is far from exhaustive and there any many other contributors to CO_2 through daily consumption and activity such as food, packaging, public services, industry, agriculture, and materials consumed that further increase the effective CO_2 emissions per person. At a national level the government figures indicate that industry accounts for 17% of energy use, transport 39%, domestic use 30% and others (such as agriculture and public services) account for the remaining 15%. Taken together, the national consumption (which excludes international air travel and imported materials) is equivalent to approximately 25,000kWh energy and 6.2[14] tonnes of CO_2 per person.

West Berkshire Council also reports the CO_2 emissions as part of a dataset published by the National Statistics. These figures indicate that on a per capita emission rate, there is the equivalent of 1.9 tonnes (33%) of CO_2 associated with industry and commercial; 1.6 tonnes (28%) associated with domestic heat and electricity; and 2.3 tonnes (39%) associated with transport leading to a total of 5.8[15] tonnes per person. When domestic emissions are scaled by an average occupancy ratio of 2.5 people per house the average emissions per house is 4.1 tonnes which is similar to the national level. It would be expected therefore that Thatcham has a very similar distribution on emissions to the rest of West Berkshire.

8. *Washing Machine [Nef, Knowledge Hub]*
9. *Carbon Footprint of Household Appliances [CarbonFootPrint]*
10. *Water Heating [WithoutHotAir, p50]*
11. *Nissan Leaf [Wikipedia]*
12. *VW Golf [WhatCar]*
13. *Including impact of radiative forcing*
14. *Obtained from Energy Consumption in the UK, UK Govt, Table 1.03 and converting toe to kWh using conversion factor of 11630kWh and appropriate kWh/CO_2 conversion factors (0.20 for gas, 0.25 for petrol, 0.27 for other fuels).*
15. *As reported in UK Local Authority and Regional CO_2 Emissions, range is 5.8 - 8.2 tonnes depending on whether motorway traffic is included in the analysis, much of which originates from outside West Berkshire*

8. INFORMATION ANNEX

Offsets through using renewables

To achieve net carbon neutrality requires both a reduction in consumption of energy and an increase in the generation of renewable energy that has zero carbon emissions. This section describes renewable energy options available in Thatcham and West Berkshire.

Within the Thatcham Town Council boundary, the opportunity for creating energy are through solar (photovoltaic and thermal), wind, and local micro hydro between the River Kennet and the Kennet and Avon Canal. Each are introduced to give example resource available.

Solar Photovoltaic (PV panels)

The solar power per unit area (m^2) is approximately 1000W/m^2 when in full sunlight. Averaged over a year, and accounting for seasonal and daily variation, this provides about 1000kWh/m^2. The useful energy that can be extracted is dependent on the efficiency of solar panels and electrical equipment that converts the direct current (DC) output of a solar panel into alternating current (AC) and typically leads to an overall figure of less than 15%.

It should be noted that the energy produced (2800kWh) from a solar array installed on a roof can make a significant contribution to the total electrical energy consumed by an average house (3800kWh). Alternatively, the output can be used to power an electric car for almost 10,000 miles per year (3300kWh).

[ref: PV Yield, CAT]

Table 3: Example electricity generated from a well sited, south facing, solar array

Item	Value	Description
Average obtained from typical solar array (South facing) of 20m^2	2800kWh/year (13% efficient)	For a 3.6kW array with 12 panels, each providing up to 300Wpeak. Assumes 800kWh/year output for each 1kWpeak installed.

[ref: Solar Water Heating, CAT]

Table 4: Electricity generated from a well sited, south facing, solar array

Item	Value	Description
Sized for average family usage (5m^2)	1500kWh/year (27% efficient)	About 1m^2 area required per person.

[ref: Vestas and EWT]

Table 5: Typical electricity generated from large and smaller wind turbine rated at 2MW and 0.5MW

Item	Value	Description
Vestas, 2MW peak power turbine, 80m hub height, 90m rotor diameter	5 GWh/year (5,000,000kWh/year)	Energy production with 6m/s average wind speed
EWT 0.5MW peak power turbine, 40m hub height, 54m rotor diameter	1.6 GWh/year (1,600,000kWh/year)	Energy production with 6m/s average wind speed with height constrained

Solar Heating (Evacuated Tubes or Flat Panels)

An alternative way to use solar energy is to provide direct heating to water which replaces, or reduces, the amount of energy required from conventional gas or oil boilers.

Using solar panels for heating produces more energy per m^2 than photovoltaics because the transfer of solar energy to heat is more efficient than for the creation of electricity. In addition, creation of solar heat benefits from the Renewable Heat Incentive (RHI) that is currently priced as 21pence/kWh. At 1500kWh/year this could lead to a subsidy paid to the house owner of £316/year as well as reducing substantially the use of gas or heating fuels.

Where sufficient space is available on a roof-top, the ideal installation includes both photovoltaics and solar thermal panels.

Wind Turbines

The energy generated from a wind turbine depends on the diameter of the rotor, the availability of wind resource, and height above ground to avoid local obstructions. By far the most efficient generation of energy from wind is from large turbines located with good unobstructed visibility to the South-West direction which is the prevailing wind direction to Thatcham.

With an average electricity demand per house of 3800kWh/year a single large wind turbine can provide the equivalent electricity demand of 1300 houses, whilst the smaller wind turbine is sufficient to meet the demand of about 420 houses.

Small scale hydro schemes

An additional source of renewable energy for Thatcham is associated to small scale hydroelectricity which captures the energy associated with the water flow at weirs that currently regulate the water level on the Kennet & Avon Canal. The power carried by water is roughly ten times the product of the effective head (the height through which the water falls) and the flow rate (the number of cubic meters of water per second).

The Shenfield Mill hydro is reported as being capable of producing the equivalent energy of 78 houses.

Table 6: Predicted electricity generated from Shenfield Mill, River Kennet, Theale

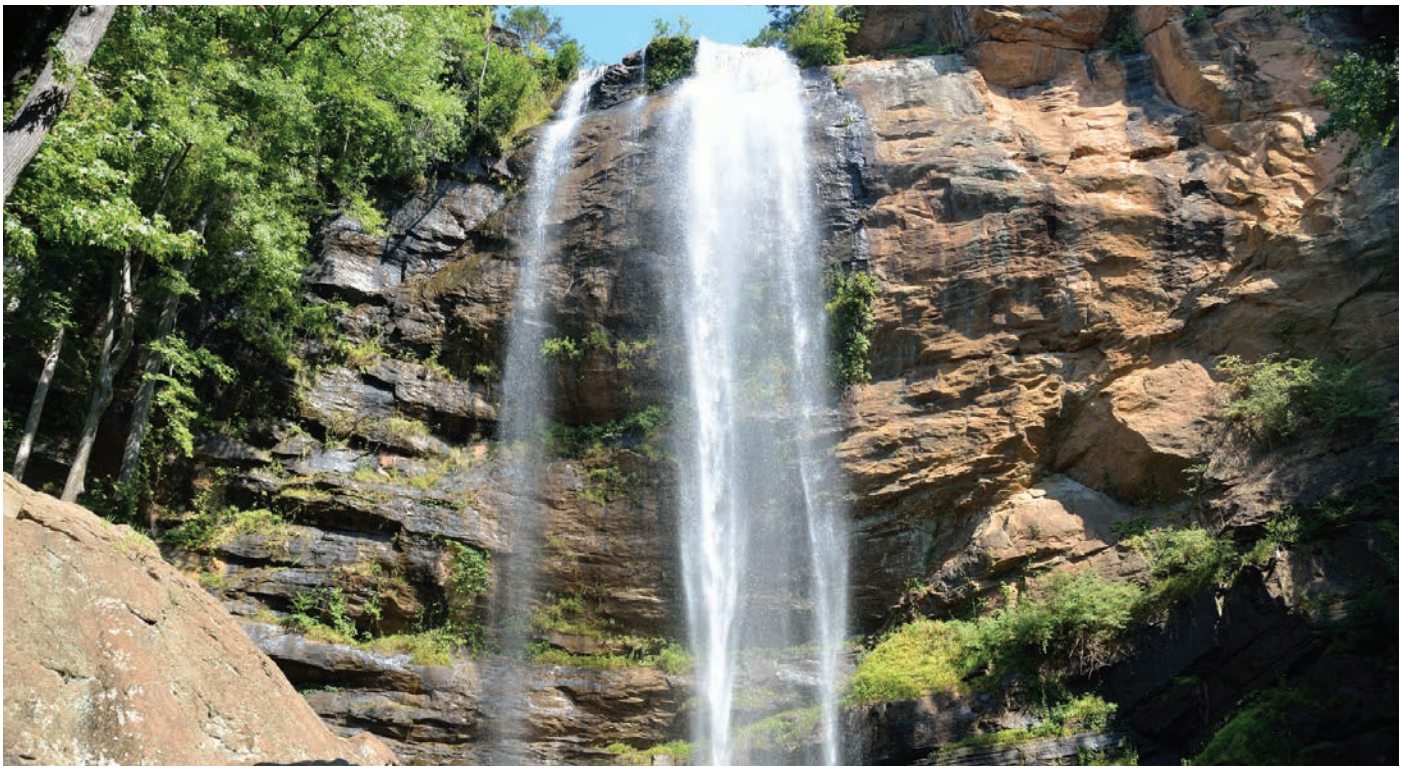
Item	Value	Description
Archimedes Screw Turbine rated at 60kW, 1.8m head and 5 cubic metres per second at 57% of rated power.	300 MWh/year (300,000kWh/year)	Example small scale hydro as used at Shenfield Mill, Theale on River Kennet.

[ref. RewablesFirst]

Woodland and biomass

The growth of trees in woodland absorbs, or sequestrates, CO_2 from the atmosphere, the rate depending on factors such as the type of tree and soil fertility. There are clear benefits with increasing woodland, not just for carbon sequestration but also for ecological reasons including habitat diversity and shading.

The Institute of Terrestrial Ecology (Cannell, 1999) have calculated that a single tree can sequestrate about 30kg of carbon per tree per year. In their estimate, 42 widely spaced oak trees, in 0.37 hectares, are required to offset the emissions from a single vehicle. In order to absorb all fossil fuel emissions in the UK would require a forest covering twice the land area of the UK. Forestry is therefore a contributor to the solution, not the sole answer; there is no avoiding having to cut fossil fuel emissions.



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Glossary

W	Watt is the standard unit of power and defined as energy per second
kW	The prefix of 'k' refers to '1000', so 1kW is equivalent to 1000W
MW	The prefix of 'M' refers to one million, so 1MW is equivalent to 1,000kW
GW	The prefix of 'G' refers to a thousand million, so 1GW is equivalent to 1,000MW
Wh	A measure of energy equivalent to one Watt for one hour
kWh	A commonly used unit for energy equivalent to 1,000Wh CO_2 The chemical representation of Carbon (C) Dioxide (O_2)
CO_2e	The CO_2 equivalent taking into account other greenhouse gasses tonne equivalent to 1000kg
toe	Tonne Oil Equivalent is a larger energy unit used in national reporting (11630kWh)
hectare	A square of 100x100m sides approximately the area of a football field.

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