Thatcham Town Council: Towards Net Zero Carbon Emissions by 2030

Prepared by members of the Thatcham Town Council Environmental Working Party

September 2019

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Thatcham Town Council Working Document

Towards Net Zero Carbon by 2030

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.

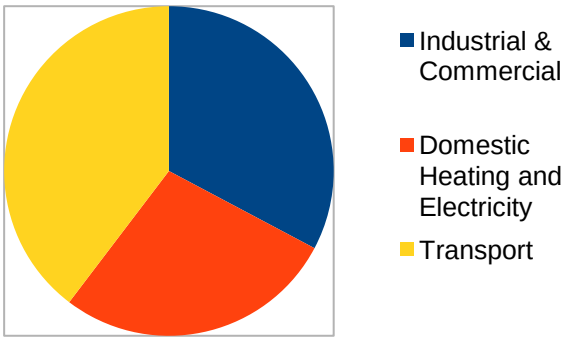
The document is written, and shared, as a working document and is expected to develop further following feedback.

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 to complement the following sections.



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 delivered to the atmosphere as a greenhouse gas is balanced by the amount sequestered from the atmosphere and captured by the earth. 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, emitted, and offsetting what is emitted through carbon capture techniques which may be natural or man-made.

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].

For the past 30 years or so a general recommendation from scientists has been that in the western world we need to reduce our greenhouse gas emissions (principally CO_2) to much reduced levels by 2050 from 1990 levels in order to keep the extent of global warming below 2^{o}C above pre-industrial levels, an amount of warming that was considered manageable though not desirable. In the UK the amount of the reduction was expressed as 80% which approximated to each person reducing their emissions from 10 tonnes per year to 2 tonnes per year on average, a huge undertaking in itself.

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

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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/

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, and to strive further to keep to a limit of 1.5°C [4].

In October 2018 the International Panel on Climate Change (IPCC) detailed the advantages of the 1.5°C limit and discussed the ways this could be achieved. The 1.5°C figure is an average across the planet, and 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]. 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".

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 in West Berkshire and with an average occupancy of 2.6 people per house, the average household contributes 14.8 tonnes of CO_2. The domestic contribution due to heating, hot water, and electricity accounts for 4.1 tonnes 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 on domestic and transport which Thatcham Town Council can influence and less on commercial activity which is mostly outside its area of influence. It 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, air-tightness, 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 unable 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 enable 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.

Recommendations:

That Council requests that West Berkshire Council specify 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.

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.

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

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.

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 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:

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

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 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:

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

That Council support increased levels of walking and cycling and where appropriate prioritise both over vehicles in new transport schemes.

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

That Council review bus routes and seek feedback from the public on alternative routing that may increase usage and improve access to the train station

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

That Council request 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 Committee

That Council request new commercial developments to have a transport policy that promotes low carbon travel including car sharing

That Council support community initiatives that encourage a migration from vehicle ownership to vehicle sharing

That Council promote ‘switch-off-your-engine’ with improved information signs at the approach to the rail crossing on Station Road.

4. Planning

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 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.

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.

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 specific to West Berkshire Council to support Thatcham:

Development of inter-connected cycle and walking routes.

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

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

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

Identify and reserve key sites for renewable energy generation schemes

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

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

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

National Level Initiatives

At a national level the 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 Select Committee on reviewing Government analysis indicate that under existing policies the carbon budget objectives will fail to be met.

There are therefore urgent initiatives that the Government need to make. These include the reintroduction for incentives for 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.

Individual and Community Initiatives

The 5.8 tonnes of CO_2 per person 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 to over 2 tonnes of CO_2 per person which is ⅓ 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 towards net carbon emissions is not without challenge but in general, an approach of “use-less”, “waste-less” and “recycle-more” has a favourable outcome whilst minimising cost.

6 Climate Change Food Calculator (BBC, 2019)

The following sections have still to be written:

5. *Reduction of Thatcham Town Council's Carbon Footprint*
6. *Waste/Recycling/Food*
7. *Plastic*
8. *Carbon Offsetting*
9. *Communications/Social Media*
10. *Education and Community Engagement*

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.

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	m3	10	0.20
Coal	kg	7	0.35

Table 1: Example conversion factors [ref: Government Conversion Factors, 2019]

So what can be learnt from this table?

7 Referenced to Net Calorific Values and CO2 equivalent emissions; energy per unit rounded to nearest integer or 2 significant figures

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.

Description	Key assumptions	Energy per year [kWh]	CO_2 equivalent per year [kg]
Electrical device left on standby	1W for 1 year	9 kWh	2kg
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

8 Washing Machine [Nef, Knowledge Hub]

9 Carbon Footprint of Household Appliances [CarbonFootPrint[

10 Water Heating [WithoutHotAir, p50]

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, NewYork 5600km	8500	2200[13]

Table 2: Example contributions to CO_2 footprint [ref: Energy Consumption in the UK, Domestic and Sector, UKGovt 2019, and UK Conversion Factors, UKGovt 2019]

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

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/CO2 conversion factors (0.20 for gas, 0.25 for petrol, 0.27 for other fuels).

15 As reported in UK Local Authority and Regional CO2 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 Berskhire

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.

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%.

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.

Table 3: Example electricity generated from a well sited, south facing, solar array [ref: PV Yield, CAT]

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).

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.

Item	Value	Description
Sized for average family	1500kWh/year	About 1m^2 area required per

usage (5m^2)	(27% efficient)	person.

Table: Electricity generated from a well sited, south facing, solar array [ref: Solar Water Heating, CAT]

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.

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

Table: Typical electricity generated from large and smaller wind turbine rated at 2MW and 0.5MW [ref. Vestas and EWT]

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).

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.

Table: Predicted electricity generated from Shenfield Mill, River Kennet, Theale [ref. RewablesFirst]

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

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.

References:

West Berkshire Emissions
Local Authority Emissions [UK Govt, 2019]
Emissions for West Berks [UK Govt, 2019, Subset Dataset]

Individual Emissions
Climate Change Food Calculator (BBC, 2019)
Carbon Footprint of Household Appliances [CarbonFootPrint]

National statistics and policy
Energy Consumption in the UK by Sector,[Government, 2019, Table 1.03]
Clean Growth: Technologies for meeting the UK's emissions reduction targets [Science and Technology Committee, 2019]
Total energy balance [WithoutHotAir,p103]

Building Standards
BREEAM UK New Construction [BREAAM, 2019]
BREEAM Refurbishment Domestic Buildings [BREEAM, 2019)
Building Regulations, Part L
Housing for the future [CCC, 2019, p14]

Energy Use and its relationship with CO_2
Government Conversion Factors [UK Govt, 2019]
Energy Consumption in the UK, Annual Domestic Consumption [Government, 2019, Table C9]
Nissan Leaf [Wikipedia]
VW Golf [WhatCar Review, buying and owning]
Washing Machine [Nef, knowledge hub]
Water Heating [WithoutHotAir, p50]

Renewables and Climate Action Recommendations
Zero Carbon West Berkshire [West Berkshire Green Exchange, 2019]
PV Yield (Centre for Alternative Technology)
Solar Water Heating (Centre for Alternative Technology)
Solar Panel Sizing (Sharp)
Large Wind Turbine Power Output (Vestas)
Small Wind Turbine Power Output (EWT)
Shenfield Mill Hydro (RenewablesFirst)
Growing Trees to Sequester Carbon (Institute of Terrestrial Ecology, Cannell, 1999)
Climate Crisis: Can Councils Deliver [Guardian, 2019]

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.