Carbon Reduction Plan

Subject :	Plan for achieving a ‘net positive’ carbon balance for Marwell Wildlife		
Issued by :	Duncan East		Issue No: 2
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Purpose	Plan for achieving a 'net positive' carbon balance for Marwell Wildlife
References	
Responsibility	Duncan East Executive team Heads of departments
Relevant legislation	Climate Change Act 2008 (As amended)
Definitions	DEFRA – Department for Environment Food and Rural Affairs CO_{2e} – Emissions of the six main greenhouses gases converted to an equivalent amount of Carbon Dioxide for ease of comparison IEMA – Institute of Environmental Management and Assessment
Records	Annual carbon footprint calculation is stored in the monitoring section of the ISO14001:2015 management system documentation

1. Introduction

Human induced climate change is a major threat to the stability of all forms of life on earth and compromises the ability of the planet to provide us with essential services such as clean air, fresh water, food, and safe places to live.

The impacts of climate change are wide-ranging and profound: Rising temperatures, shifting seasons, and changing patterns of rainfall and snow are transforming vegetation communities, and allowing spread of infectious diseases. Droughts and floods are becoming more frequent, severe and widespread because of more intensive circulation of water around the planet. Thermal expansion and melting polar ice are leading to sea level rise.

Carbon dioxide (CO_2), the most significant anthropogenic greenhouse gas, has increased by 40% in the atmosphere since 1750 due to use of fossil fuels, deforestation and changes in land cover. Atmospheric concentrations of CO_2 and methane (CH_4) now far exceed the natural range over the last 650,000 years, and global temperatures are 1^{o}C above pre-industrial levels. Urgent action is therefore needed to reduce emissions and sequestrate carbon if we are to limit warming to no more than 2^{o}C, with international, regional, national and local targets being set to achieve this (Box 1).

2. Carbon reduction plan

Our carbon reduction plan is a critical part of our over-arching Conservation Plan which recognises the need to adapt to a rapidly changing world. By following a series of actions identified in this plan, we seek to:

- become operationally carbon positive by the end of 2022 by reducing emissions and offsetting those that we cannot reduce through carbon sequestration on our own land;
- understand our supply chain impact and encourage the wider business community to reduce carbon emissions and take action on climate change; and
- encourage our staff and guests to reduce carbon emissions through communications, education, and public awareness.

Box 1: Global, National & Local Carbon Reduction Targets

The United Nations Framework Convention on Climate Change Paris Agreement (COP21) sets a long-term goal of holding global warming below 2ºC above pre-industrial levels and aims to limit the increase to 1.5ºC to significantly reduce risks and impacts of climate change. Given that global temperatures have already reached 1ºC above pre-industrial levels, action is urgently needed.

The European Union Low Carbon Economy Roadmap includes targets to reduce emissions from member states by 80% from 1990 baseline levels by 2050 with interim milestones of 40% by 2030 and 60% by 2040 (European Union, 2011)

The UK Climate Act (2008) enacts the EU roadmap and commits the UK to 100% reduction target by 2050 (net zero)

Hampshire County Council declared a climate emergency in 2019. The HCC's Carbon Strategy aims to make the council carbon neutral by 2050 with an interim target of 35-40% reduction by 2025. This is to be achieved through a series of four-year action plans tackling energy efficiency and baseline consumption plus investment in local renewable energy infrastructure. The council also aims to lead and support community energy projects within the county and promote carbon reduction across all areas of the county (Hampshire County Council, 2010)

Winchester City Council declared a climate emergency in 2019. Having previously published "Live for the Future: Tackling Climate Change" in 2007 and the Low Carbon Route Map in 2014, WCC now aim to make the council net zero for carbon by 2024 and for the district by 2030

In 2012 the Enterprise M3 Local Economic Partnership (LEP) acknowledged that energy consumption in the region was high compared to national averages and that this had implications for long term sustainable development. Carbon emissions from business and travel are also higher in the M3 LEP area than either regional or national averages. Promoting the development of a low carbon economy was therefore introduced as one of four strategic actions in 2014.

2.1 Our Carbon Footprint

In measuring our carbon footprint, we follow the guidance in the Greenhouse Gas (GHG) Protocol (WBCSD / WRI, 2004) and the DEFRA reporting guidelines on GHG emissions (DEFRA, 2013). The guidance distinguishes between two different types of emissions:

- Direct emissions that are produced directly from our activities. This applies to oil, LPG (and to a lesser extent woodchip) used for heating and cooking, diesel and petrol used in vehicles and fugitive emissions from refrigeration plant.
- Indirect emissions are those emitted by others as a consequence of our actions. This includes emissions from power stations producing the electricity we use, from the production and transport of goods for our use (including mains water), from the disposal of our waste (including sewage) and from the travel of both staff and guests to and from Marwell.

For reporting purposes emissions are divided into three 'scopes':

- Scope I – All direct emissions
- Scope II – Indirect emissions resulting from the generation of electricity.
- Scope III – Indirect emissions from other sources

Scope 1 - Heating and Transport fuel

- Marwell has no mains gas. Instead, oil, kerosene and woodchip are currently used to heat the larger buildings in the park, while LPG is used to heat the Science & Learning Centre, for heat and cooking in Café Graze and as backup to the woodchip at Energy for Life
- Road going vehicles, including four-wheel drive vehicles, vans, pickup and tipper trucks, use DERV (Diesel for Road Vehicles). Non-road going vehicles, including rail and road trains, agricultural vehicles, street sweepers and ride on mowers, use 'red' diesel; a lower taxed but chemically comparable product
- Fugitive emissions from refrigeration equipment are included under scope 1 in recent carbon footprint calculations. This data was not available for the baseline year, however, for the years this data has been available there have been zero emissions, so the omission of this data from early years is unlikely to be significant

Scope 2 - Electricity

- Electricity is used for heating, lighting, ITC, pumps, air handling / cooling, electric vehicles, tools and equipment. Electric heating is used in animal stalls, aquaria, reptile and amphibian vivaria, staff offices and mess rooms and various smaller facilities around the site. Consumption increases greatly in the winter months as heating is a significant proportion of the energy use.
- With only limited sub-metering, some assumptions were made about where and how electricity is being used.

Scope 3 - Indirect emissions included in the Carbon Footprint

- Waste disposal and recycling; business travel, mains fresh water consumption and sewage treatment, and emissions associated with energy losses during electricity transmission.

2.1.1 Current Exclusions

Staff commuting, guest travel and supply chain impacts will significantly contribute to the total amount of carbon emitted because of our operations. However, at this stage, we do not have sufficient data on these emissions, or control over them, to accurately calculate their contribution or the impact of a reduction in carbon emitted from these sources. For these reasons these emissions have not been incorporated into the Carbon Footprint at this stage but will be addressed through this plan.

Commitment 1: We will expand the scope of our carbon footprint to include emissions currently excluded from scope III when better quality data from external sources becomes available

2.1.2 System Boundary

In order to calculate the carbon footprint, it is necessary to define a 'system boundary' and determine which scope III emissions we have sufficient control or influence over to warrant their inclusion in the carbon footprint. We use an 'operational control' approach to setting the boundary of the carbon footprint:

- Marwell Zoo: The activity of running a major visitor attraction in Hampshire including energy and fuel use on site, consumption of electricity supplied to the site, off site travel to meetings, conferences etc. and scope III emissions from waste management, fresh water provision and sewage services to Marwell Zoo: Scope III emissions from our supply chain are currently excluded.
- Conservation programmes: International travel to conservation field sites, meetings and conferences are included in scope III. Emissions from operations including in-country travel, aerial surveys, offices / research facilities at field locations are excluded at this stage.

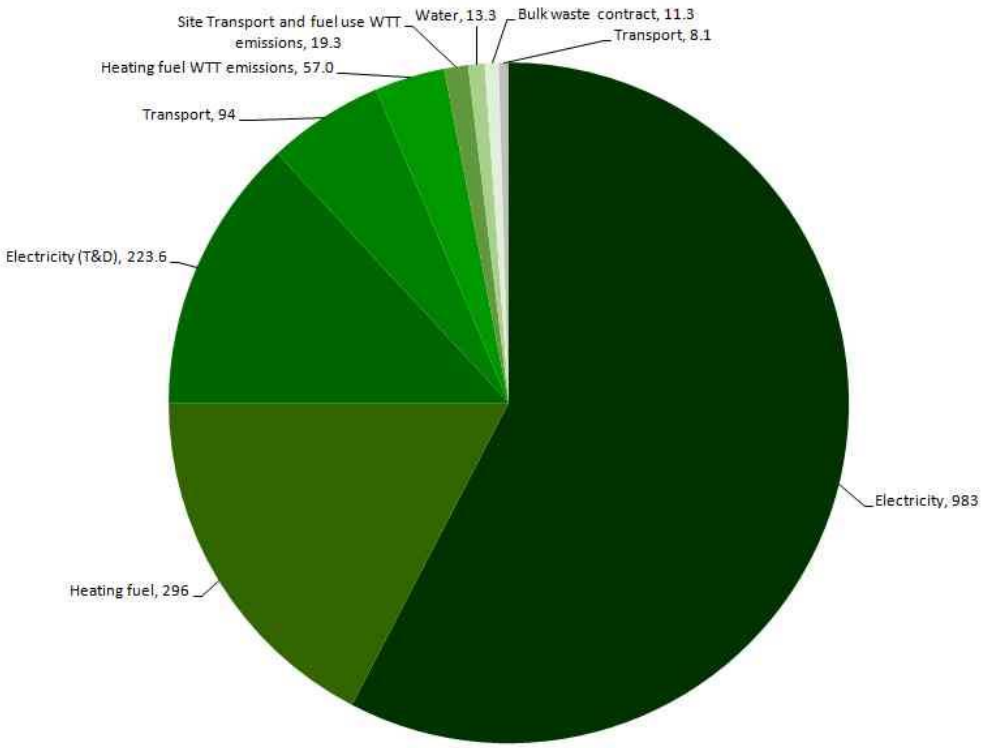
2.1.3 Data Sources

- Data on electricity and water consumption are obtained as half hourly data from our energy supplier and from monthly meter readings.
- Data on sewage was estimated by our local water wholesaler, Southern Water, as a percentage of metered fresh water (23%). This is based on an analysis of the amount of water not returned to sewer. Total quantities of water and sewage are taken from monthly meter readings
- Data on fuel for heating, cooking, site vehicles and grounds maintenance equipment are obtained from purchasing records of volumes delivered.
- Data on business travel mileage by road, rail and air are obtained from staff travel logs.
- These data sets are converted to CO_2e using conversion factors supplied by DEFRA
- Carbon emissions data from waste disposal for the majority of our waste streams are provided by our waste contractor or are estimated from DEFRA conversion factors and include a reduction in emissions from diverting waste to composting or anaerobic digestion, recycling and the creation of refuse derived fuel.

Commitment 2: We will increase the amount of sub-metering on site to help identify carbon reduction priorities.

Marwell's carbon footprint was first calculated in 2008 at 1,706 tonnes. This was the first year that reasonably complete data on emissions was available and as such forms the baseline that future carbon savings will be measured against. Data on fugitive emissions from refrigeration was not available for the baseline year but has been included in the carbon footprint calculation since 2014.

Fig 1. 2008 Carbon Footprint



3. Carbon Reduction

3.1. Reducing the carbon footprint has three components:

- ✓ Efficiencies achieved through monitoring, behaviour change, and improved technology.
- ✓ Generating our own energy using renewable or low carbon sources.
- ✓ Off-setting of carbon emissions through our own conservation activities or through a verified scheme. Off-setting will only be used for residual emissions which it has not been possible to reduce by other measures.

3.1.1. Buildings and their operation

New buildings will be designed with low embodied carbon and efficient operation in mind. Natural light will be used whenever possible through windows, light pipes and skylights. In existing buildings all lighting will be replaced with low energy LED bulbs. New and older buildings will be insulated to retain heat, and passive ventilation systems are preferred. Timers, thermostats and sensor controls will be used to ensure heating and any artificial lighting and mechanical ventilation

are only used when necessary. Where automated controls are not fitted, local control procedures will ensure equipment is only turned on for the period needed.

Commitment 3: New buildings will be designed to have low embodied carbon and be efficient to run, while energy efficiency of existing buildings will be improved through insulation and installation of low energy technology.

Commitment 4: All light bulbs will be replaced with low energy options.

Commitment 5: Controls will be fitted to new and existing buildings and in conjunction with high energy consumption equipment where they are not already present.

3.1.2 Equipment & Machinery

When replacing or purchasing new equipment only the most efficient (energy rated) and appropriately sized equipment, machinery and appliances will be purchased. This is particularly important for energy intensive applications such as refrigeration, heating and pumps.

Commitment 6: The most energy efficient equipment will be purchased.

3.1.3 Travel & transport

Telephone calls and internet applications reduce need for travel for external meetings. When needed, public transport is the preferred option, unless the location is inaccessible, it is more efficient to car share, or a vehicle is needed to carry equipment or materials. On-site transport is similarly only used for good reason e.g. moving heavy or bulky items. Efficient electric vehicles are preferred to those running on fossil fuels. Vehicles will be replaced with more fuel-efficient models when replacements are due.

Commitment 7: We will replace vehicles with the lowest emission alternatives that can perform the required function when they become due for replacement.

3.1.4 Water Conservation

Water requires treatment before and after use and is pumped and pressurised during its journey. The energy needed for these processes therefore results in greenhouse gas emissions. Reducing consumption of mains water and reducing the amount of water entering the sewage system will help lower our carbon footprint. Fixing leaks, filtering and retaining water used on site, and adopting water efficient practices throughout our operations will all help as part of a wider water conservation and efficiency plan.

Commitment 8: We will create and deliver a water conservation and efficiency action plan.

3.1.5 Waste and Recycling

Reusing, finding alternative uses and recycling of products and materials helps reduce energy consumption and produces less pollution than making new products from raw materials. Emissions from extraction and production of primary products and from disposal including biodegradation at landfill are all avoided by keeping products or materials in circulation.

Commitment 9: We will apply the waste hierarchy and reuse products and materials where possible and segregate materials at disposal to maximise recycling opportunities. We will specify recycled content in new products where possible to support the circular economy.

3.2. Generating Renewable and Low Carbon Energy

With available space, ability to retro-fit appropriate technology and by incorporating low carbon energy generation into new capital projects, there is the potential for Marwell to become self-sufficient. However, as capital costs can be prohibitive, incremental changes will need to be made over time. During the period of this plan, we will install additional solar PV panels on available roof spaces and investigate and incorporate appropriate low carbon energy generation into new developments.

3.2.1. Solar Photo-Voltaic Panels

To date, we have installed ground and roof mounted solar photo-voltaic (PV) arrays in four locations generating approximately 72,500 kWh and a carbon saving of around 32 tonnes CO_2e p.a. Roof spaces on two more south facing animal houses were designed to take solar PV panels as part of the 2015 'Wild Explorers' development, providing immediate scope for an additional 17,500kWh of energy generation p.a. While we have otherwise used currently available and suitable roof spaces for solar PV, further opportunities may arise with new developments and the potential for covered walkways, solar car ports, and at ground level.

Commitment 10: We will install additional solar PV panels to Wild Explorers and other spaces as opportunities arise.

3.2.2. Energy from animal waste

Marwell's large herbivores produce around 700 tonnes of manure and soiled bedding material each year. This has a relatively low calorific value compared to other fuels but using it on site offers a cost effective and low carbon solution to energy generation and waste management. Various options were explored to manage and utilise this material on site. The most promising of these are:

- **Combustion** of animal waste could be carried out following a drying process, with the material being compressed into pellets / briquettes and burnt in a biomass boiler. This would produce significant amounts of heat and ash as a by-product. The ash should contain high concentrations of phosphorous, potassium and other minerals so could be a valuable fertiliser or added to compost.

- **Aerobic composting** can be carried out in-vessel or in windrows to produce a quality compost which can be spread on farm land to replace fossil fuel derived fertilizers and improve soil structure.

Commitment 11: We will evaluate and install technologies to generate energy from animal waste on site.

Commitment 12: We will evaluate in house composting options to process any remaining herbivore waste into a usable product

3.2.3 Woodchip biomass

Marwell is surrounded by woodland which is of high conservation value but in need of ongoing management. We estimate that the entire area has the potential to yield about 80 tonnes of woodchip p.a., through coppicing and thinning but as such an intensive management regime is not desirable across the whole area, actual production is more likely to be about half this amount. Nevertheless, this could provide a significant fuel source and the volume could be increased through management of neighbouring woodlands. Woodchip is also available from various commercial suppliers in Hampshire and the New Forest.

Commitment 13: We will investigate opportunities to produce and / or locally source woodchip as a fuel source for biomass heating.

3.3 Other technologies

- **Ground, Water & Air Source Heat Pumps:** These technologies extract heat from the surrounding environment for use in radiators, under-floor heating systems, or warm air convectors and are particularly attractive propositions for new developments.

- **Wind:** The average wind speed at Marwell's location is marginal for efficient wind generation, although this may change as technology such as vertical axis and sail turbines develops.

- **Solar water heating:** Solar water heating is currently installed on Cafe Graze and the Science & Learning Centre to provide hot water for the guest toilets, and this technology could be used elsewhere.

Commitment 14: We will continue to investigate low carbon energy generation options and incorporate appropriate technologies into new developments or existing buildings.

4. Purchasing renewable energy

While increasing the proportion of energy we generate ourselves, we will for the foreseeable future need to continue purchasing electricity from the national grid. However, we have the option of procuring carbon neutral electricity by using a supplier that guarantees to match our energy needs

to renewable sources. This is verified through Renewable Energy Guarantee of Origin (REGO) certification.

Commitment 15: We will purchase carbon neutral electricity verified by Renewable Energy Guarantee of Origins certification.

5. Carbon offsets

Through this plan we will reduce carbon emissions where possible through efficiencies, our own low carbon energy generation, and by purchasing genuine low carbon, renewable electricity. However, if this is insufficient to achieve carbon neutrality in itself, we will seek to offset residual emissions.

We will review carbon offsetting opportunities and seek to deliver this through our own habitat restoration and biodiversity conservation programmes or by contributing to an existing certified scheme. This includes calculating the carbon sequestration rate of our parkland trees, surrounding woodlands and of our grazed and ungrazed grassland and arable fields. We will also investigate the possibility of achieving certification of carbon sequestration activities through a recognised scheme such as Verified Carbon Standard or REDD+ (Reducing Emissions from Deforestation and forest Degradation + Conservation and Sustainable Development).

Commitment 16: We will calculate the carbon sequestration rate of our own land for incorporation on the positive side of our carbon ledger

Commitment 17: We will investigate the potential to certify areas where we undertake field conservation to an appropriate international standard for carbon offset

Commitment 18: We will purchase carbon credits as part of an existing verified project delivering high biodiversity conservation value if we are unable to sequester sufficient carbon through our own actions

6. Supply Chain and Wider Business Community

Our Ethical Sourcing Policy commits us to selecting suppliers that meet their obligations to protecting the environment and act in a socially responsible manner. We have well over a thousand regular suppliers and are actively engaged in the local and regional business community through the Winchester Sustainable Business Network, Future South / Greentech South and Solent Region IEMA networking group, providing an opportunity to encourage and contribute to carbon reduction strategies.

Commitment 19: We will engage and encourage our supply chain and wider business network to reduce and offset carbon emissions.

7. Communications, Education & Public Awareness

As key drivers of our Education & Public Awareness Plan, we seek to increase awareness of the multiple values and benefits of nature for human health and well-being, and to empower people to make a difference for themselves, wildlife and the wider environment. In the coming years, this will include opportunities to learn about the science behind climate change models, ways of reducing carbon emissions, and how ecosystems help regulate climate, and keep us safe and healthy.

At the heart of these initiatives will be ‘Energy for Life’, the most ambitious exhibit created at Marwell to date. It will incorporate the low carbon energy generation technologies (sections 3.3.2 and 3.3.3), and a tropical house experience interpreting the flow of energy through life and the challenges of powering modern lifestyles, including public engagement in climate science and solutions for low carbon energy generation.

Commitment 20: We will evaluate the impact of Energy for Life and other acitvities on the behaviour of our guests through programmes such as enabling switching to renewable energy and tree planting.

Appendix 1: References

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Marwell Wildlife

	Action	Target date	Complete?	Cost	Payback period
1	Switch to 100% renewable electricity supply with Renewable Energy Guarantee of Origins (REGOs) certificates to achieve carbon neural electricity supply.	2014	Y	~	~
2	Ensure embodied carbon and energy efficiency are included in capital project briefs.	2016	Y	~	~
3	Install additional sub-meters to smaller buildings to enhance energy performance data and set targets for improvement, estimate 5% saving	2016	N[1]	£2,000	1yr
4	Deliver the Energy for Life project, including biomass heating to replace Tropical World	2018	Y	£80K	7yrs
5	Ensure purchase of energy efficient equipment and machinery becomes policy for all departments through implementation of ethical sourcing procedure, estimate 5% saving	2019	Y	~	~
6	Produce and implement a water conservation and efficiency plan to reduce fresh water consumption and amount of waste water processed as sewage	2019 - 2022	Y	TBD	
7	Evaluate impact of energy and carbon interpretation on guest behaviour and their carbon emissions	2020 - 22		~	~
8	Evaluate feasibility of additional solar PV including car ports, ground mount systems and additional rooftop systems	2020	Y[2]		[3]
9	Convert animal waste to heat the new Energy for Life tropical house and replace oil fired heating in Marwell Hall, Okapi house and other buildings, saving c. 200 tonnes of carbon emissions.	2020	Y[4]	£900K	12-14yrs
10	Replace air conditioning unit for the shop with air source heat / cooling, reducing electricity consumption by 15,000 kWh p.a.	2022		£35K	15yrs

[1] Sub meters have been installed in various areas but only minimal data analysis
[2] Car ports need to wait until car park changes complete. Other possible sites have been identified, cost and funding options are being explored
[3] Likely to be done as power purchase agreements (PPA) so payback not relevant
[4] Animal manure to heat plant completed in 2021. Heat network to distribute heat planned for winter 2021/22

11	Replace oil fired heating of the giraffe house with a renewable energy option saving c. 50 tonnes of carbon emissions p.a.	2022	£80-£100K	7-10yrs
12	Evaluate possibility of verification of our own carbon sequestration to international standard, eg REDD+	2022	~	~
13	Complete replacement of all non-low energy lamps with LED bulbs to reduce electricity consumption by 80,000 kWh p.a.	2022	£20,000	3-5 yrs
14	Calculate carbon sequestration rate of Marwell land to offset remaining carbon footprint. Part of PhD research project.	2022	£30,000	~

Marwell should be carbon positive following the implementation of actions 1-14. All subsequent actions will help to compensate for supply chain embodied carbon to be included in scope 3 emissions

16	Replace oil fired heating of the semi-aquatic mammal house with a renewable energy option saving c. 30 tonnes of carbon emissions p.a.	2025	TBD	
17	Replace calor gas heating of the Science & Learning Centre with renewable energy option saving c. 40 tonnes of carbon emissions p.a.	2025	TBD	
18	Replace air handling in Cafe Graze with air source heating / cooling, reducing electricity consumption by 50,000 kWh p.a.	2025	TBD	
19	Replace water pumps with efficient variable speed versions to reduce electricity consumption	2022	TBD	
20	Replace one diesel engine road vehicle every two years with electric or hybrid equivalent reducing fuel consumption and polluting emissions.	2020 - 2025	TBD	
21	Gather data on staff commuting, guest travel and supply chain impacts for inclusion in scope 3 emissions	2025	~	~
22	Encourage our supply chain and wider business network to reduce their carbon emissions.	ongoing	~	~
23	Draught proof Marwell Hall to reduce heat load by 20% and increase staff comfort (any window repairs or decorating need to be completed prior to implementation)	TBC	£7,000	6yrs

24	Fit efficiency controls to large refrigeration equipment to reduce electricity consumption by 30,000 kWh p.a.	TBC	~	~