Product Carbon Footprint

Product Carbon Footprint: Life Cycle Assessment Report for WUKA

A comparison of WUKA's Period Pants comparing to tampon and sanitary pad emissions

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Executive Summary

Carbon Footprint Ltd analysed the greenhouse gas emissions associated with WUKA's Period Pants and comparison single-use tampons and sanitary pads. This assessment focuses on the embodied raw material emissions, the transport of these materials, the manufacture/processing, distribution and disposal of the sanitary products.

The determined scenario for both products for this study is defined as:

a 2-year timeframe[1]

WUKA aims to understand the differences in emissions between their period pants and the comparison single use alternatives.

WUKA's products are designed to be sustainable, made predominately from a mix of cotton, Tencel modal, thermoplastic polyurethane (TPU) and elastane. All the materials are sourced from China where they are manufactured in the Shantou factory before being sent to St Albans in the UK for distribution. The life cycles have been modelled as 2 years for the period pants. This has been used as the scenario to compare emissions.

The WUKA usage (cleaning) was modelled as all products being washed within a washing machine and line dried once a month. The period pants were also modelled to be rinsed under a cold tap pre-wash. The products can be recycled at the end of life.

The comparisons account for the use of 5 WUKA period pants per 2-year period, allowing for 5 pairs to be used and washed each month. The comparison single-use alternatives have been calculated based on modelling the emissions for tampons (Weir 2015; Hait and Powers 2020) and sanitary pads (Hait and Powers 2020). This has been scaled up based on statistics from aphma (2021). Manufacture emissions has been supplied from Hait and Powers (2020), this has been calculated on a per product basis and scaled to show the emissions for 2 years. The distribution of the products has been modelled based on the supplier location in the USA to the UK for distribution.

The following tables show the emissions breakdown for the average WUKA pants and single-use alternatives for the 2-year period:

Product Name	WUKA Average (gCO_2e)	Pads (gCO_2e)	Tampons (gCO_2e)
Raw materials - embodied	1,270.86	12,355.67	10,937.72
Raw materials transport	30.29	330.84	829.77
Manufacture	754.50	2,705.11	1,185.43
Product distribution	142.41	593.70	272.48
Usage	892.49	-	-
Disposal	7.20	5,169.84	1,038.58
Delivery to customer	343.93	-	-
Total emissions gCO_2e	**3,441.68**	**21,155.17**	**14,263.98**
Total emissions $kgCO_2e$	**3.44**	**21.16**	**14.26**

[1] More details on the assumptions made can be found in section 3.7, for both the WUKA products and the single-use alternatives.

The carbon footprint of single use alternatives is significantly higher than the WUKA alternative. This is mainly due to significantly more materials needed because of the single-use nature of the tampons and pads requiring considerably more materials over the 2-year period. This increased materials also causes higher emissions in transport due to higher weights and as expected significantly higher waste emissions for the single-use products.

The major impact of the single use alternatives on the environment alongside the carbon impact, is the persistence of the chemicals and plastics and the decades it can take for the plastic packaging and applicators to breakdown. In addition, the leachate from the chemicals used in the products and plastics can cause toxic properties in soils and oceans when plastic bags breakdown under sunlight. If the products are not disposed of properly, they can have significant impacts to wildlife and the environment by causing littering and stormwater drain blockages.

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Quality Control

Report issue number:	1.0
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Calculations reviewed by:	Rebecca Pattison
Report produced by:	Myles Howard
Report reviewed by:	Rebecca Pattison
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1. Introduction

1.1 Scope of this Assessment

The aim of this assessment is to compare the emissions for WUKA's period pants and single-use alternatives over a 2-year period. This is the first comparisons assessment WUKA has completed and will be used to demonstrate to their clients the environmental credentials of their products and to differentiate their products in an increasingly competitive marketplace.

Carbon emissions for the products assessed in this report include those derived from the extraction and processing of virgin raw materials, transport of raw materials and on-site construction vehicles to the site, the fuels used on site by the construction vehicle, and disposal.

1.2 What is a Product Life Cycle Assessment (LCA)?

Product LCA is the assessment of the environmental impacts of a product during its life cycle. It incorporates the analysis of raw materials, manufacture, transport and disposal. LCA can evaluate several environmental impacts (air pollution, ozone layer depletion, climate change, etc.) or focus on a single impact (e.g. climate change). When only climate change is considered, it is called products carbon footprint or carbon LCA.

The products carbon footprint has detailed in this report is a *Cradle-to-Grave* carbon LCA.

1.3 How is the products carbon footprint calculated?

The products carbon footprint is derived from a combination of activity data provided by WUKA and from publicly available sources (primary data), and emission factors extracted from internationally recognised metrics, greenhouse gas (GHG), activity data is then multiplied by GHG emission factors to produce carbon metrics.

To guarantee transparency and reproducibility, the emission factors used in this report are shown in Annex 1 detailing the exact name of the emission factor as it appears on its respective database. Material emissions factors are sourced from EcoInvent's database (v3.7.1) and the UK Government (BEIS, 2021). All EcoInvent factors account for all processes during the production of raw materials and all processes.

1.4 Abbreviations

CO_2e	Carbon Dioxide Equivalent
Defra	Department of Environment, Food and Rural Affairs
GHG	Greenhouse Gases
kg	Kilograms
km	Kilometres
kWh	Kilowatt Hours
LCA	Life Cycle Assessment

2. Products overview

2.1 Company Overview

WUKA was founded in 2017 and has produced the UK's first ever reusable and leak-proof period pants. WUKA stands for 'Wake Up Kick Ass' and have strong environmental and social goals to meet its target that, 'Periods should not cost the earth'. WUKA aims to encourage its customers to be more sustainable when it comes to purchasing, and is looking to show the benefits from switching to reusable sanitary products.

2.2 WUKA Pants

WUKA produces all their products in a factory in Shantou, China. All the materials are sourced from within China, which are then transported by truck to the factory. The main components of the underwear are all made from cotton, Tencel modal or nylon and the period pants also include a layer of thermoplastic polyurethane (TPU) which is used to absorb the menstruation.

Once manufactured, they are then shipped to the UK and sent to the distribution centre in St Albans. The products are distributed to individual customers (B2C) and businesses (B2B). The distribution was modelled as 70% sent B2C. Of those sent B2C, 70% were modelled to be located in the UK (50 km used as proxy distance); and 30% within Europe (for which Berlin was used as proxy). The 30% of products sent to B2B were modelled to be split evenly between Cardiff, Edinburgh and London.

The period pants (Bikini, Midi Brief, Seamless, Basics) are modelled to have a life expectancy of 2 years. Each product is expected to be cleaned on a monthly basis within a washing machine, and line dried once a month. The period pants were also modelled to be rinsed under a cold tap for 30 seconds pre-wash. The products can be recycled at the end of life.

WUKA produce the products in several different sizes. This assessment focuses on garments of the most popular size sold (medium). All the products are packaged in a biodegradable plastic bag. More details for the full process can be found in the previous Carbon Footprint report. The following table details the period pants and average for the 2-year period:

Table 1: Overview of the emissions per product

Lifecycle Stage	GHG Emissions (gCO_2e)				
	Bikini	Midi Brief	Seamless	Basics	Average
Raw materials – embodied	282.54	273.80	217.32	243.03	**254.17**
Raw materials transport	6.08	6.16	6.13	5.86	**6.06**
Manufacture	150.90	150.90	150.90	150.90	**150.90**
Product distribution	29.94	32.86	31.04	20.08	**28.48**
Usage	185.58	199.76	190.90	137.75	**178.50**
Disposal	1.53	1.70	1.59	0.95	**1.44**
Total Emissions	**656.57**	**665.18**	**597.87**	**558.58**	**619.55**

2.3 Single-Use Alternatives

The single-use alternatives assessed are tampons (Based on Tampax Compak regular tampon) and sanitary pads (based on U by Kotex® Security® Maxi Pads). Within this assessment, the emissions associated with the raw materials, transport, production and disposal of the sanitary products are examined (Weir 2015; Hait and Powers 2020).

Table 2 details the single-use products materials. It can be seen that the pads use over double the materials used for the tampons, although there are fewer key materials.

Table 2: Overview of the materials per product

Product	Material	Material in final product (g)
Sanitary Pad (Kotex® Security® Maxi Pads)	Corrugated Board	2.12
	Paper	0.48
	Wood Pulp	3.68
	Polyethylene low density	5.86
Weight of materials per product (g)		**12.14**
Tampon (Tampax Compak regular)	rayon	0.62
	cotton	0.62
	polypropylene	0.45
	polyester	0.62
	cotton string	0.08
	polyethylene	3.19
Weight of materials per product (g)		**5.57**

3. Accuracy of the carbon footprint LCA calculation

The accuracy of the overall carbon footprint calculations for the WUKA comparison (Table 3) is very good as the majority of the data used in the calculation is primary data or from WUKA's supplier.

Table 3: Source data and calculation accuracy for WUKA products

Dataset	Source of data and comments	Accuracy
Raw materials Embodied emissions	Product specifications (materials and weight (g)) supplied by WUKA for medium sized garments. The main garment is modelled as 5% elastane and the sanitary pad layer (absorbent poly/cotton blend) is modelled as 80% polyester fibre and 20% cotton.	Very Good
Raw materials Transport	Destinations and distances provided. Materials sourced within Shantou were modelled as 35 km.	Good
Manufacturing Products	Annual energy consumption data was provided, which was then apportioned using the percentage of the business that WUKA accounts for (10%) and the total number of products made (20,000).	Very Good
Product distribution	Distribution was modelled as 70% sent to B2C to individual customers, 70% of which being located in the UK (50 km used as proxy distance) and 30% within Europe (for which Berlin was used as proxy). The 30% of products sent to B2B were modelled to be split evenly between Cardiff, Edinburgh and London.	Good
Usage	Each product was modelled to be cleaned on a monthly basis within a washing machine and line dried once a month. The period pants were also modelled to be rinsed in the shower pre-wash. The energy consumption for the washing machine was modelled assuming a 4kg load using 40 litres water and 1 kWh per cycle which was apportioned to each garment based on weight. Rinsing in the shower was modelled as consuming 8 litres of water.	Good

The single-use alternatives assessed are tampons (Based on Tampax Compak regular tampon) and sanitary pads (based on U by Kotex® Security® Maxi Pads). Within this assessment, the emissions associated with the raw materials, transport, production and disposal of the sanitary products are examined (Weir 2015; Hait and Powers 2020).

The transporting of the raw materials and the product distribution was based on Weir (2015)'s report for the tampons as these included details for the Tampax tampons which are typical in the UK. The embodied emissions from Weir (2015) were updated to use the latest Ecoinvent 3.7.1 and DEFRA 2021 factors. The average emissions for sanitary pads were based on the Hait and Power (2020) paper. As the material manufacturing was not provided within the Weir (2015) paper the Hait and Power (2020) paper's manufacturing emission for tampons (U by Kotex® Click® Tampons) was used as a proxy. The single use disposal route has been modelled as landfill.

4. Product Carbon Footprint Results

1.1 Embodied emissions from raw materials

Table 4 provides a breakdown of embodied emissions. It shows that the sanitary pad layers and the elastane use in the waistbands/stretch mix have the greatest impact, with the emissions accounting for the majority of the embodied emissions (44-78% of the total embodied emissions).

Table 4: Embodied emissions from raw materials

Component	Material	Raw Material Emissions (gCO_2e)			
		Bikini	Midi Brief	Seamless	Basics
Main Garment	Organic cotton	44.83	-	-	-
Main Garment	Cotton	-	-	-	7.71
Main Garment	Tencel modal	-	13.52	-	-
Main Garment	Recycled nylon	-	-	31.20	-
Sanitary pad layer	TPU	41.56	42.64	42.13	39.35
Sanitary pad layer	Absorbent Poly / Cotton Blend	94.40	94.40	94.40	94.40
Waistband / stretch mix	Elastane	56.03	56.03	-	56.03
Waistband	Organic cotton	-	-	3.86	-
Side Panels to main garment	Polyester mesh	-	21.48	-	-
Packaging	Biodegradable plastic	45.72	45.72	45.72	45.72
Total		**282.54**	**273.80**	**217.32**	**243.03**

In comparison, the tampons and period pants have been modelled to consider the most material elements that comprise their total weight for the tampons (Weir 2015) and sanitary pads (Hait and Powers 2020). The embodied emission from the Weir 2015 paper were recalculated using the latest equivalent Ecoinvent 3.7.1 factors as the original report was calculated using Ecoinvent 2.2 factors. There are also a large number of chemicals that are used to provide their properties that will have environmental impacts but not a significant carbon impact.

1.2 Emissions from transport of raw materials

The emissions associated with transport reflect the mass of each component, the mode of transport and the distance travelled. These were calculated based on WUKA's supplier locations in China.

The alternatives were modelled based on transport from China to the production facility in the USA. This has been calculated based on, the emissions associated with the mass of each component, the average mode of transport and the distance travelled.

1.3 Manufacturing emissions

All of WUKA's products are manufactured in a Shantou factory in China. WUKA accounts for 10% of the factory's business, and produced 20,000 products in the last year. The factory provided production energy consumption which was apportioned to a single product and multiped by the appropriate emission factor for each energy type. A summary of manufacturing emissions is provided in Table 5 below.

Table 5: Production Emissions per product

Factory Location	Manufacturing emissions (gCO_2e)
China	150.90

The alternatives were modelled using the manufacturing emissions for both the tampons and pads based on the Hait and Powers paper (2020). This includes, the US specific electricity grid calculations and thermal energy from natural gas.

1.4 Product Distribution

Product distribution for WUKA's products, was from the St Albans site and was modelled as 70% sent B2C, 30% of products sent to B2B. The B2C deliveries were modelled as 70% being sent to locations in the UK (for which 50 km used as proxy distance) and 30% within Europe (for which Berlin was used as proxy). For the B2B deliveries, it was modelled that the products were split evenly between Cardiff, Edinburgh and London.

In comparison the single-use alternatives were modelled based on tonnes.km for sea freighted from the United States to the UK with the DEFRA average 96km used for distribution of the products within the UK via the average UK truck emissions factor.

1.5 Usage

Emissions associated with WUKA's usage of the product have been modelled on the following assumptions:

- Each product is cleaned on a monthly basis within a washing machine, and line dried once a month. The energy consumption for the washing machine was modelled assuming a 4kg load using 40 litres water and 1 kWh per cycle which was apportioned to each garment based on weight.
- The period pants were also modelled to be rinsed under the tap pre-wash. Rinsing under the tap was modelled as consuming 3 litres of water.
- The period pant has a 2-year life expectancy.

As the alternative products are single-use there are no emissions associated with the use phase as they are not cleaned and reused.

1.6 Emissions from Disposal

The products are regarded as recyclable and packaging is regarded as compostable at the end of life.

In comparison the tampons and pads have been modelled as going to UK landfill as these are considered household sanitary waste.

5. Summary of results

This report provides an analysis of the greenhouse gas (GHG) emissions associated with a 2-year scenario using 5 of WUKA's period pants and 2 years of single-use alternatives (tampons or sanitary pads). The total ***cradle-to-grave*** products life cycle carbon emissions are shown in the following table and chart; split by lifecycle stage. For breakdown of WUKA's products see the previous product footprint report.

Table 6a: GHG emissions per WUKA period pants 2-year lifespan per person (5 Pairs)

Product Name	WUKA Bikini	WUKA Midi Brief	WUKA Seamless	WUKA Basics	WUKA Average
Raw materials - embodied	1,412.68	1,369.01	1,086.60	1,215.15	1,270.86
Raw materials transport	30.41	30.78	30.63	29.32	30.29
Manufacture	754.50	754.50	754.50	754.50	754.50
Product distribution	149.72	164.32	155.19	100.42	142.41
Usage	927.92	998.79	954.50	688.75	892.49
Disposal	7.63	8.48	7.95	4.75	7.20
Delivery to customer*	-	-	-	-	343.93
Total emissions gCO2e	**3282.86**	**3325.88**	**2989.37**	**2792.90**	**3441.68**
Total emissions kgCO2e	**3.28**	**3.33**	**2.99**	**2.79**	**3.44**

Table 6b: GHG emissions 2 years supply of tampons and sanitary pads per person

Product	Pads (gCO_2e)	Tampons (gCO_2e)	Average (gCO_2e)
Raw materials - embodied	12,355.67	10,937.72	11,646.70
Raw materials transport	330.84	829.77	580.31
Manufacture	2,705.11	1,185.43	1,945.27
Product distribution	593.70	272.48	433.09
Disposal	5,169.84	1,038.58	3,104.21
Total emissions gCO_2e	**21,155.17**	**14,263.98**	**17,709.58**
Total emissions $kgCO_2e$	**21.16**	**14.26**	**17.71**

As Table 6 shows, based on the 2-year scenario, the single-use products have significantly higher emissions when compared to the average WUKA pants, as result of the significantly less material, transport, manufacturing and waste amounts due to the product's reusability.

<u>WUKA Average</u>

The 2-year period is based on:

- The average emissions based on the 4 period pant cuts calculated in WUKA's Product Footprint Assessment, Bikini, Midi Brief, Seamless, Basics
- This is an average of the medium size product as this was used for the original LCA
- As the lifespan of the product is 2 years, the usage has already been accounted for within the numbers.
- 5 pairs of pants have been included to account for the average person's cycle.

- **Delivery to customer*-** includes the average weight 78g of carboard multiplied by the 5 products. This includes the embodied emissions of the cardboard and the transport of the product and cardboard an average of 100km by average UK van

Single Use Average

The 2-year period is based on:

- Around 11,000 products will be used in a lifetime (ahpma 2021).
- On average a woman will menstruate until she is fifty years old, for an average total of 38 years (ahpma 2021).
- This has been used to calculate and average of 289.47 per year, with 2 years at 578.95 products.
- The emissions do not include delivery to the customer as these are often purchased alongside the products.

In both scenarios the embodied emissions attributed to the raw materials, account for the majority of the total emissions. However, the single use products have higher emissions in all areas of analysis, as a result of the single use nature of the product. This coupled with the additional environmental impacts from the waste and chemicals used puts WUKA's pants as a significantly more sustainable product.

The major impact of the single use alternatives on the environment alongside the carbon impact, is the persistence of the chemicals and plastics and the decades it can take for the plastic packaging and applicators to breakdown. In addition, the leachate from the chemicals used in the products and plastics can cause toxic properties soils, oceans when plastic bags breakdown under sunlight. If the products are not disposed of properly, they can have significant impacts to wildlife and the environment by causing littering and stormwater drain blockages.

6. Lifetime emissions

This shows the lifetime emissions for the products based on scaling the two years up to the average of 38 years (ahpma 2021). This shows a significant emission saving over a person's lifespan if they switch to reusable period pants.

Table 7a: GHG emissions per WUKA period pants lifetime emissions (5 Pairs every 2 years)

Product Name	WUKA Bikini	WUKA Midi Brief	WUKA Seamless	WUKA Basics	WUKA Average
Raw materials - embodied	26,840.90	26,011.14	20,645.34	23,087.88	24,146.32
Raw materials transport	577.87	584.89	581.99	557.08	575.46
Manufacture	14,335.50	14,335.50	14,335.50	14,335.50	14,335.50
Product distribution	2,844.61	3,122.14	2,948.68	1,907.97	2,705.85
Usage	17,630.52	18,976.95	18,135.43	13,086.32	16,957.31
Disposal	144.94	161.14	151.02	90.27	136.84
Delivery to customer	-	-	-	-	6,534.65
Total emissions gCO_2e	62,374.35	63,191.76	56,797.97	53,065.01	65,391.92
Total emissions $kgCO_2e$	62.37	63.19	56.80	53.07	65.39

Table 7b: GHG emissions lifetime supply of tampons and sanitary pads per person

Product	Pads (gCO_2e)	Tampons (gCO_2e)	Average (gCO_2e)
Raw materials - embodied	234,757.82	207,816.68	221,287.25
Raw materials transport	6,286.05	15,765.69	11,025.87
Manufacture	51,397.01	22,523.10	36,960.06
Product distribution	11,280.36	5,177.07	8,228.72
Disposal	98,226.91	19,732.99	58,979.95
Total emissions gCO_2e	**401,948.15**	**271,015.53**	**336,481.84**
Total emissions $kgCO_2e$	**401.95**	**271.02**	**336.49**

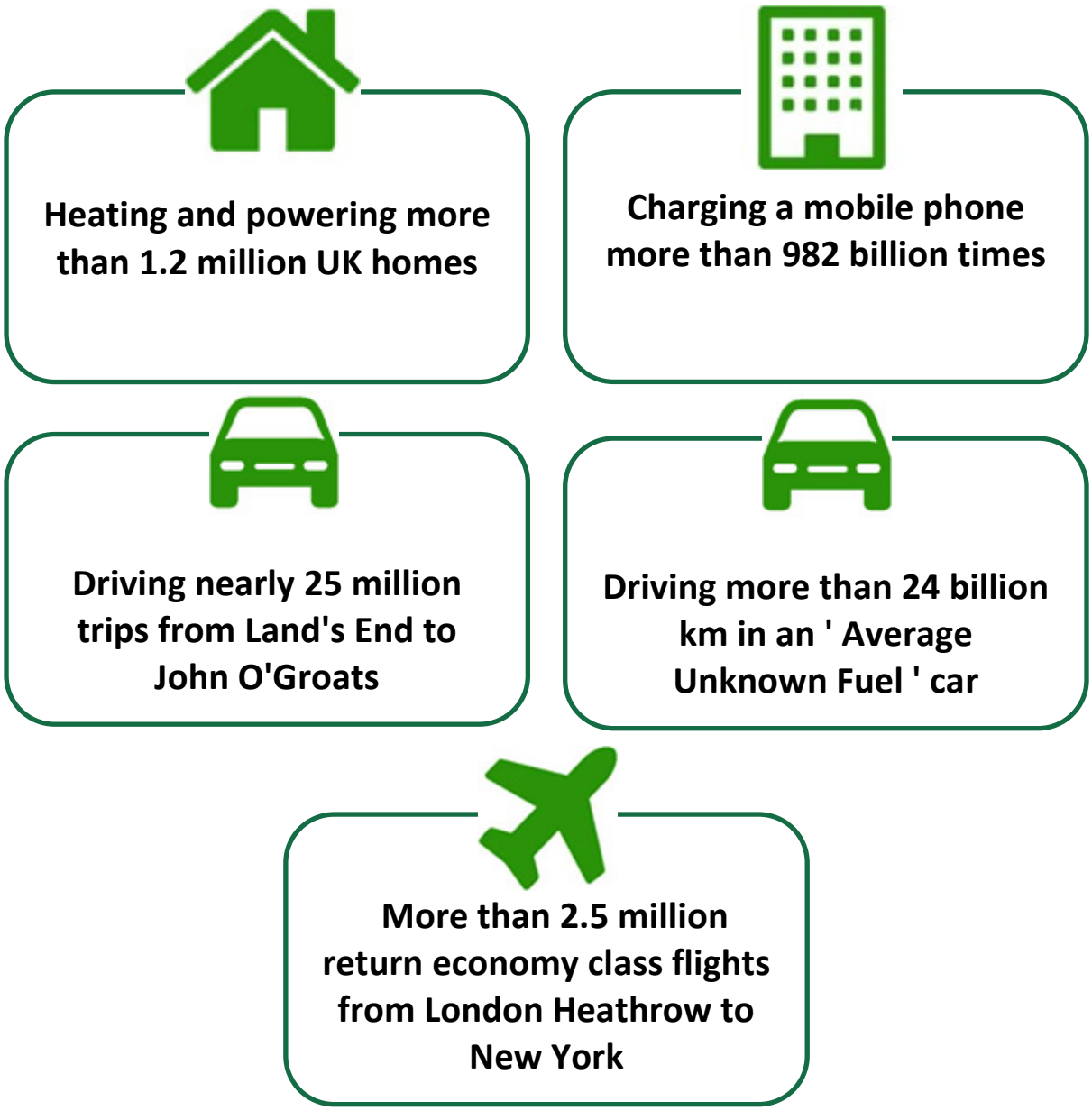
Table 8 shows the emissions scaled up to the 15 million people who are of menstrual age in the UK (ahpma 2021). The carbon savings are based on a 100% switch to WUKA's pants. Table 8 shows the average saving of nearly 4.2 million tonnes of carbon dioxide equivalent, if every person who is currently menstruating in the UK switched to WUKA's reusable pants for the rest of their menstruating years.

Table 8: GHG emissions for lifetime emissions of products scales to the UK's menstruating population.

Lifetime Emissions (15m people)	Total Emissions (tCO_2e)	Emissions Saved (tCO_2e)	Emissions Saved (%)	Emissions Saved (Fraction)
WUKA Period Pants	980,878.81	-	-	-
Pads	6,150,630.24	5,169,751.43	**84.05%**	1/6
Tampons	4,120,952.50	3,140,073.68	**76.20%**	1/4
Average	5,135,791.37	4,154,912.55	**80.90%**	1/5

7. Carbon Equivalents

Based on the carbon saving of on average 4,154,912.55 tCO_2e the carbon equivalents can be seen below:



This has been calculated using the latest DEFRA 2021 factors. With the heating and powering of UK homes coming from the UK average energy usage (BEIS 2019). The average phone charges are based on fully charging an average of the top two current UK phone sales, Samsung Phone (Galaxy s10+) charges and iPhone (Model 12).

8. References

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