New Mobil SHC 632, energy efficient, synthetic gearbox oil increases efficiency of Smurfit Kappa gearbox operation by 6.5%. Corresponding operating temperature drop of 8.4°C observed with new synthetic lubricant

Presented by : Conor Wilkinson, Field Engineering Services,

Mobil Industrial Lubricants

For more information on Mobil Industrial Lubricants and services, please call your local company representative or contact the Technical Helpdesk on TechDeskEurope@exxonmobil.com.

Also visit www.mobilindustrial.com

Contents

Acknowledgement

Mobil Industrial Lubricants and Smurfit Kappa have a shared vision to improve the energy and environmental efficiencies of their operations. This shared ideology makes for a successful working partnership, in which we have sought mutually beneficial solutions to the challenges presented in the search for effective lubrication.

Mobil Industrial Lubricants would like to thank the following people who contributed to this project and achievement of this success story, and without whose collaboration these savings would not have been realised.

Jeff Tyson
Engineering Manager
Smurfit Kappa UK

Jason Hughes
Engineering Supervisor
Smurfit Kappa UK

Mobil Industrial Lubricants Team

1.0 Proposal

As part of a trial to demonstrate the benefits of new formulation synthetic gearbox oil, the proposal was made to Smurfit Kappa in Snodland, Kent, to run a trial on new formulation Mobil SHC 632 in PM7 2nd press drive Santasalo 2S56 double reduction gearbox.

The goal was to demonstrate the benefits of the new formulation synthetic oil over the existing mineral equivalent, Mobilgear 600 XP 320, in terms of energy efficiency and temperature reduction.

2.0 Background

Smurfit Kappa is the leading packaging supplier in Europe. Their UK Paper Division comprises two containerboard mills, Townsend Hook in Kent, and SSK in Birmingham, producing a range of products for supply to the European Corrugated Case making industry.

The opportunity for the trial arose when Mobil engineers identified the site as ideal for demonstrating the benefits of new synthetic oil technology, and from Smurfit Kappa's commitment to continually improve the energy efficiency and environmental performance of their operations.

The gearbox identified for the trial was a Santasalo, 2S56 double reduction type. The gearbox drives the second press bottom roll on the stock approach of the PM7 machine. It was selected as it is a critical piece of equipment which runs constantly at a similar load, giving a good opportunity for a consistent reference between the performance of the equipment both before and after oil change to the new synthetic candidate.

ExxonMobil supplied Smurfit Kappa with a data logger machine, with which they could measure temperature data from the gearbox in operation. The gearbox was fitted to two probes, one inside the oil bath to measure the operating temperature and the other externally to measure the ambient temperature. These probes fed temperature information back to the data logger machine and enabled the temperature results to be plotted over time. Measuring the ambient temperature meant that the influence of the external environment on oil temperature could be accounted for. Smurfit Kappa also continuously records power usage of the motor driving the gearbox (armature and field voltage and current levels).

3.0 Trial Period

On 6th April 2011, during a routine plant shut down, the maintenance team at Smurfit Kappa drained the gearbox containing Mobilgear 600 XP 320, and refilled with new formulation Mobil SHC 632. The gearbox was then operated for a period of one hour and then the drain and refill process repeated, a double flush ensured that the machinery was completely free of the old mineral product and set a good baseline for the beginning of the trial.

The plant was then returned to normal operation from the 8th April, and the gearbox was in continuous operation for the remainder of the trial when final samples were taken on 17th May 2011.

In order to verify the validity of results found with the trial fluid, it was further agreed to further re-introduce the mineral product to the system to complete the A-B-A testing schedule. This should confirm that the results attained were solely due to the oil change. The trial fluid was replaced with Mobilgear 600XP 320 on the 11th August 2011, following the same flushing procedure as before, and the system performance evaluated once more.

4.0 Results

The main criteria that were outlined to achieve a successful trial were improvements in terms of energy efficiency and temperature reduction. Additional potential benefits such as increase in oil drain interval and reduced maintenance requirements were not able to be measured in this timeframe.

4.1 Power Usage Reduction

The data outlined in appendix one shows the power consumption of the electric motor, voltage and current readings directly, and calculated power consumption values. (Power measured in watts can be calculated by multiplying voltage and current values – P=VI). As the gearbox electric motor is DC operated, there is no need for power factor correction, and the results can be taken as calculated.

The combined average energy consumption with the new synthetic fluid of 54,000 W was 6.5% lower than with the old mineral grade, which averaged at 58,000 W. The reduction in power consumption can be seen in the graphical representation below.

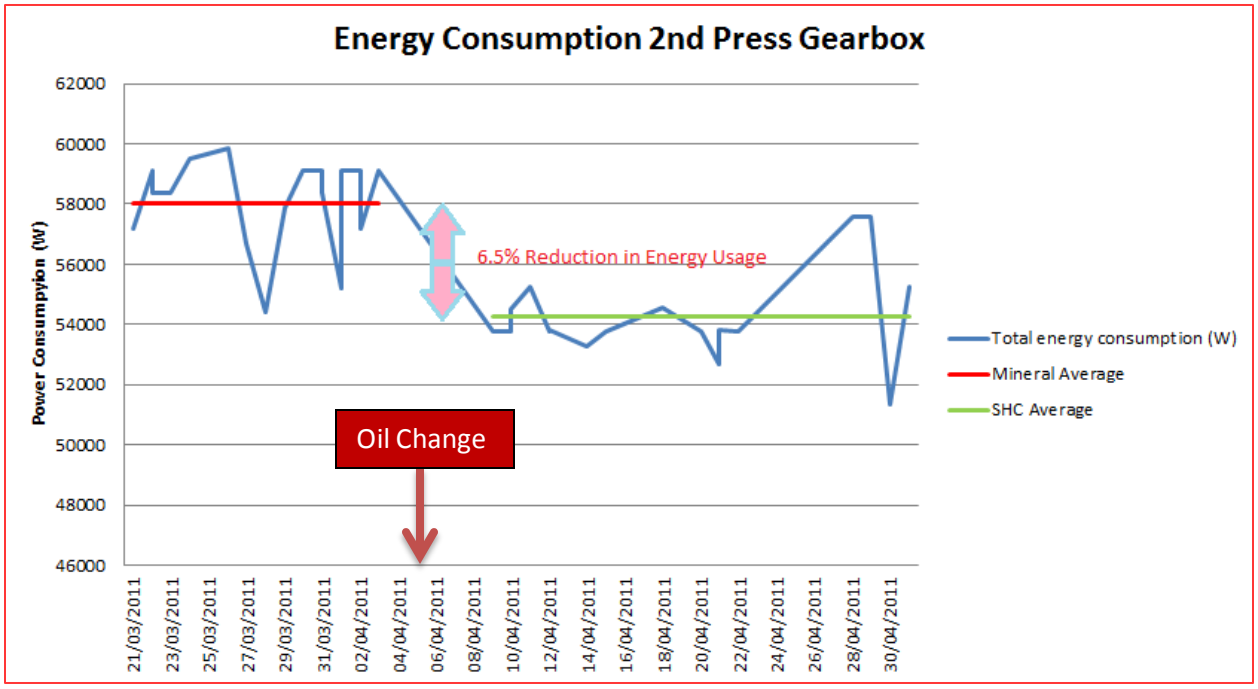

Figure 1.0 – *Reduction in Energy Usage with Mobil SHC 632 trial fluid*

4.2 Energy Saving

The average power saved through the use of the energy efficient synthetic trial fluid was 4,000 W, or 4 kW. With energy costs to Smurfit Kappa around 8 p/kW.hr, and an operating period of 8000 hr/year, this equates to (4*0.08*8000=) £2,560 saving per annum for Smurfit on just one gearbox.

4.3 Carbon saving

Using the carbon footprint calculator outlined in appendix two, it can be calculated from the energy efficiency data that the improved efficient operation will help save 17.6 tonnes of carbon dioxide equivalent a year (based on 8000 operating hours per year). This is a real environmental benefit and fitting with the view taken by Smurfit's management board, who see the Environmental Performance of Smurfit Kappa Group as fundamental to the company's business strategy.

4.4 Temperature drop

The graph below illustrates the lower operating temperature with the new formulation synthetic oil.

Plotted are the operating temperatures of the gearbox and the corresponding ambient temperature of the external environment surrounding the gearbox. Also plotted is the

Operating temperature minus the ambient temperature (in green), from this the temperature reduction is plotted, eliminating outside environmental influence on oil operating temperature.

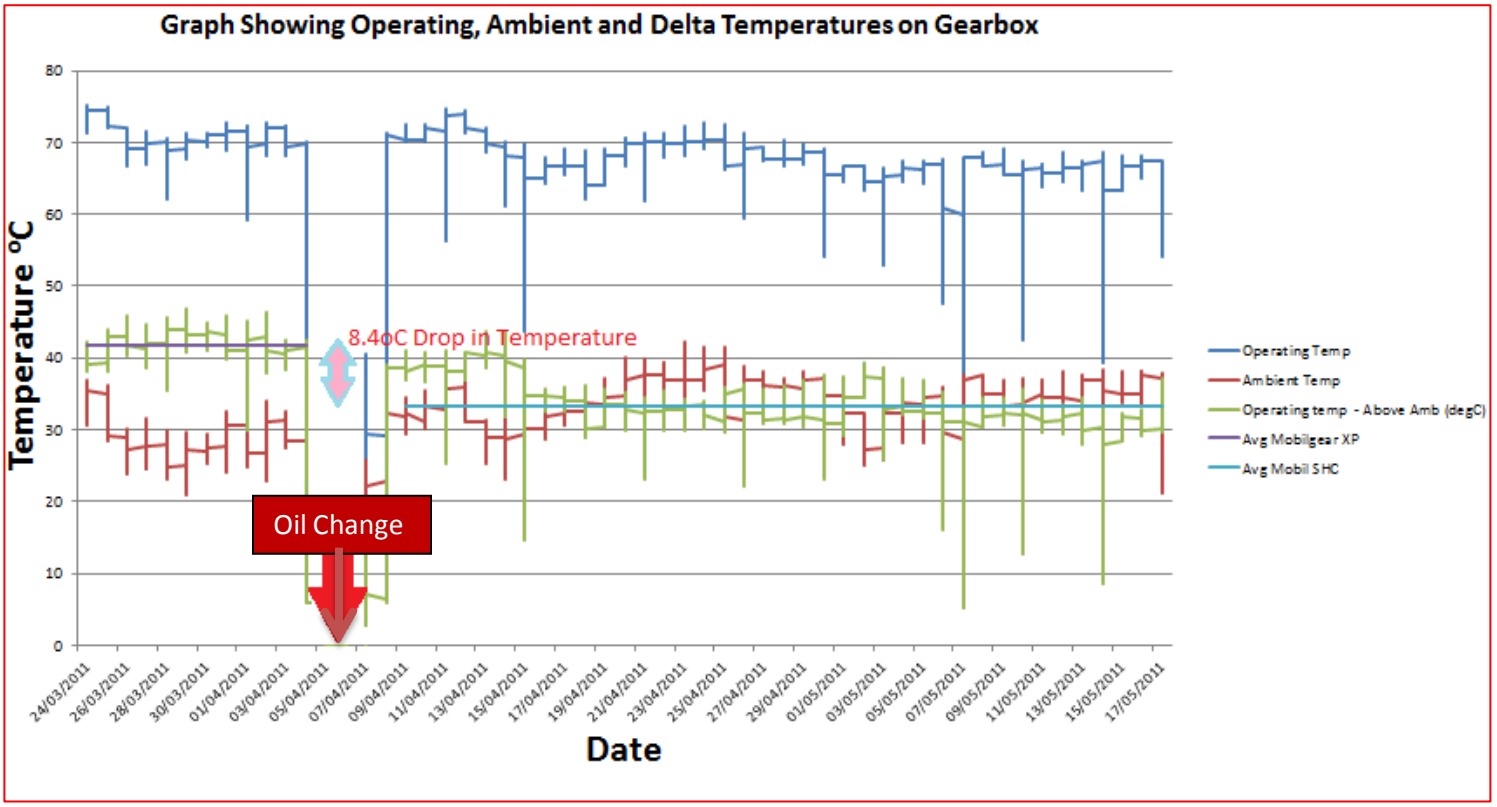

***Figure 2.0** – Temperature data for Smurfit Kappa Santasalo Gearbox 24th March – 17th May 2011*

The operating temperature can be seen to decrease significantly after the oil change, from just over 70°C to mid 60's, even when counteracted by increasing ambient temperatures moving towards the summer months. This is even more apparent when viewing the operating temperature as measured above ambient, with the differences in average temperatures here equating to an 8.4°C drop in average temperature of operation. Running gearboxes cooler is a key goal for Smurfit's engineering team, enabling more efficient operation and improving equipment lifetime.

4.5 Results Verification

In order to confirm that the results for energy efficiency increase and temperature drop were solely due to the improved viscometrics and traction coefficient of the synthetic oil, the trial synthetic fluid was

replaced with Mobilgear 600 XP 320. The decrease in energy efficient performance is immediately apparent from the graph below, with an increase in average power consumption of 5.8%.

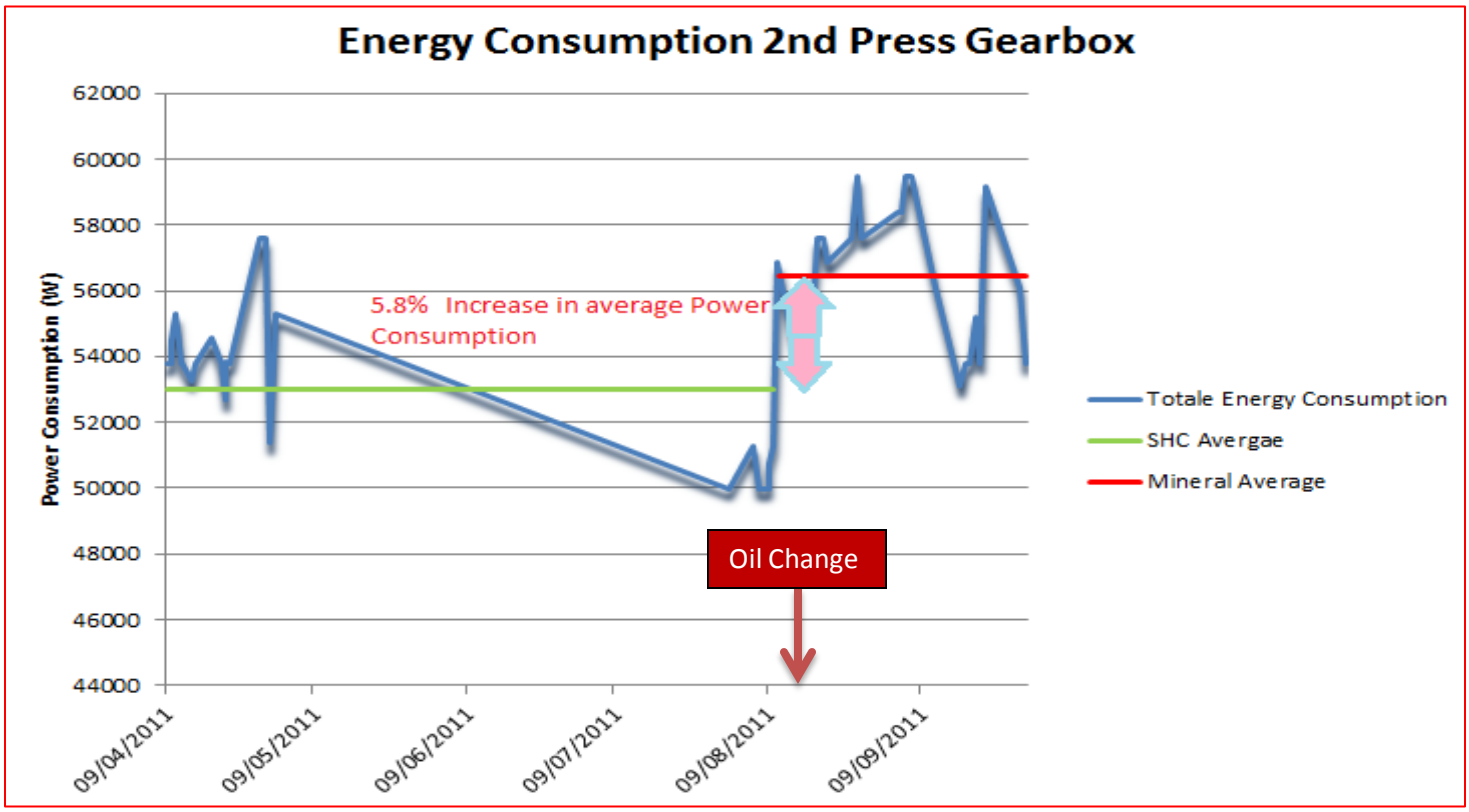

Figure 3.0 – *Increase in Energy Usage upon replacement with Mineral oil*

This increase was calculated from a weighted average of the available data from the synthetic trial period, and the September/October data after the mineral changeover.

In addition, the operating temperature of the gearbox increased significantly with the reintroduction of the mineral oil grade, with an average operating temperature increase of 6.6°C, when corrected for ambient temperature influence.

This significant temperature increase along with similar increase in power consumption suggests that the improved performance previously demonstrated was due to the improved qualities of the SHC trial fluid over its mineral counterpart.

The PM7 machine, when in operation, is extremely consistent in terms of production. The speed of the machine is between 300 and 400 metres per minute, with the weight of packaging produced varying only from 95 to 100 grams per square metre. The machine operates continuously for periods of six weeks, with 12 hour shutdowns in between, and relatively few unplanned shutdowns took place over the trial period. This means that the load on the gearbox was consistent, and the trial results give an accurate representation of the benefits gained.

Also, the average motor speeds of application did not vary more than +/- 0.5% for the application throughout the test period, meaning that changes in gearbox operation had negligible effects on the results attained.

5.0 Conclusion

New formulation Mobil SHC 632 greatly improved the energy efficiency of Smurfit Kappa's PM7 2nd press drive Santasalo 2S56 double reduction gearbox. The lower traction coefficient and superior viscometrics of the fluid meant that an average of 6.5% less energy was required to power the gearbox, which represents a drastic reduction in energy usage over the previous mineral grade. This energy saving was further outlined by an average delta operating temperature drop of 8.4^{o}C, meaning that the gearbox runs considerably cooler at similar production rates, prolonging the life of both the oil and the equipment.

The results mean that Smurfit Kappa can save over two and a half thousand pounds per year on energy costs from just one gearbox application, and they have already begun the process of switching like gearboxes to the new Mobil SHC 600 formulation.

This energy saving will also help to improve the carbon footprint of Smurfit Kappa's operation, saving the equivalent of 17.6 tonnes of carbon dioxide a year from the more efficient operation.

The A-B-A test schedule implemented proved beyond reasonable doubt that the savings generated were solely due to the replacement of the mineral oil with the synthetic trial fluid, as once the mineral oil was re-introduced the system increased energy consumption and in temperature to similar levels as before.

Appendix 1: Energy data from gearbox

			Field		Armature		Wattage		
Date	Time	Speed	Volts	Current	Volts	Current	Field	Armature	
Mobilgear 600 XP 320			V	Amps	V	Amps	W	W	
21/03/2011	08:00	387	122	5	390	145	610	56550	
21/03/2011	19:30	392	122	5	390	145	610	56550	
22/03/2011	08:00	387	122	5	390	150	610	58500	
22/03/2011	19:30	393	122	5	385	150	610	57750	
23/03/2011	19:00	387	122	4.9	385	150	597.8	57750	
24/03/2011	19:00	387	122	4.9	380	155	597.8	58900	
26/03/2011	02:30	387	120	5	395	150	600	59250	
27/03/2011	08:00	392	122	5	395	142	610	56090	
28/03/2011	08:00	392	122	5	390	138	610	53820	
29/03/2011	08:00	392	122	5	395	145	610	57275	
30/03/2011	07:30	392	122	5	390	150	610	58500	
31/03/2011	08:00	387	122	5	390	150	610	58500	
31/03/2011	19:00	392	122	4.9	385	150	597.8	57750	
01/04/2011	08:00	387	122	5	390	140	610	54600	
01/04/2011	20:00	392	122	5	390	150	610	58500	
02/04/2011	14:00	386	120	5	390	150	600	58500	
02/04/2011	19:00	385	122	5	390	145	610	56550	Average total
03/04/2011	19:00	386	125	5	390	150	625	58500	power use (W)
Averages		389.06	121.94	4.98	389.44	147.50	607.69	57435.28	58042.97
New SHC 320 grade			V	Amps	V	Amps	W	W	
09/04/2011	07:30	392	118	4.8	380	140	566.4	53200	
10/04/2011	08:00	386	120	4.9	380	140	588	53200	
10/04/2011	19:00	392	122	4.9	385	140	597.8	53900	
11/04/2011	08:00	389	120	5	385	142	600	54670	
12/04/2011	02:30	393	122	4.8	380	140	585.6	53200	
12/04/2011	19:00	387	122	4.9	380	140	597.8	53200	
14/04/2011	19:00	387	122	5	390	135	610	52650	
15/04/2011	19:00	387	120	4.9	380	140	588	53200	
18/04/2011	13:13	392	122	4.9	380	142	597.8	53960	
20/04/2011	19:40	392	121	4.8	380	140	580.8	53200	
21/04/2011	08:00	385	122	4.9	380	137	597.8	52060	
21/04/2011	20:40	392	122	4.9	380	140	597.8	53200	
22/04/2011	19:00	386	122	4.8	380	140	585.6	53200	
28/04/2011	09:00	392	122	4.8	380	150	585.6	57000	
29/04/2011	09:00	392	122	4.8	380	150	585.6	57000	
30/04/2011	20:00	348	122	4.9	350	145	597.8	50750	Average total
01/05/2011	19:00	394	121	4.9	385	142	592.9	54670	power use (W)
Averages		387.41	121.29	4.88	379.71	141.35	591.49	53662.35	54253.84
% reduction		0.42%	0.53%	2.14%	2.50%	4.17%	2.67%	6.57%	6.53%

			Field		Armature		Wattage		
Date	Time	Speed	Volts	Current	Volts	Current	Field	Armature	
01/08/2011	19:00	384	120	4.8	380	130	576	49400	
06/08/2011	08:30	392	121	4.8	390	130	580.8	50700	
07/08/2011	08:30	391	121	4.8	380	130	580.8	49400	
08/08/2011	18:50	391	121	4.8	380	130	580.8	49400	
09/08/2011	08:00	385	120	4.8	380	130	576	49400	
09/08/2011	19:45	391	121	4.7	380	132	568.7	50160	Average total
10/08/2011	19:00	386	120	4.8	390	130	576	50700	power use (W)
Averages		388.57	120.57	4.79	382.86	130.29	577.01	49880.00	50457.01
11/08/2011	19:00	379	120	4.9	375	150	588	56250	
15/08/2011	08:00	392	120	4.8	380	140	576	53200	
16/08/2011	11:20	391	122	4.8	380	145	585.6	55100	
18/08/2011	07:00	389	122	4.9	380	145	597.8	55100	
18/08/2011	21:30	395	121	4.8	380	145	580.8	55100	
19/08/2011	20:00	395	121	4.8	380	150	580.8	57000	
20/08/2011	19:00	388	120	4.8	380	150	576	57000	
21/08/2011	19:00	387	120	4.8	375	150	576	56250	
26/08/2011	09:00	392	121	4.8	375	152	580.8	57000	
27/08/2011	08:30	395	121	4.8	380	155	580.8	58900	
28/08/2011	08:00	389	120	4.9	380	150	588	57000	
04/09/2011	08:00	395	122	4.9	380	152	597.8	57760	
05/09/2011	08:00	395	122	4.8	380	152	585.6	57760	
06/09/2011	09:00	395	121	4.8	380	155	580.8	58900	
07/09/2011	19:00	395	121	4.8	380	155	580.8	58900	
12/09/2011	08:00	385	120	4.8	370	150	576	55500	
17/09/2011	22:30	385	121	4.8	375	140	580.8	52500	
18/09/2011	19:00	389	121	4.8	380	140	580.8	53200	
19/09/2011	19:00	383	120	4.9	380	140	588	53200	
20/09/2011	19:00	383	122	4.9	390	140	597.8	54600	
21/09/2011	19:00	387	120	4.9	380	140	588	53200	
22/09/2011	19:00	390	122	4.9	380	154	597.8	58520	
29/09/2011	19:00	380	122	4.8	370	150	585.6	55500	Average total
30/09/2011	19:00	388	120	4.8	380	140	576	53200	power use (W)
Averages		389.25	120.92	4.83333	378.75	147.5	584.43	55860	56444.43
% Increase		0.32%	-0.01%	0.05%	-0.67%	4.17%	-1.21%	3.93%	5.84%

NB. On Weighted Average of available SHC data

Appendix 2: UK electricity associated carbon footprint calculation

UK electricity supply carbon footprint calculator

Fuel Source	Carbon footprint (gCO2eq/kW.h)	% UK power production
Gas	500	40
Coal	1000	35
Nuclear	5	20
Renewables	5	5

Weighted Average	551.25