by Dr Samantha Mudie, Head of Technical Development at Carbonxgen

# Saving the Hospitality Sector 1 kWh at a Time

Catering businesses feature in every town and city in the world and are vital buildings to be considered in any low-carbon plan. Commercial kitchens are some of the most profligate users of gas, water and electricity in the UK. As a result, they leave a large carbon footprint, with relevant benchmarks (in $kWh/m^2$) exceeding ten times the energy intensity of the majority of commercial premises (i.e., supermarkets, offices, retail premises, etc.)[1&2].

The catering sector has been severely affected by the coronavirus pandemic, as well as Brexit. Consumer spending on hospitality remains at less than 70% of pre-pandemic (2019) levels[3], and 72% of hospitality sector businesses were expected to close in 2021[4].

In a world where income is dropping and expenses are growing, the traditional measures of success (turnover, market share and like-for-like sales increase) are not as important as profitability, and reducing utilities spend is an obvious way to increase resilience in these trying times. Energy is frequently the third largest overhead after labour, food and drink in a food service operation, amounting to an average yearly spend of £27,000 (250,000 kWh) for an average sized pub. There has never been a more urgent need to manage this cost.

## Establishing the Pathway

'Energy Reduction in Commercial Food Preparation', is an award-winning engineering doctorate, sponsored by one of the largest pub and restaurant operators in the UK, in conjunction with the University of Reading. The organisation spent around £70M on utilities per year, in around 2,000 sites with over 40,000 employees.

When we set out on this 6-year project, there was very little innovation and research available on how to meaningfully reduce energy consumption over the long term in the sector, from academia or industry. Headed up by Richard Felgate (founding board member of the EMA), the Energy, Environment and Sustainability Team had already made great strides before the project commenced. AMR, LED lighting, voltage optimisation and minimum energy standards across several aspects of the front and back of house operations had already been rolled out.

However, the industry as a whole lacked a robust method to assess the minimum consumption required to deliver diverse and evolving menus. A strategy for reducing energy use specifically from cooking operations just didn't exist. Knowing where to start, where to stop, and what to include within the scope of the project was an ongoing challenge. We ambitiously selected four key-focus areas for priority:

1. **State of the art review**

Despite comparatively low emissions compared with other areas of the food chain, the energy use attributed to catering activities is equivalent to both agriculture and food retail combined (24 TWh per year) and is responsible

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[1]CIBSE. Guide F Energy Efficiency in Buildings. The Chartered Institution of Building Services Engineers (CIBSE) 222 Balham High Road, London SW12 9BS, 2012.

[2]Mudie S, Essah EA, Grandison A, et al. Benchmarking Energy Use in Licensed Restaurants and Pubs. Chartered Institute of Building Service Engineering (CIBSE) Technical Symposium 2013. Liverpool John Moores University, UK, 2013.

[3]ONS Coronavirus and its impact on UK hospitality: January 2020 to June 2021, available at https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/articles/coronavirusanditsimpactonukhospitality/january2020tojune2021).

[4]"72% of hospitality and pub businesses face closure in 2021, says new research". Stefan Chomka, 19th November 2020, Big Hospitality. Available at (https://www.bighospitality.co.uk/Article/2020/11/19/72-of-hospitality-and-pub-businesses-face-closure-in-2021-restaurants-Coronavirus-lockdown).

for 11% of UK service sector energy consumption[5]. Yet, beyond the procurement of 'more energy efficient cooking appliances', very little innovation has been achieved within these operations. Indeed, the design of cooking technologies has remained virtually stagnant since their creation!

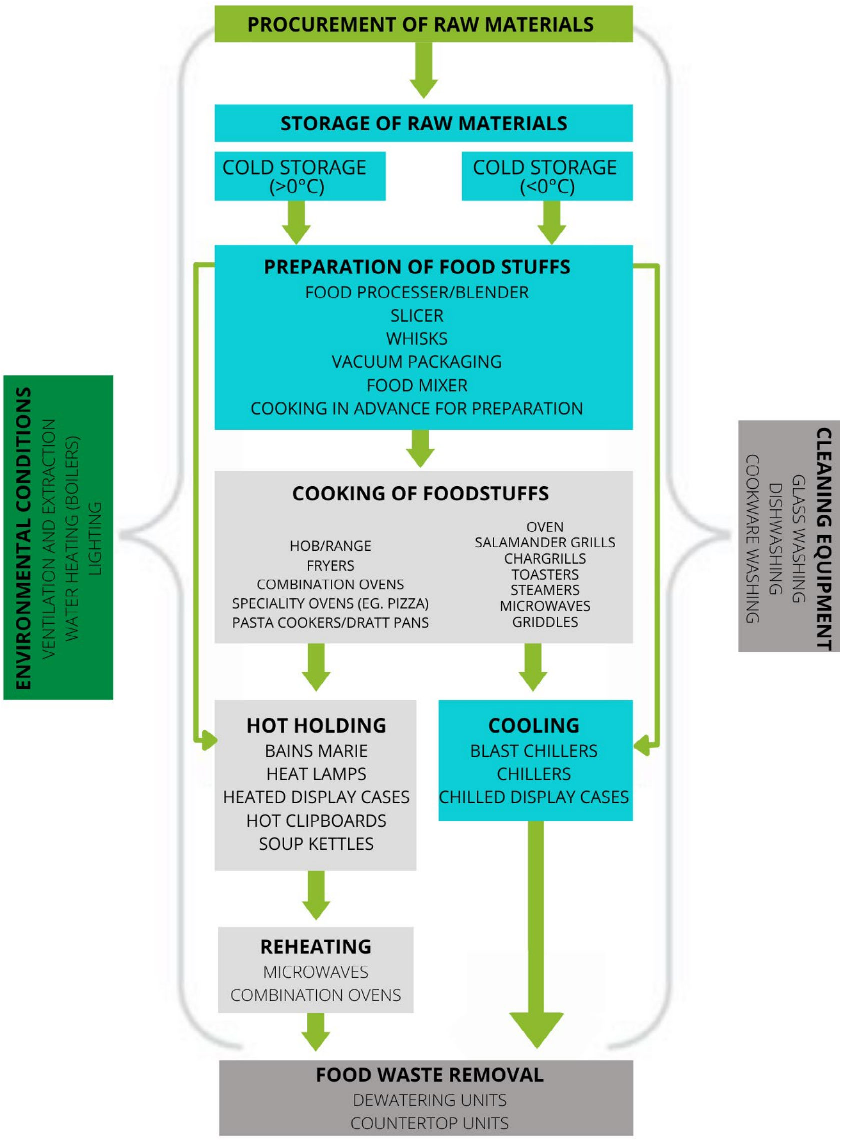
### 2. Energy monitoring and analysis

Before the project commenced there was very little in the way of energy consumption data from whole buildings, kitchen operations or specific sub-metered appliances. Neither operators nor appliance manufacturers were previously forthcoming with sharing their private data. To fill this gap, extensive energy monitoring and comprehensive analysis would need to be published to enable the sector to predict and understand their consumption. This work really sets the scene and shapes priorities and strategy for the future.

### 3. Energy benchmarking

Current published benchmarks reported in CIBSE's TM50, TM22 and Guide F: Energy Efficiency in Buildings, originated from work conducted in the 1980s with no substantial review or updated data set in four decades. Pubs especially have evolved dramatically, expanding towards food-led businesses in response to increased duty on alcohol sales. Reviewing and, if necessary, updating the benchmarks is key to moving the sector onto realistic carbon reduction targets. Numerous energy intensity metrics existed including kWh/m$^2$, kWh/£ turnover, and kWh/meal; and operators needed clarity regarding the optimum benchmark to use for their operations both internally, and between the sector.

### 4. Relating menus and food throughput to energy consumption of appliances




[5]Energy Reduction in Commercial Food Preparation". S. Mudie Engineering Doctorate Thesis, University of Reading, 2017.

Anyone can buy a more efficient appliance, but it is a more radical and interesting question to ask if the appliance is needed at all. There are hundreds of methods one can use to cook each menu item, and the cooking appliances selected need to be flexible in order to adapt to future menu changes.

Energy consumption must be related to food throughput and numerous other operational factors such as food palatability, cooking times, space and training requirements etc. to be of any value to a specific hospitality business. Tying these factors into what, when and how an operator delivers a menu was the greatest challenge. Minimising energy consumption without compromising on diversity, quality, timings and volume of product served was the major aim of this project.

## Approach:

For the benchmarking study, half hourly AMR data were gathered for one year from over 1,500 sites and 14 brands. Data concerning the estimated drinking/dining area, number of covers, financial turnover, and food and drink sales were obtained from the operators. Correlations between energy usage and the above metrics were analysed via linear regression and compared with the current published benchmark figures. When the most suitable metric was established, it was applied to a much larger dataset of over 11,000 managed pubs and restaurants (65% of the UK's total managed pub and restaurant estate at the time).

From this sample, 14 sites were selected and over 400 individual appliances within them were monitored, resulting in a published academic journal article. Using a bottom-up approach and the principles of life-cycle analysis, we then set about developing a holistic, sophisticated and award-winning method to model the entire food preparation operation. Number, type and timings of food served were directly downloaded via till records, and the operators' standard procedures were assessed in order to map catering activity on an ingredient level, encompassing all energy-using processes required to deliver each menu item.

## Findings:

Consumption within the sector was found to be significantly greater than previously reported; 19.57 TWh for managed pubs alone, compared with previous CIBSE estimates of 21.6 TWh for the entire catering sector. The energy use of the new dataset was found to be over 80% more than expected when compared to the kWh/m$^2$ published benchmarks at the time (and 66% in terms of kWh/meal). Updated electricity and gas benchmarks were published and submitted to CIBSE (0.20 kWh/£ turnover for electric and 0.16 kWh/£ turnover for gas).

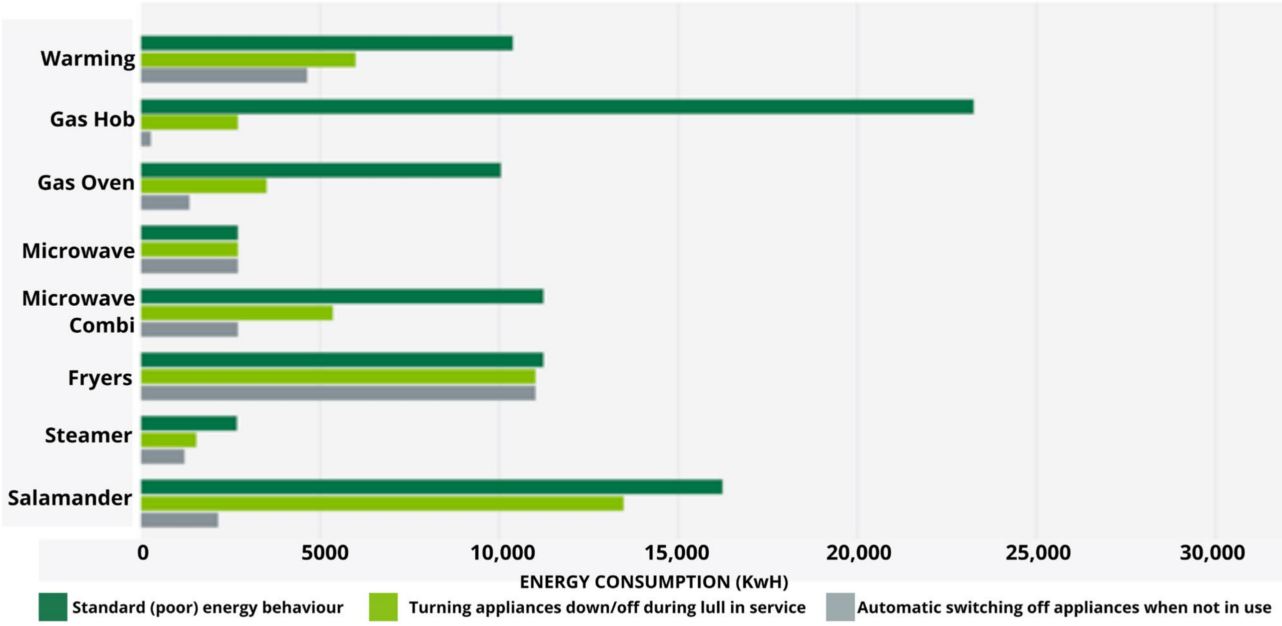
This part of the project won several awards at international conferences. This initial work also revealed large opportunities in the area of behaviour change, with 71% savings found from one study of over-fired grills. Other immediate opportunities included appliance specification and maintenance strategies.

The subsequent model development allowed, for the first time, several energy and carbon reduction strategies to be run without disruption and cost to catering operations from physical trials.

The brief specified looking in detail at the cooking methodology and appliances, food throughput, equipment features and specifications, operational planning and management decisions, and providing a return-on-investment of less than two years. The following scenarios were selected for input into the menu-model after extensive consultation with the broad range of stakeholders:

- Replace chargrill with low-carbon cooking alternative
- Replace fryers with low-carbon cooking alternative
- Replace microwaves with low-carbon cooking alternative
- Reduce freezer demand
- Elimination of hot-holding
- Replace gas hob with induction hobs

| Inputs | Outputs |
|---|---|
| • Menu - All ingredients, cooking methods and variations<br>• Number and timings of meals sold from sales data<br>• Kitchen use profile - opening hours, hot holding and batch cooking preferences, cover, behavioural factors and more<br>• Equipment specifications - makes, models and numbers<br>• Extraction and ventilation information<br>• Refrigerant data<br>• Bills of materials and embodied carbon of kitchen appliances<br>• A range of energy reduction scenarios and equipment replacements | • Hourly cooking distribution from analysis of meals served and their timings<br>• Hot finishing and preparation demand considering batch cooking and hot holding strategies<br>• Capacity and maximum throughput for each appliance category<br>• Appliance utilisation per hour and capacity checks<br>• Total energy consumption per appliance category (kWh) per day, week, and yearly<br>• Total running cost per appliance category (£) per day, week, yearly<br>• Total emissions (kg CO2e) per day, week, & yearly<br>• Return on investment<br>• Embodied, use phase, and end of life carbon and cost |




## Operational feasibility

Wasteful energy use is often a symptom of inefficient processes in general; the range of calculations encompasses several operational impacts to assess the true benefit of the energy saving outside of just carbon emissions and cost. For example, any effect on cooking times, spatial footprint of appliances, seasonal menu changes, consistency of product and any staff training requirements are also assessed and presented for consideration.

Actual meal demand per hour was mapped through till-sales data. Three behavioural scenarios (above) were built into the model based on the results of our prior study; poor energy performance (business as usual), some energy demand reduction (turning things down or off during mid-morning and/or late afternoon lull in dining), and energy minimisation (reflects very thrifty behaviour and automatic switching off appliances when not in use).

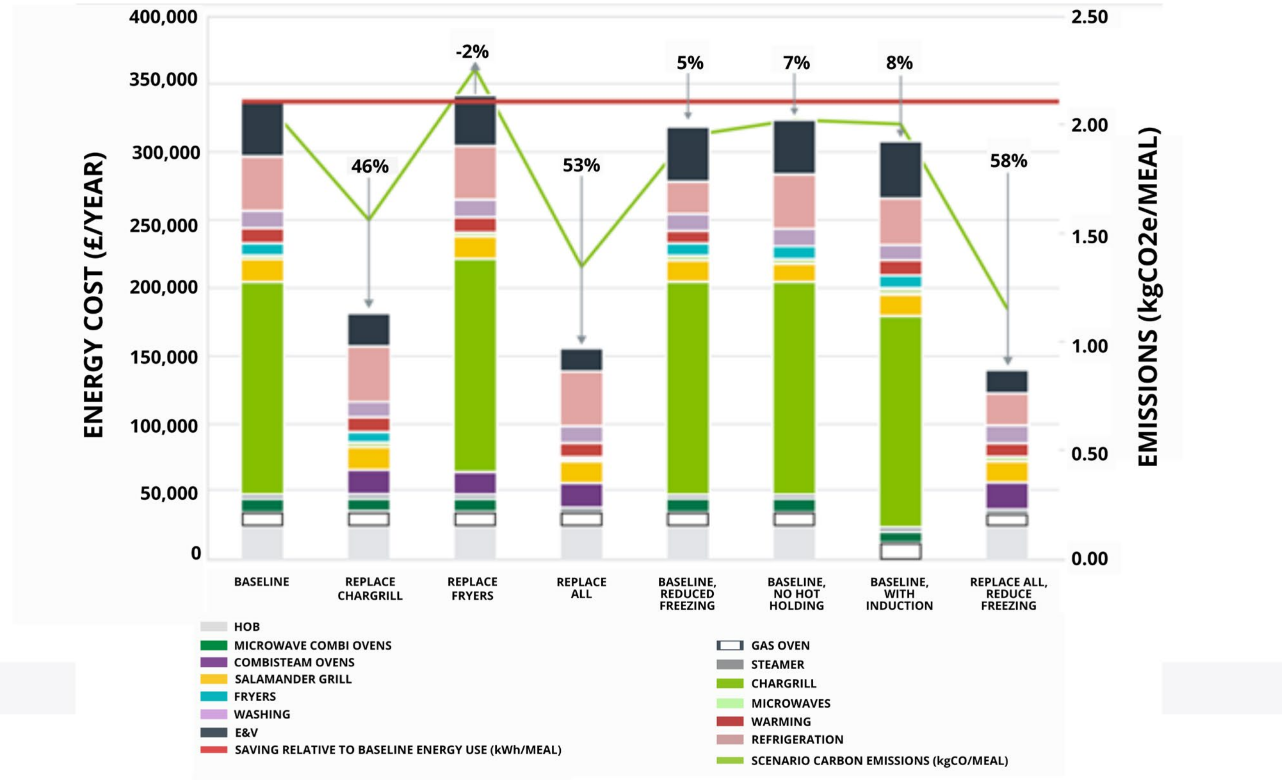
Appliance utilisation analysis provides an indication of the priority for energy reduction in relation to demand. It also provides insight into their operations outside of energy consumption, such as the crowded chargrill on specials weekends and the barely used steamers and gas ovens.

**The results were really quite staggering (below). The most favourable energy reduction scenario saw a 58% reduction in energy use, which equates to 37.77 million kWh, 10.71 million kg$CO_2$e and £2 million saved per year across the chain of restaurants. A simple payback of <6 months was calculated.**

Interestingly, the cost of not acting was an astonishing £38,500 for every week that went by as 'business as usual'. These savings were achievable without further staff training to minimise wastage through behaviour.

On top of the carbon credentials, there were many other co-benefits identified such as space savings in the kitchen, uniformity and consistency of product could be improved by utilising new cooking features, and training needs could also be minimised. Peak appliance utilisation was never over maximum capacity which also streamlined operations. Average cooking times per meal were increased by 50%. However, considering that the operator stood to gain £18.3 million per year savings if the template was rolled out to all restaurant brands, and more importantly, customers are crying out for more sustainable businesses and products, this may be more than acceptable to operators and consumers alike!

| APPLIANCE CATEGORY | MAXIMUM CAPACITY UTILISATION (%) | | |
|---|---|---|---|
| | TYPICAL WEEK | PEAK WEEK | SPECIAL WEEKEND |
| FOOD STORAGE | 29 | | |
| CHARGRILL | 91 | 114 | 122 |
| SALAMANDER | 11 | 14 | 15 |
| STEAMER | <1 | <1 | <1 |
| FRYERS | 7 | 8 | 9 |
| MICROWAVE COMBI OVEN | 2 | 3 | 2 |
| MICROWAVE | 27 | 33 | 35 |
| GAS OVEN | <1 | <1 | <1 |
| GAS HOB | 20 | 25 | 26 |




## Future plans:

While Covid has taken a huge toll on the industry, it has shown how quickly the sector can adapt, and this is very encouraging. Reluctance to modify cooking practices and shying away from radical improvements required for energy efficiency is not something that these businesses can continue with any longer.

There are huge financial savings to be made and opportunities are everywhere. With the recent buzz surrounding COP26 and the publication of the Net Zero Guide for the Hospitality Sector, many larger firms are beginning to make more ambitious commitments towards carbon neutrality. Scope 3 emissions reduction will form a large part of this. Our research also identified significant opportunity in the area of behaviour change; over 70% energy savings could be realised purely through staff training and engagement in some cases. The government has recently acknowledged this will be a major focus in reaching our Net Zero targets.

I sincerely hope that the pandemic gives operators the chance to reflect on how investing in energy saving measures could (and should!) be the key to unlock the profits desperately required to see them through the coming season.

## Author's Profile:

Dr Samantha Mudie has published 8 peer-reviewed academic journal papers and has a doctorate in the field of commercial catering energy reduction, winning both national and international awards for her work in hospitality carbon saving. She has developed and led sustainability strategies for a wide range of businesses for over ten years and chaired various energy focused groups in industry. An avid EV owner, she is also actively involved in local renewable energy and carbon reduction initiatives in the Reading area.

### References:

[1] - CIBSE. Guide F Energy Efficiency in Buildings. The Chartered Institution of Building Services Engineers (CIBSE) 222 Balham High Road, London SW12 9BS, 2012.

[2] Mudie S, Essah EA, Grandison A, et al. Benchmarking Energy Use in Licensed Restaurants and Pubs. Chartered Institute of Building Service Engineering (CIBSE) Technical Symposium 2013. Liverpool John Moores University, UK, 2013

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