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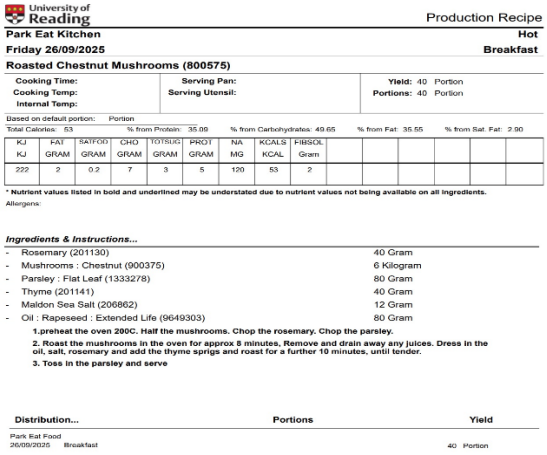
MEALTWIN-H: Smart Data-Driven Digital Twin for Hospitality Energy Management

This presentation addresses the challenge of reducing the environmental footprint of meal preparation (e.g., breakfast, lunch, or dinner) through the development of a Digital Twin (DT) for the University of Reading's Park Eat restaurant.

Park Eat has partnered with Measurable.Energy Ltd to deploy smart plug sockets with traffic-light carbon intensity indicators, based on the UK National Grid's carbon intensity API (Figure 1). These provide real-time and forecasted emissions data; however, they reflect grid-level intensity and do not capture appliance-level or meal-specific carbon impacts.

Figure 1. Measurable.Energy Ltd smart socket with carbon-intensity traffic-light indicator in the Park Eat kitchen.

To estimate the carbon footprint of meals, appliance-level electricity data must be integrated with ingredient composition (Figure 2), preparation methods, portion sizes, sales, and food waste data. A key challenge is translating this complex data into meaningful, actionable insights for kitchen staff to support sustained behavioural change.



University of Reading — Production Recipe

Park Eat Kitchen — **Hot**

Friday 26/09/2025 — **Breakfast**

Roasted Chestnut Mushrooms (800575)

Cooking Time: **Serving Pan:** **Yield:** 40 Portion
Cooking Temp: **Serving Utensil:** **Portions:** 40 Portion
Internal Temp:

Based on default portion: Portion

Total Calories: 53 % from Protein: 35.09 % from Carbohydrates: 49.65 % from Fat: 35.55 % from Sat. Fat: 2.90

KJ KJ	FAT GRAM	SATFOD GRAM	CHO GRAM	TOTSUG GRAM	PROT GRAM	NA MG	KCALS KCAL	FIBSOL Gram					
222	2	0.2	7	3	5	120	53	2					

*** Nutrient values listed in bold and underlined may be understated due to nutrient values not being available on all ingredients.**

Allergens:

Ingredients & Instructions...

- Rosemary (201130) — 40 Gram
- Mushrooms : Chestnut (900375) — 6 Kilogram
- Parsley : Flat Leaf (1333278) — 80 Gram
- Thyme (201141) — 40 Gram
- Maldon Sea Salt (206862) — 12 Gram
- Oil : Rapeseed : Extended Life (9649303) — 80 Gram

1.preheat the oven 200C. Half the mushrooms. Chop the rosemary. Chop the parsley.
2. Roast the mushrooms in the oven for approx 8 minutes, Remove and drain away any juices. Dress in the oil, salt, rosemary and add the thyme sprigs and roast for a further 10 minutes, until tender.
3. Toss in the parsley and serve

Distribution...	Portions	Yield
Park Eat Food 26/09/2025 Breakfast		40 Portion

Figure 2. Example of a week-ahead production recipe: Roasted Chestnut Mushrooms prepared at Park Eat Kitchen, Hot Meal (Friday 26/09/2025 Breakfast)

The proposed DT integrates these data streams into a unified, interactive platform, enabling real-time simulation of kitchen operations and visualisation of energy use and carbon emissions at the meal level. It supports scenario analysis, allowing staff to explore alternative preparation methods, ingredient choices, and operational strategies with immediate feedback.

The presentation objectives are to: (1) identify user needs for DT adoption; (2) quantify energy use per meal and (3) link energy consumption with carbon emissions.

This work bridges research and practice, promoting sustainable catering and supporting knowledge exchange with industry stakeholders to advance low-carbon foodservice systems.

References

[1] Mudie, S., Vadhati, M. (2017) Low energy catering strategy: insights from a novel carbon-energy calculator. Energy Procedia, 123:212-219. https://doi.org/10.1016/j.egypro.2017.07.244

[2] Kanyiki, Z., Merino, A., & Lőrincz, M. (2024). Design for sustainable behaviour: exploring the electricity-related feedback interventions of Measurable Energy smart sockets at Park Eat restaurant.