Cooking demand profiles in Euro-Calliope

This document outlines the methods and assumptions associated with the computation of cooking demand profiles for use in the Sector-Couple Euro-Calliope model.

Methodology

In the absence of metered hourly data at a national resolution, we use a bottom-up stochastic modelling approach to generate synthetic cooking demand profiles. The approach, based on the open-source RAMP engine (Lombardi et al. 2019) for stochastic demand modelling, has been developed and validated in previous work (Lombardi, Rocco, and Colombo 2019) with application to Italy. The approach is extended here to 26 European countries.

In short, the model assumes two main user archetypes, i.e. *small* (1 to 3 members) and *large* (3 to 6+ members) households. The two user archetypes are differentiated in terms of meal behaviour. More precisely, for each archetype and for each type of meal (breakfast or similar, lunch, dinner) the model considers up to 6 user subgroups with increasing probability/frequency of home-cooking events compared to outdoor meals (with outdoor meals not entailing any household energy consumption). When an in-home cooking event takes place, this can be either a main or a side dish type of meal, with different associated power cycles. Lunch and dinner, the two main cooking events, always entail either the contemporary preparation of a main dish and a side dish or the simultaneous use of two different cook plates for different ingredients of a unique dish.

Each cooking event is simulated uniquely for each individual household within a user-defined overall population. For each such individual cooking event, the timing, duration, power level and cooking sequence are stochastically varied within pre-defined ranges, leading to a diverse set of profiles which are ultimately aggregated to provide a realistic picture of the overall cooking behaviour of the population. The flow chart of the model is summarised in Figure 1, while the reader is referred to Lombardi, Rocco, and Colombo (2019) for further details about the original model rationale and assumptions.

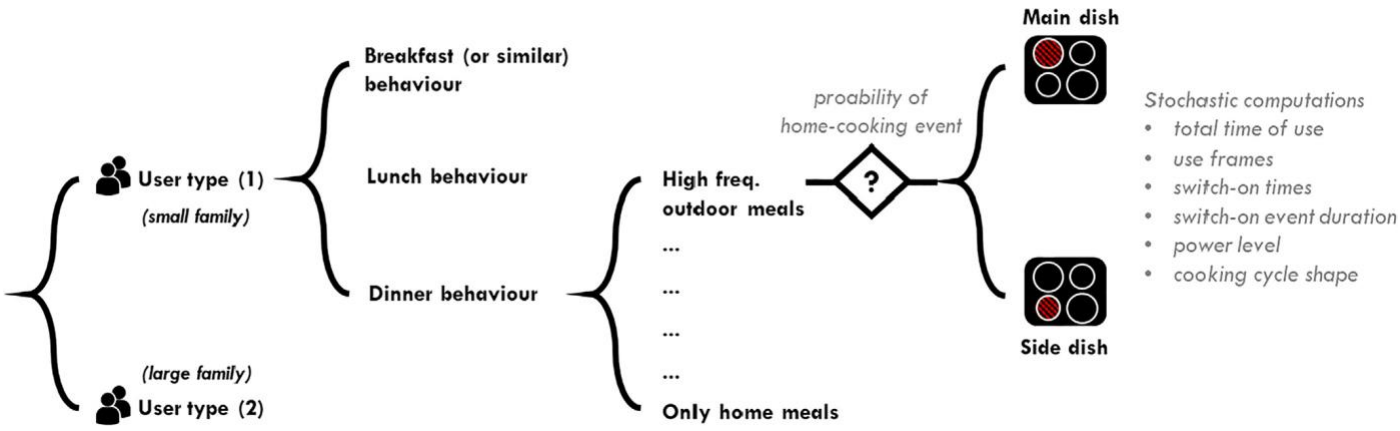

Figure 1. Conceptual flow chart of the adopted bottom-up model; source: (Lombardi, Rocco, and Colombo 2019).

Data and assumptions for Euro-Calliope extension

Cooking behaviour statistics for the original model were gathered from Italy-specific sources, as further detailed in the associated publication. For extension to other countries in Europe, we assume that microdata related to home-cooking frequency and cooking sequence preferences do not vary significantly across Europe. However, we do model country-specific preferences in terms of average lunch and dinner timing. In fact, the timing of main meals experiences large variations, for instance between Northern-Europe and the Mediterranean. Accordingly, we refer to the Harmonised European Time of Use Survey (HETUS; https://ec.europa.eu/eurostat/web/time-use-surveys) to define country-specific meal timings and ensure that peak cooking demand is fine-tuned with the realistic macroscopic social behaviour in each country. Inasmuch as the HETUS data do not cover all the countries represented in our model, we use data from neighbouring countries as a proxy for those that are missing (see Table 1). Finally, considering that

the model distinguishes between weekday and weekend or holiday behaviour, country profiles are further differentiated by taking into account realistic calendars with country-specific festivities.

Table 1: Countries for which cooking demand data is generated using the RAMP model and the source of meal behaviour data. For countries not included in the HETUS dataset, a neighbouring country has been used, which is given here. All countries are defined according to their European statistics country codes, which closely follow ISO 3166 alpha-2 standards, except for "UK" (a.k.a. "GB").

Country code	*Meal-behaviour source*	*Country code*	*Meal-behaviour source*
AL	Data from RS	**LT**	Data from PL
AT	Data from DE	**LU**	HETUS
BA	Data from RS	**LV**	Data from PL
BE	HETUS	**ME**	Data from RS
BG	Data from PL	**MK**	Data from GR
CH	Data from CH	**NL**	HETUS
CZ	Data from DE	**NO**	HETUS
DE	HETUS	**PL**	HETUS
DK	Data from DE	**PT**	Data from ES
EE	HETUS	**RO**	HETUS
ES	HETUS	**RS**	HETUS
FI	HETUS	**SE**	Data from NO
FR	HETUS	**SI**	Data from RS
GR	HETUS	**SK**	Data from CZ
HR	Data from RS	**UK**	HETUS
HU	HETUS		
IE	Data from UK		
IT	HETUS		

References

Lombardi, Francesco, Sergio Balderrama, Sylvain Quoilin, and Emanuela Colombo. 2019. 'Generating High-Resolution Multi-Energy Load Profiles for Remote Areas with an Open-Source Stochastic Model'. *Energy* 177 (June): 433–44. https://doi.org/10.1016/j.energy.2019.04.097.

Lombardi, Francesco, Matteo Vincenzo Rocco, and Emanuela Colombo. 2019. 'A Multi-Layer Energy Modelling Methodology to Assess the Impact of Heat-Electricity Integration Strategies: The Case of the Residential Cooking Sector in Italy'. *Energy* 170 (March): 1249–60. https://doi.org/10.1016/j.energy.2019.01.004.