

1 CEE consumption by food

Cumulative embodied energy (CEE) is the total energy that is put into the supply chain, summing up everything from agricultural production needs to wastewater management after disposal. The CEE is given for various types of food that make up a food basket, but not all food is considered. Instead 1 to 3 popular products are used to represent an entire category (e.g.: Potatoes for vegetables; Beef, pork, poultry for meat and seafood). The source for these CEE values is a JRC science and policy report named "*Energy use in the EU food sector: State of play and opportunities for improvement*" [1] which is freely available online. The CEE values are given in MJ/kg and multiplied with the amount of consumed food in each category to yield the total energy needed to maintain your diet. You will find the supply chain, food basket and CEE values on pages 17 to 20.

2 Average Omnivorous

The average amount of food that a Luxembourger eats is extracted from two different websites: OurWorldInData and WorldPopulationReview. If given, a measured consumption for a specific food was preferred. If there was only a number for an entire category (e.g. fruits) then the total consumption was simply split equally among the representing products. In general, the two sources were averaged or the most meaningful value was chosen. Sometimes, when neither of the sources provided the information, the average between the average German and French consumption was used as a substitute.

3 Aware Omnivorous

The Food-based dietary guidelines (FBDG) of Luxembourg are split into 6 categories: Starchy, Fruit and Vegetables, Meat/Fish/Pulses, Dairy, Alcohol and Water. The amount of the suggested food as well as the make up of the CEEs used for each food category are listed below. Please note that entries like "50% Potatoes" do not mean that the person would eat 300 grams of potatoes but that the CEE of potatoes is used for half of the starchy food, as potato is the only representation of vegetables in the food basket.

Table 1: Omnivorous

Food Category	FBDG per day	Used CEE
Starchy	600g	50% Potatoes, 50% Bread
Fruit and Vegetables	450g	50% Potatoes, 25% Apples, 25% Oranges
Protein Sources	175g	27% Fish*, 27% Beef, 30% Pork, 26% Poultry
Dairy	600ml Milk/375g Yoghurt/Slice of Cheese	200ml of Milk, 125g of Yoghurt**, 75g of Cheese per day
Drinks	1.5l of Water, 50cl of beer	Same as Average = 2l of Water, 25.1cl of beer

*Fish=(Poultry+Pork+Beef)/3

**Yoghurt=(Milk+Butter+Cheese)/3

4 Non-Omnivorous

There are no direct guidelines for a pescatarian, vegetarian or vegan diet. Instead we distribute the suggested amount to different types of food that provide the same nutrients.

Table 2: Pescatarian

Food Category	FBDG per day	Used CEE
Starchy	600g	50% Potatoes, 50% Bread
Fruit and Vegetables	450g	50% Potatoes, 25% Apples, 25% Oranges
Protein Sources	175g	50% Fish, 50% Potatoes
Dairy	600ml Milk/375g Yoghurt/Slice of Cheese	200ml of Milk, 125g of Yoghurt, 75g of Cheese per day
Drinks	1.5l of Water, 50cl of beer	Same as Average = 2l of Water, 25.1cl of beer

Table 3: Vegetarian

Food Category	FBDG per day	Used CEE
Starchy	600g	50% Potatoes, 50% Bread
Fruit and Vegetables	450g	50% Potatoes, 25% Apples, 25% Oranges
Protein Sources	175g	50% Potatoes, 50% Crop Based*
Dairy	600ml Milk/375g Yoghurt/Slice of Cheese	200ml of Milk, 125g of Yoghurt, 75g of Cheese per day
Drinks	1.5l of Water, 50cl of beer	Same as Average = 2l of Water, 25.1cl of beer

*Crop Based=(Olive oil + Sunflower oil + Sugar)/3

Table 4: Vegan

Food Category	FBDG per day	Used CEE
Starchy	600g	50% Potatoes, 50% Bread
Fruit and Vegetables	450g	50% Potatoes, 25% Apples, 25% Oranges
Protein Sources	175g	50% Potatoes, 50% Crop Based
Dairy	600ml Milk/375g Yoghurt/Slice of Cheese	100% Crop Based
Drinks	1.5l of Water, 50cl of beer	Same as Average = 2l of Water, 25.1cl of beer

5 Example Calculation

Let's take the "Aware Omnivorous" diet as an example to see how you could replicate the solution or estimate the energy needed to maintain a more specified diet. The Luxembourg FBDG recommends 600 grams of starchy food per day. The main source of starch in Luxembourg is cereal-based or vegetable products, which we assume to be consumed in equal amounts. The food basket in the JRC report represents these groups by one product each: bread and potatoes. Therefore, the CEE for starchy food for aware omnivores originates half from the CEE of potatoes and half from the CEE of bread:

$$\begin{aligned}
 E_{Starchy} &= (50\%CEE_{Potatoes} + 50\%CEE_{Bread}) * M_{starchy} \\
 &= (0.5 * 2.484 \frac{kWh}{kg} + 0.5 * 4.428 \frac{kWh}{kg}) * 0.6 \frac{kg}{day} \\
 &= 2.074 \frac{kWh}{day}
 \end{aligned}$$

The daily recommendation for fruit and vegetables is about 450 grams. Again, we assume that an average person would consume fruits and vegetables in equal quantities. This time, the food basket group of fruits is made up of two entries: oranges and apples. This means that the CEE for fruits itself is made up by an equal part from the CEEs of these two products:

$$\begin{aligned}
 E_{F&V} &= (50\%CEE_{Fruits} + 50\%CEE_{Vegetables}) * M_{F&V} \\
 &= (50\%(50\%CEE_{Oranges} + 50\%CEE_{Apples}) + 50\%CEE_{Potatoes}) * M_{F&V} \\
 &= (0.25 * 2.268 \frac{kWh}{kg} + 0.25 * 1.944 \frac{kWh}{kg} + 0.5 * 4.428 \frac{kWh}{kg}) * 0.45 \frac{kg}{day} \\
 &= 1.470 \frac{kWh}{day}
 \end{aligned}$$

In case of the protein sources CEE we uniquely assume the proportions of its basket products CEEs to be the same as for the average omnivores. As you can see, fish is consumed in non-negligible amounts and becomes even more important for the pescatarian diet. Unfortunately, we do not have a specific CEE for fish, but since fish is part of the "Meat and seafood" basket group, it is simply assumed that the CEE of fish is the average of the entries in this category.

After calculating the daily energy needs for each food category the total energy requirements will be:

$$E_{Daily} = E_{Starchy} + E_{F&V} + E_{Protein} + E_{Dairy} + E_{Drinks}$$

References

- [1] Monforti-Ferrario F, Dallemand J, Pinedo Pascua I, Motola V, Banja M, Scarlat N, Medarac H, Castellazzi L, Labanca N, Bertoldi P, Pennington D, Goralczyk M, Schau E, Saouter E, Sala S, Notarnicola B, Tassielli G, and Renzulli PA. Energy use in the eu food sector: State of play and opportunities for improvement. Scientific analysis or review, Policy assessment LD-NA-27247-EN-C (paper), LD-NA-27247-EN-N (online), Joint Research Centre, Luxembourg (Luxembourg), 2015.