Supplement to:

The climate- and energy-efficient school kitchen

Making school meals climate friendly and child friendly

Melanie Speck, Lynn Wagner, Xenia El Mourabit, Michael Scharp, Guido Reinhardt, Tobias Wagner, Sabine Schulz-Brauckhoff, Tobias Engelmann, Ruth Bartels

Methodology

Identification of aspects that are relevant to the climate

The energy measurements were carried out in the participating kitchens over a period of four weeks between March and April 2017. Three of the weeks corresponded to normal operations, and one week corresponded to reduced kitchen operations during school vacation programs. To check the data quality, individual plausibility checks were performed instead of pedigree matrices. For example, kitchens were compared with each other, or measured energy consumption was compared with the manufacturer's specifications. Kitchen ventilation could only be partially taken into account, and no energy measurements were taken for hot water, small appliances or heating, as it could be assumed that only a small amount of energy was used in each of these cases.[1]

The greenhouse gas calculations for the menus were based on the ISO standards 14040 and 14044 for product life cycle assessments and the ISO/TS 14067 technical standard for the carbon footprints of products [1–3]. Individual greenhouse gases (GHGs) and their respective global warming potentials (GWP 100a in CO_2eq) were taken into account. The characterization factors according to IPCC 2013 were selected without climate-carbon feedback (i.e., CH_4: 28; CH_4, fossil: 30; N_2O: 265) [4]. In addition, land use and land use change throughout the primary production process and the entirety of the value chains were included using an attributional approach developed at the Institute for Energy-Related and Environmental Research (*Institut für Energie- und Umweltforschung*—ifeu), known as "attributional land use and land use change" (aLULUC) [5]. A lunch menu portion for an average elementary school child was set as the reference [6]. Depending on the school, this may include an appetizer, a main course, and a dessert, as well as other meal options such as a salad bar or beverages [6].

The system boundary included agricultural products and processes, transportation, processing and packaging, distribution and sales, kitchen operations (including storage and refrigeration/freezing, preparation, serving, return and cleaning), waste, wastewater and waste recycling. The model did not take account of roads used for transportation or factories used for processing food (cut-offs). In any case, according to our own estimates, these areas would account for less than 3% in terms of cumulative energy demand (CED) and GHGs.

Environmental databases were also used to model material flows along the value chains. With regard to the areas of agricultural production, transport and packaging, the Institute for Energy-Related and Environmental Research (ifeu) has an internal database that has grown over the course of more than 20 years and contains comprehensive information such as the environmental impact of fertilizers and composite packaging. Transportation was mapped using TREMOD. Additional data were obtained from KTBL, ecoinvent, and other sources.

A distinction was made between conventionally and organically produced products in the modeling of foodstuffs because there are both qualitative differences (such as which processes, co-products, etc. have to be taken into account) and quantitative differences (such as the area occupied per kg of food).

The LCI data sets used are identical in most cases, such as in the case of the diesel for tractors. Only the quantities per functional unit differ. The environmental burdens were determined based on "average" foods as they are used in the KEEKS schools, i.e., they were determined based on the weighted average across proportions of domestic and foreign production, across different production methods such as open field or greenhouse, the months of the year (seasonal/non-seasonal cultivation), and

[1] Heating: mostly decentralized, no heating in the kitchens due to the heat generated by cooking and refrigeration/freezing. Hot water: low requirements, as dishwashers have their own heating systems. Small appliances used in food preparation: low energy consumption was assumed for these appliances, so they were not taken into consideration [6].

all related transportation, such as the proportion of sea and air transport. The country-specific composition of imported foodstuffs was taken from the Destatis database.
An attributive approach was taken to the LCA. The reason for this is that the main objective of the project was to determine the environmental impact of school catering in terms of real operation over many years ("accounting"), so that the influence of the different life cycle stages could be quantified, among other things. In addition, the impact of different measures was to be determined based on examples. The impact of the measures on the underlying system remains low because only the around 50 schools that participated in KEEKS were taken into account. The effectiveness of decision-making support therefore remains at a comparatively low level. Allocation in the case of co-products was dealt with using the attributive approach through multi-output processes—by allocating environmental burdens (and credits) among co-products (no system expansion). Allocation was generally based on economic criteria. In the case of dairy products, allocations were made according to the guidelines of the International Dairy Federation, i.e., using total milk solids [7].

Development of practically feasible measures

Ceterus paribus analyses were used to identify potential savings in the area of menu composition [6]. In each case, the entire menu and selected variations in the composition of the recipes were calculated. Care was taken to ensure that the functional unit, i.e., the portion size, remained largely constant. The key criterion for high savings potential was therefore high absolute savings in greenhouse gas emissions per portion compared with the status quo menu, while keeping the input in terms of mass the same.
In order to validate the measures derived from the results, the change in results brought about by each of the individual measures was tested with different food compositions.

Literatur

1. *DIN EN ISO 14040:2021-02: Umweltmanagement – Ökobilanz – Grundsätze und Rahmenbedingungen (ISO 14040:2006 + Amd 1:2020).*
2. *DIN EN ISO 14044:2006-07: Umweltmanagement – Ökobilanz – Anforderungen und Anleitungen (ISO 14044:2006).*
3. *DIN EN ISO 14067: Treibhausgase – Carbon Footprint von Produkten – Anforderungen an und Leitlinien für Quantifizierung (ISO 14067:2018).*
4. *IPCC: Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: 2013; 1535 pp.*
5. *Fehrenbach H, Keller H, Abdalla N, Rettenmaier N: Attributive Landnutzung (aLU) und attributive Landnutzungsänderung (aLUC) – Eine neue Methode zur Berücksichtigung von Landnutzung und Landnutzungsänderung in Ökobilanzen. ifeu paper 2018/03. Heidelberg: 2020.*
6. *Scharp M, Eyrich R, Schmidthals M, et al.: Das KEEKS-Projekt – Eine klimafreundliche Schulküche. IZT-Text 21-2018, Institut für Zukunftsstudien und Technologiebewertung. Berlin: 2018.*
7. *International Dairy Food Association: Definitions. IDFA, Washington, USA: 2021. www.idfa.org/definition (last accessed on 29 April 2021).*