Food Clim

# FOOD WASTE DIARIES

## QUANTIFICATION OF GREENHOUSE GAS EMISSION REDUCTION POTENTIAL

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## DESCRIPTION

Greenhouse gas emissions from food waste occur both before the food reaches the consumer and once the consumer has disposed of the food waste. These are generally called "upstream" and "downstream" emissions respectively. The upstream emissions come from food production and processing and packaging. The downstream emissions come from the waste disposal system. By reducing food waste, one hopes to reduce emissions due to less food production, etc., and also emissions through a reduction in waste processed.

The relation between upstream, downstream and the consumer are shown in **Figure 1**. The diagram illustrates the complex nature of the waste processing stream (downstream) as food wastes may be composted (making fertilizer), digested or incinerated to produce energy, and landfilled which also may produce energy. In addition, the packaging may be recycled. During the project, two additional downstream flows were included in the Food Waste Diaries: animal feed (i.e. house pets) and waste water system (e.g. drain or toilet). In Austria, household waste is not anaerobically digested, so this stream will not be discussed further.

## METHODOLOGY

The greenhouse gas emissions are calculated by taking an estimate of the avoidable food waste (from WP 2 & 3) and multiplying these values by emission factors calculated as the emissions per kg of food production avoided (i.e. upstream) and by the emissions per kg waste produced (i.e. downstream). Both upstream and downstream emission factors are estimated using a life-cycle assessment methodology (LCA).

Upstream emission factors have been taken from the GEMIS database and have modified to fit the Austrian situation in 2016 (as necessary). The GEMIS database has limited emission factors for downstream emissions. These have been augmented by a survey of recent literature.

From discussion with Günter Felsberger , we have limited the possible waste streams for household waste to four: landfill, incineration, industrial composting, and house composting. Only agriculture and industrial organic wastes are anaerobically digested. In addition we assumed that 98% of the waste that enters the organic public waste management stream (brown box) is processed as industrial compost and 2% is landfilled. If the user placed the waste in the garbage (black box) then in Styria 80% is incinerated.

### FOOD CHAIN FLOWS

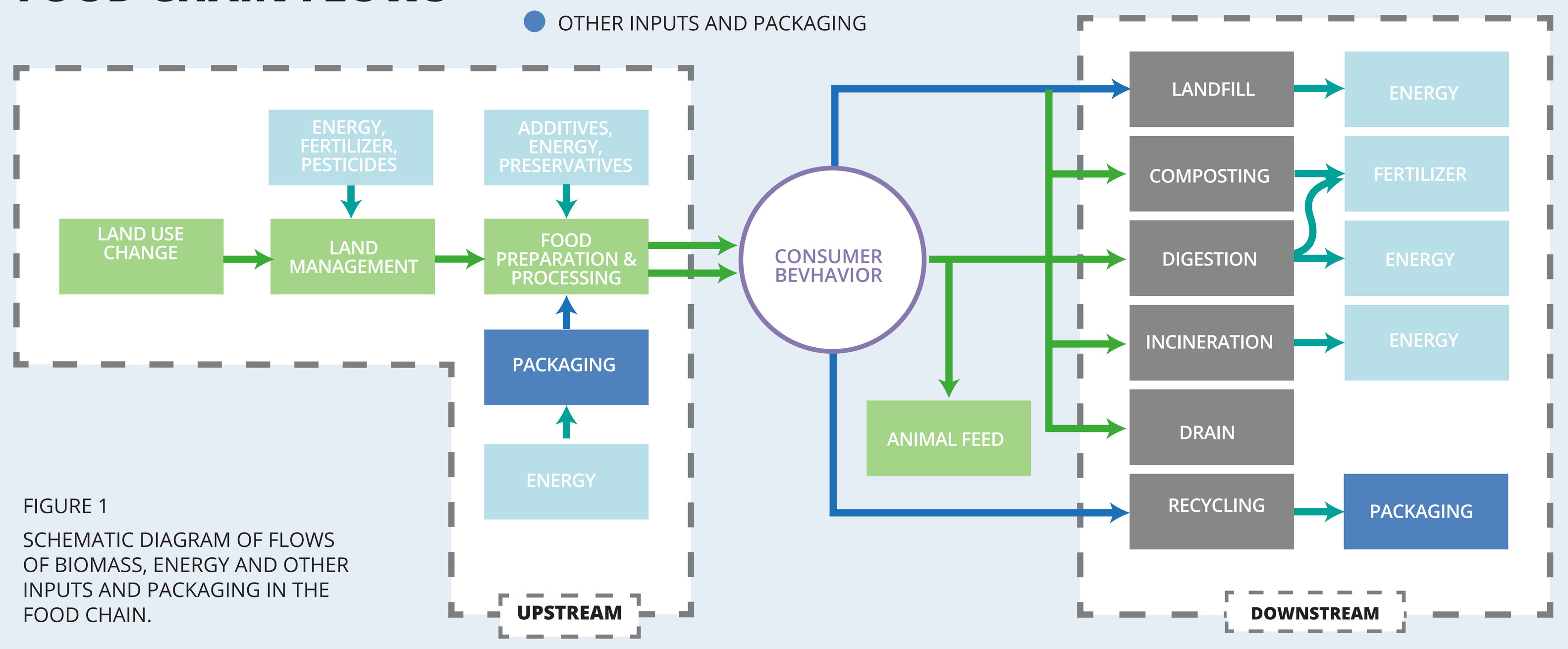


FIGURE 1
SCHEMATIC DIAGRAM OF FLOWS OF BIOMASS, ENERGY AND OTHER INPUTS AND PACKAGING IN THE FOOD CHAIN.

## RESULTS

### ESTIMATION OF FOOD WASTE AMOUNTS

Using data from the food diaries, we estimated of the amount of food waste in terms of average waste per person-meal. In total, there were 2,066 person-meals recorded (1,531 in Neumarkt and 534 in Vienna). There are significant differences between some components of the food diaries (using Welch's T-test at the 5% significance). For example, there is no significant difference between Neumarkt and Vienna due to the reason for food waste (category). However, what was thrown away and how it was thrown away were different between the two samples. In addition, since the waste disposal streams and emission factors for waste disposal are different for the two samples, they have been analysed separately.

The food diary results scaled to Austria assuming the Neumarkt sample represents the Austrian semi-rural and rural population and that the Vienna sample is representative of the Austrian population in larger cities (i.e. provincial capitals). A population weighted average food waste per person-meal was calculated and this was multiplied by the total number of person-meals eaten in household in the year (Total person-meals = total population x 3 x 365 x %meals in the home). Orfanos et al [3] estimated that 26% of meals were eaten out of the home in 2009. We have increased this 33% to account for the age of the publication.

In comparison to other studies, Schneider et al [5] as reported in Pladerer et al [4] estimated that 276,000 t/a of food waste ended up in the black bin and 90,700 t/a of food waste ended up in the brown bin. Their total amount (366,700 t/a) is very similar to our up-scaled estimate (390,000 ± 39,000 t/a). This represents about 16% of the food consumed by households in Austria.

However, what are important for the estimation of the potential for reductions in upstream and downstream emissions are the amounts of avoidable and possibly avoidable food waste by food type and waste stream. As shown in **Figure 2** this mostly comes from vegetables, fruit, breads & grains and milk products. Schneider et al [6] as reported in Pladerer et al [5] estimated that 157,000 t/a of food waste in the black bin and 49,000 t/a of food waste in the brown bin, was avoidable. Their value is significantly larger than our up-scaled estimate of 153,000 ± 26,000 t/a. It is hard to comprehend how Schneider et al were able to assess whether the food waste was avoidable because their estimate was made sorting through collected waste and the categorisation of whether the food waste was avoidable or not is somewhat subjective. Our categorisation of unavoidable, possibly avoidable and avoidable attempted, as much as possible, to use the definition proposed by Beretta et al [1]:

> **Avoidable losses** refer to food and drink thrown away because they are no longer wanted, e.g. because they perished or exceeded their date of expiry.
>
> **Possibly avoidable losses**, in contrast, refer to food and drink that some people eat and others do not (e.g. apple peels), or that can be eaten when prepared in one way but not in another (e.g. potato or pumpkin skins).
>
> **Unavoidable losses** comprise waste arising from food and drink preparation that is not, and has not been, edible under normal circumstances. This includes apple cores, banana skin, tea leaves, and coffee grounds.

### FLOW OF FOOD WASTE

AS ESTIMATED FROM THE FOOD WASTE DIARIES AND UP-SCALED TO AUSTRIA

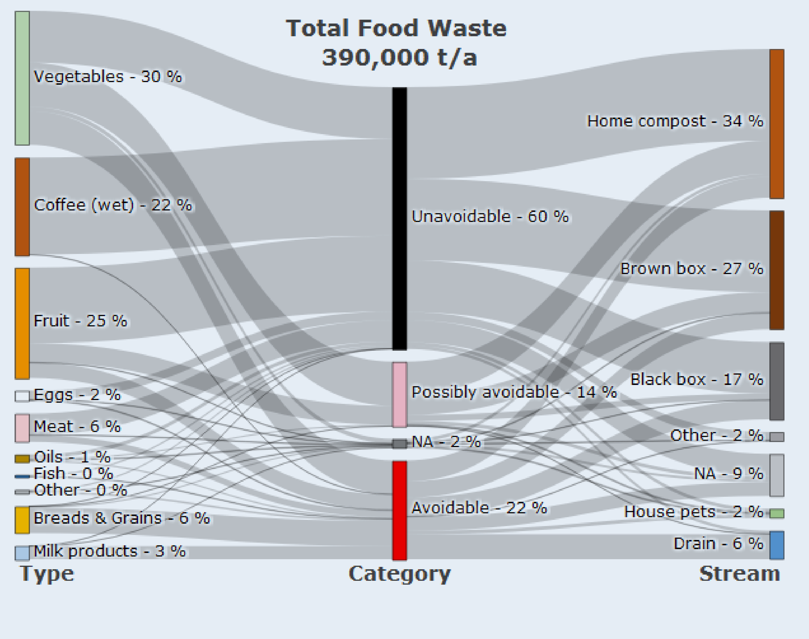


FIGURE 2
SANKEY DIAGRAM OF THE FLOW OF FOOD WASTE AS ESTIMATED FROM THE FOOD WASTE DIARIES AND UP-SCALED TO AUSTRIA.
THE PERCENTAGE SUM OF EACH NODE MAY NOT EQUAL 100% DUE TO ROUND-OFF ERRORS.

### ESTIMATION OF POTENTIAL SAVINGS OF GREENHOUSE GAS EMISSIONS FROM AVOIDABLE FOOD WASTE

We estimate that there is the potential to save 130,000 ± 25,000 t CO2e/a due to avoidable food waste (**Figure 3**). This represents about 0.2% of Austria's national inventory and 1.0% of Austria's total consumption-based emissions for food [7]. A reason that the emissions are such a small proportion of the total consumption-based emissions is that foods with high emission factors (i.e. meat and milk products) are the foods that are the least likely to be wasted.

#### GHG EMISSIONS FROM THE PRODUCTION OF AVOIDABLE FOOD WASTE BY FOOD TYPE

130,000 ± 25,000 t CO2e/a

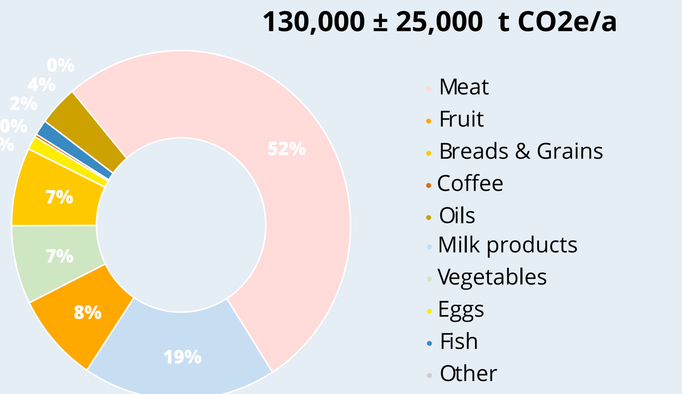


FIGURE 3
THE ESTIMATE OF THE GREENHOUSE GAS EMISSIONS FROM THE PRODUCTION OF AVOIDABLE FOOD WASTE BY FOOD TYPE.
Coffee = coffee grounds and tea bags. Other = coffee, tea and other liquids, that are not juices, which were not consumed. They are assumed to be mostly water.

#### GHG EMISSIONS FROM THE DISPOSAL OF AVOIDABLE FOOD WASTE BY WASTE STREAM

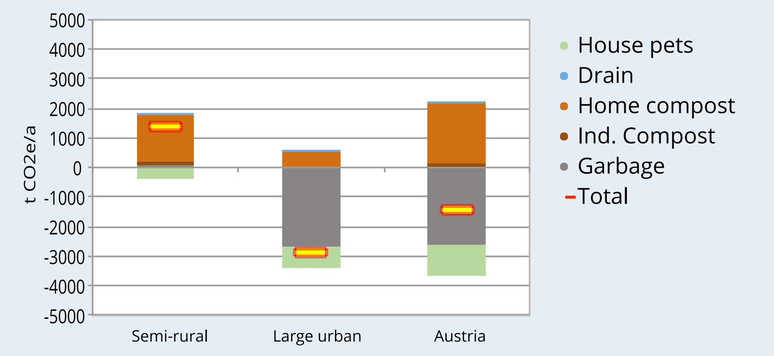


FIGURE 4
THE ESTIMATE OF THE GREENHOUSE GAS EMISSIONS FROM THE DISPOSAL OF AVOIDABLE FOOD WASTE BY WASTE STREAM

**Figure 4** displays our estimate for downstream emissions from avoidable food waste. They are small: in semi-rural Austria about 1,400 t CO2e / a; and in large urban areas, the emissions are actually negative (i.e. saves emissions) due to the practice of waste combustion for energy. In total, disposal of avoidable food waste saves about 1,500 t CO2e/a.

### ESTIMATION OF GREENHOUSE GAS EMISSIONS SAVED FROM THE FOOD SHARING INITIATIVE

TThe food sharing initiative is in its infancy and it "shared" 788 t of avoidable food waste in 2017. This is about 0.5% of the estimated total amount of avoidable and possibly avoidable food waste in Austria. The food sharing initiative does not estimate the amount of meat separately. Instead, they know an approximate amount of ready-made meals from stores and meals from restaurants. We have assumed that these are composed of meat (30%) and vegetables (70%).

The amount of greenhouse gases saved from the production of the shared waste by food type is shown in **Figure 4**. At 590 t CO2e/a, the shares by food type are about the same as in the national estimate (**Figure 3**). The food sharing initiative has caused an increase in emissions by about 16 t CO2e/a.

#### GHG EMISSIONS SAVED FROM THE PRODUCTION OF "SHARED" FOOD WASTE BY FOOD TYPE

590 t CO2e/a

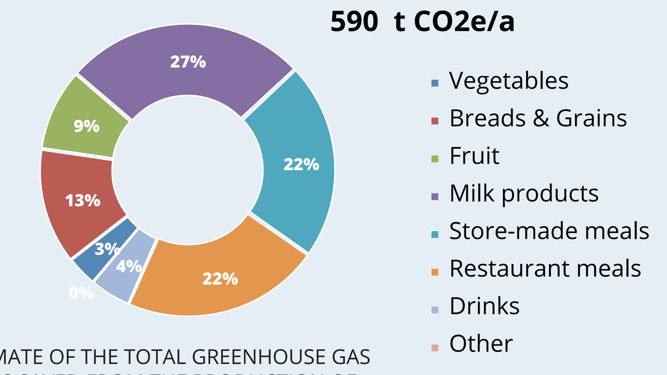


FIGURE 5
THE ESTIMATE OF THE TOTAL GREENHOUSE GAS EMISSIONS SAVED FROM THE PRODUCTION OF "SHARED" FOOD WASTE BY FOOD TYPE

## CONCLUSIONS

The food waste diaries have provided a new detailed The food waste diaries have provided a new detailed estimate of the amount of food waste by food type, category and method of disposal. The survey was small and the sample was not selected based on the distribution of population by state and location (urban versus non-urban), hence the results may not be representative of the country as a whole. Nevertheless, value experience in the design of food diaries has been gained. The total amount of food waste is very close to other estimates, which suggests the food waste diary method has merit.

Since 2003, Austria has modernised its waste disposal system to reduce greenhouse gas emissions and develop waste as a source of value (compost and energy). Hence, reducing food waste means less compost and energy are produced and this shortfall increases greenhouse gas emissions downstream (using the LCA accounting convention of a credit for by-products). However, if reducing food waste means that less food is produced, then there is potential for saving emissions upstream. The upstream emissions saved are two orders of magnitude larger than the increase in emissions downstream.

Nevertheless the savings are modest, since the amounts of avoidable or possibly avoidable food waste are small (roughly 40% of total food waste) and the type of food wasted tends to be bread and grains, fruit and vegetables, which have lower emission factors during production.

The food sharing initiative is very much in its infancy, and has large room for expansion as barriers (e.g. logistics, social acceptance) are overcome.

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