GLOBAL UNIVERSITY CLIMATE FORUM

KØBENHAVNS UNIVERSITET

Climate conscious canteen pricing for consumer-driven change

A sustainability plan based on awareness and economic incentive

Project report

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University of Copenhagen
Global University Climate Forum
June 3, 2021

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Executive Summary. Catering businesses are increasingly in need of innovative sustainability solutions in order to reduce their climate footprint. Consumers exhibit a growing readiness to eat more sustainably. In this report, we present an actionable plan to reduce greenhouse gas emissions in buffet-style canteens. Focusing on simplicity and economic stability, the goal is to incentivize a consumer-driven shift towards low-emission food choices, combining carbon pricing with increased climate awareness. The idea was developed as part of the Global University Climate Forum, in which we participated as a student team of the University of Copenhagen. Motivated by the wide interest in our project, we here describe our experience so far and outline a roadmap for further implementation.

Contents

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1 Introduction

Food constitutes a large share of humanity's greenhouse gas emissions [1, 2]. Therefore, what we eat becomes a crucial factor in fighting the climate crisis, both individually and on a systemic level. Companies and institutions around the world have entered the race towards climate-neutrality, which demands innovative sustainability strategies. In particular, catering suppliers are increasingly in need of climate-friendly dining solutions, both due to policy changes and a shift in consumer demands towards more sustainable products [3].

We, five students of the University of Copenhagen, have addressed this issue by asking: how can we lower greenhouse gas emissions in our university canteens through a consumer-driven change in dietary preferences? As participants in the Global University Climate Forum 2020/2021, we developed an actionable plan that we presented to the university and canteen company. The key idea is to combine a climate-conscious pricing scheme with consumer awareness of the carbon footprint of foods. We envision a pilot project to investigate how awareness and economic incentive impact consumer behavior; a shift towards low-carbon food options would demonstrate that our concept is a valid approach to make canteens more sustainable.

Due to the prolonged lockdown in Denmark related to the COVID-19 pandemic, we could not implement our project within the time frame of the Forum, despite positive resonance from university and canteen collaborators. Given the wide interest in our idea, we nonetheless believe in its potential to be successfully implemented in the future. This report outlines the vision and details of our proposal. We hope that it may serve as a source of inspiration and further action for engaged students, university initiatives, and food professionals.

2 Yes we canteen! – Our story

The journey began in September 2020 with a dinner conversation in our student dorm in Copenhagen. A call for applications to the *Global University Climate Forum*, which we spotted on our university website, triggered a brainstorming session on how we could contribute to a more sustainable campus. Recognizing food choices as one of the most impactful and direct ways for students to reduce their individual climate footprint, we decided to focus on the canteens.

The Global University Climate Forum is a world-wide program for engaged students to learn about, share, and implement climate action [4]. Hosted by the International Alliance of Research Universities, it connects 134 teams from 44 countries who were selected based on their submitted project proposals. After a week of expert talks and interactive workshops in November 2020, the teams launched their projects in December. The official time frame of the Forum ended in May 2021.

Team photo for the Global University Climate Forum. From left to right: Reyk, Erik, Michelle, Ognjen, and Pihla.

Team "*Yes we canteen*" consists of five full-degree master students from different study programs at the University of Copenhagen, Denmark: *Reyk*, Master of Science in Physics, from Germany; *Erik*, Master of Science in Geoinformatics, from the United States; *Michelle*, Master of Science in Biotechnology, from New Zealand; *Ognjen*, Master of Science in Computer Science, from Serbia; and *Pihla*, Master of Science in Pharmaceutical Sciences, from Finland. The project was formally

supervised by Jørgen Dejgård Jensen, professor at the Department of Food and Resource Economics.

3 Sustainability plan for low-carbon canteens

Primarily, this document proposes a plan for climate action at universities by introducing a collaboration project between engaged students, the canteen catering company, and the university. At the same time, the underlying idea may easily be applied to canteens in other contexts, and may be interesting for catering companies serving a range of venues and institutions. We thus attempt to keep the following description general while also discussing the specific case of our university canteen project.

3.1 Project philosophy & goals

We propose a canteen system where consumers can make active and informed food choices based on awareness of the food's carbon footprint, and where low-carbon choices are economically rewarded. This approach is inspired by carbon pricing as a widely used instrument to reduce greenhouse gas (GHG) emissions.

Currently, most of the larger canteens at our university offer food as a buffet. Students and staff load their plate with dishes of their choice and proceed to payment at self-service counters, where the final food price is determined by total weight. While this system scores with convenience, we argue that it has two major flaws with respect to sustainability. Firstly, it is bad for the climate; and secondly, it puts students acting climate-consciously at a disadvantage.

Buffet-style canteens, where food is uniformly priced by weight, also exist at other universities and institutions. Often, consumers develop the following rationale: "I get the best value for money if I take a lot of those foods that are normally expensive, and avoid fillers such as potatoes or cooked vegetables." Since those normally expensive dishes often correlate with a relatively high carbon footprint, there is an incentive to choose foods with a comparatively high climate impact. Consequently, consumers who actively select climate-friendly options may end up paying a high price for the value they get, essentially subsidizing consumers with high GHG emission food choices.

One option to reduce GHG emissions in canteens is to offer less meat dishes, or to exclude meat dishes altogether, e.g. on so-called meat-free days. However, this approach removes the free choice of the consumer, which could lead to lower acceptance. In contrast to enforcing sustainability, we want to encourage it. With our system, students and staff will be motivated and rewarded for adapting their every day food choices, while retaining their dietary freedom. Combining economic incentive with climate awareness, we anticipate that this will ensure high acceptance and support a lasting transformation in consumer behavior.

Students belong to a generation that will be strongly affected by climate change. Thus, many students are highly perceptive of the issue and show great willingness to adapt. At the same time, we observe that the connection between food and climate is still a rather new topic for many. We see this as a very promising basis to involve the consumer and achieve change through shared knowledge [5].

Our goal is to achieve a user-driven change in food consumption patterns in the canteen with a shift towards lower emission food. This shift will demonstrate that our system is a valid approach for institutions to take in reducing their footprint. A stable shift in consumption patterns will prompt the catering company to change their food orders accordingly, thereby saving carbon dioxide equivalent

(CO_2e) emissions[2] as a business. Students will reduce their individual carbon footprint on campus in a way that benefits them. We envision that a conscious change in food choices will expand beyond the canteen, as consumers will carry their changed habits to their homes and into society. Additionally, the goal is to learn more about which sustainability strategies work best, and how awareness and incentive interplay to drive change.

Of course, the implementation of our idea has to be feasible both for the catering company and the consumers. Therefore, the proposition described in the following sections is guided by the principles of simplicity, user-friendliness, and economic stability for the business.

3.2 Value proposition

Our project offers value to all three parties involved: the catering company, the university or institution which employs the caterer, as well as the students or consumers in general.

Canteen suppliers in Denmark and worldwide are increasingly committed to making their business more sustainable. Proposed and implemented strategies include waste management, circular economy approaches, more prominent placement of vegetarian or vegan options, reduced meat servings, and eco-labeling of dishes [6, 7, 8, 9]. However, in order to reach carbon neutrality of the catered institutions, further innovative ideas and actions are in high demand. Our proposal offers a flexible solution approach that minimizes effort and maximizes user friendliness while ensuring constant revenue. The system can be adapted to the existing payment infrastructure. Under successful implementation, the canteen reduces CO_2e emissions with a potential for associated cost savings. The data analysis described below can also improve the monitoring and optimization of canteen operations. Lastly, hosting this project would help the business position itself as a green, innovative, and climate-just business.

The University of Copenhagen has recently updated its sustainability strategy, aiming to become one of the greenest campuses world-wide. Many universities and institutions around the globe pursue similar ambitions. To achieve these targets, we believe that the food offered on site is a crucial factor with high emissions savings potential. In line with our university's green goals, our pilot project would offer an exciting testing ground to compare different policy mechanisms, contributing to the institution's position as a leader in innovation and research. Generally, we are convinced that universities should encourage and invest in student-led climate initiatives as much as possible.

The benefit for consumers has already been highlighted in the previous section. In summary, consumers retain free choice and can save money by selecting climate-friendly options. They also get the opportunity to educate themselves in an every-day setting about the climate impact of their every day choices, information which is currently difficult to obtain.

3.3 Key requirements

The path from idea to realization is not easy and often requires a lot of intermediate steps. There are certain key requirements that are crucial for our plan to be successfully executed. In this section we simply list these requirements; the following sections describe in which way they are met.

[2] Carbon dioxide equivalent, or CO_2e, is a measure of global warming potential scaled to the warming potential of carbon dioxide (CO_2). In addition to a product's CO_2 emissions, it includes other greenhouse gas emissions such as methane and translates their climate effect into the corresponding amount of CO_2 that would have the equivalent effect. Thus, considering CO_2e emissions is a more complete way of quantifying a climate footprint.

First of all, it is necessary that both the canteen and the university or other institution are willing to cooperate and help facilitate pilot testing. To create a carbon inventory and to make the pricing scheme work, we require access to operational data from the caterer. Specifically, we would at least need food order data resolving the quantity (in kilograms) of the purchased raw ingredients and food items. Recipes of selected dishes are essential to calculate their carbon footprint. Here the recipes should ideally include the quantities or proportions of ingredients.

Optionally, it would be helpful to have additional information about the purchased food, such as country of origin, seasonality, and food standard (organic/not organic). As a general rule, a higher quality and detail of available data corresponds to more accurate carbon footprint estimates. Particularly the region of origin can play a large role for the carbon footprint, and ignoring these differences might render the estimates rather crude. However, we stress that for the purpose of this project, the goal is not to precisely compute GHG emissions but rather to obtain an approximate ranking of different dishes.

Implementing our pricing system as described furthermore requires modifications of the buffet layout and payment infrastructure (more details below). If the system is to be implemented permanently after successful pilot testing, the pricing needs to be updated whenever the offered dishes or the consumption patterns change. The updated prices would be calculated based on the canteen order data using our algorithm, which we explain below.

3.4 From concept to implementation

After describing our vision and requirements, we now go into detail to show how our project would work in practice at our university canteen. Again, we try to keep the concept general such that it becomes easy to transfer the ideas to other canteens.

Pricing scheme. At the core our our incentive system lies a rearrangement of the canteen food setup in order to enable climate-conscious pricing for buffet-style canteens.[3] The concept is simple: based on their lifecycle carbon dioxide equivalent (CO_2e) emissions per kilogram, we group foods in three categories (low/green – medium/yellow – high/red), where each category has an individual price per weight. Instead of a single price for all, we thus have three prices. This requires an adjustment of the payment system such that it remains convenient for students to use.

One idea would be that students weigh their plate after each category and scan their university ID card so that system can keep track of how much food has been taken from each category. At the last checkpoint, students can scan their ID cards for the final price that is calculated by the system. The system would also give an estimate of the CO_2e emissions for the meal and students could inform themselves on their carbon footprint. A simpler but less precise procedure would be that consumers only weigh their plate at the end, but indicate (e.g. on a touchscreen, which already exists in our canteen) from which categories they have selected food. Then, there could again be three prices per weight (food from green category only; green and yellow categories only; some food from red category). In the end, the best solution depends on the existing infrastructure and the level of automation of the payment process, as well as the canteen's willingness to invest in software changes.

In order to define the three food categories and determine their prices, we have devised a simple algorithm (see figure 1). It calculates the CO_2 equivalent per kilogram for each dish on the given day by

[3] Even if food is not offered as a buffet, the carbon footprint of dishes may still be displayed and reflected in the price; in this case the payment system would not even require modifications.

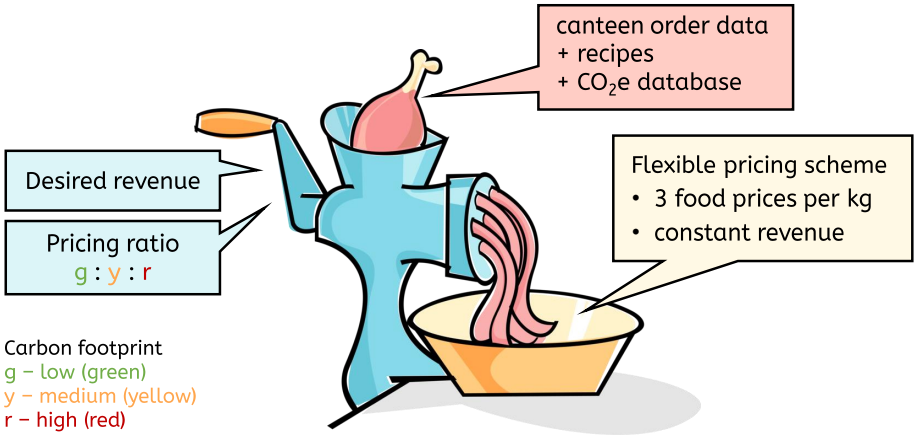

Figure 1: Our pricing scheme works like a meat grinder. The caterer prescribes a desired total revenue R as well as the ratios of the prices g, y, and r (fineness of the minced meat). Based on canteen operational data combined with a suitable food database of CO_2 equivalents (the incoming raw chunk of meat), the algorithm calculates the three different food prices g, y, and r that ensure the desired revenue (the outgoing minced meat). Meat grinder drawing designed by Wannapik.

taking into consideration the carbon footprint of each ingredient in the recipe. The CO_2e emissions for each ingredient would be calculated based on a suitable food database, for example *Den store klimadatabase* [10]. The dish itself would then be labeled into green, yellow or red accordingly, where the caterer decides on the threshold CO_2e value between green/yellow and yellow/red. Optionally, the system would keep track of consumption and waste data of different dishes in each category, and the daily menu could be further improved by running machine learning algorithms on collected data. This analysis, which could be part of a student project, would predict patterns of food consumption and help optimize future food orders. This way, not only the increased cost of high-emissions options subsidizes the reduced cost of dishes with lower climate footprints, but food waste is also reduced.

Once the food categories are defined, our algorithm determines the three prices under the condition that the canteen's revenue stream remains constant. The current revenue stream (R) can be described by the following equation:

$$R = p \cdot M - C\,,$$

where p is current price per kilogram, M is the total food mass consumed and C represents the total expenses of the canteen. With the implementation of our system, the new revenue stream (R') would be governed by the equation

$$R' = g \cdot M_g + y \cdot M_y + r \cdot M_r - C\,,$$

Where g, y and r correspond to the price per kilogram of the green, yellow and red category, respectively. Similarly, M_g, M_y and M_r correspond to total food mass consumed of the green, yellow and red category, respectively. For simplicity we have assumed that the expenses C remain unchanged. The different prices in the two equations are connected by the fact that the masses of the three categories add up to the total food mass,

$$M = M_g + M_y + M_r\,.$$

We now introduce the two price ratios $a = y/g$ and $b = r/g$. For example, setting $a = 1.2$ and $b = 1.5$ would mean that the yellow category is 20% more expensive than the green category, while red is 50% more expensive than green. Once these ratios are set, the prices g, y, and r can be calculated for a given M_g, M_y, M_r, and C such that the new revenue stream R' is the same as the old revenue stream R.

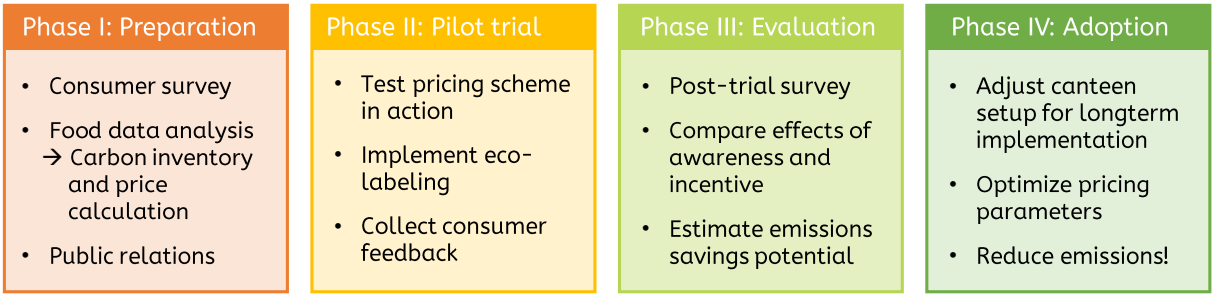

Figure 2: Exemplary timeline from idea to realization.

Under implementation of a more sophisticated system that incorporates machine learning algorithms for prediction of supply and demand, canteens could end up with a positive difference in the revenue stream which could be used to lower the prices of green and yellow food categories. The optimization of the algorithm naturally depends on the quality of the available data and on how frequently the prices are adjusted.

Eco-labeling. A great side-product of the above analysis is that the caterer will have a carbon inventory of the dishes they offer. This information can be used to raise awareness among the consumers, by putting the carbon footprint of foods on display. For instance, one could place little signs or labels next to each dish, stating the CO_2e emissions per kilogram. The eco-labeling could be supplemented with informative posters at the canteen entrance. Similar approaches are recently being explored at the University of Oxford, UK [11].

Pilot testing. Since the COVID-19 pandemic interrupted the implementation of our project on campus, we could so far not verify all important assumptions. This uncertainty is associated with certain risks for the success of our plan. We therefore suggest to first test our system in a pilot trial, perhaps lasting one to two weeks. Pre- and post-pilot surveys of canteen customers and the caterer can indicate the suitability of our project for long-trem implementation. In figure 2, we illustrate a possible timeline for pilot testing. The next section addresses open assumption, potential risks and associated solutions.

3.5 Assumptions, risks and solutions

Our sustainability plan depends upon the following core assumptions.

1. Under an appropriate choice of pricing ratios and labeling of the foods' carbon footprint, a significant fraction of consumers will shift their dietary choices towards a larger share of low-carbon food options – either because of their awareness or the economic incentive, or both. Some customers will still choose dishes from the yellow and red sections, subsidizing the low price of the green section.
2. The shift towards more low-carbon food options is temporally stable, allowing the canteen to modify their food orders and reduce GHG emissions.
3. Free choice, combined with the sustainability reward due to climate-conscious pricing, leads to high consumer acceptance of the proposed system, even if the payment process takes a few extra seconds compared to the payment model with one uniform food price per weight.

4. The caterer is collecting the operational data (see section 3.3) needed to compile a carbon inventory and calculate the food category prices. Unless the analysis is conducted internally, the caterer will make this data available to the external group (e.g. student team) that shall perform the analysis.
5. The caterer or institution is willing to cooperate in implementing the project, specifically by adapting the buffet layout and payment process to fit the new pricing system (under consideration of the existing infrastructure to minimize cost and effort).
6. There exists a database of CO_2 equivalents of food for the location (country or state) of the institution, which provides information of sufficient quality on the food ingredients used by the caterer.

The first assumption poses an interesting research question in itself; it seems unknown how awareness or carbon pricing, or a combination, would impact consumer behavior in the context of canteen dining. Based on previous research (e.g. [11, 12]), we find it likely that the anticipated dietary shift will occur. Tuning the pricing ratios may steer the magnitude of the shift, which should be investigated in a test phase. But even if the first two assumptions fail the reality check, the consequences for the canteen would be mild, because the revenue from food sales is designed to remain stable. The worst case scenario is that consumers show no intent to eat more sustainably despite the incentive,[4] in which case returning to the old pricing system is a possible option. This scenario would show that our approach is ineffective to reduce canteen GHG emissions, but it would not jeopardize the canteen business overall. Although some efforts would have turned out fruitless, the caterer would still be left with the data analysis of its food-related carbon footprint, which in any case could be very valuable for further sustainability endeavors.

In the hypothetical case where nobody chooses food from the red category anymore, we encounter the paradoxical situation where the incentive works so well that the price of the green category must increase again (due to the absence of subsidies from the red category). This should not play a relevant role in practice and would be balanced by the fact that foods within the green category typically also cost the canteen less.

Regarding the third assumption, we believe that for a majority of customers, the benefits of a sustainability rewarding canteen can outweigh the downside of a slightly more involved payment procedure. At fast food restaurants for instance, diners often have to navigate through a multitude of options when ordering on self-service machines, and this does not seem to scare customers away. Pre-implementation consumer surveys can provide an estimate of expectable acceptance. Should the new payment system however receive too little acceptance, a fallback alternative would be to focus only on the awareness part, i.e. display the carbon footprint of dishes without having different price categories. In principle, increased consumer awareness alone could trigger a shift towards more sustainable dining behavior [11].

Assumptions four and five are general essential requirements. In the case of our university canteen, communication with the canteen contract manager has already revealed the caterer's interest in collaboration and a willingness to share operational data (see also section 4). This makes us optimistic that these assumptions can be affirmed.

Finally, pertaining to the sixth assumption, we know that CO_2e databases for food now exist specifically for Denmark [10]. In response to a high demand for carbon inventories, such databases become increasingly available and sophisticated.

[4] Note that even if there is no measurable shift in dining choices, the climate-conscious pricing would be more fair compared to a one-price-for-all model; "red" consumers would pay more than "green" consumers, accounting for the fact that foods in the red category have the highest environmental cost for society.

Strengths	**Weaknesses**
– Flexible design, simple adaptable concept – CO_2 emissions, cost, & waste savings potential – Revenue control for economic stability – Consumer-driven sustainability – Innovative and climate-just business	– Requires modification of payment system – Payment process may take slightly longer – Analysis effort increases with diversity of offered dishes & complexity of recipes
Opportunities	**Threats**
– High demand for sustainability solutions – Readiness of consumers to change food habits – Uni campus as a laboratory for green ideas – Room for further optimization of business – Co-beneficial use of student skills/capacities	– Competing approaches, e.g. meat-free days – Consumers may prefer one-price-for-all – Caterer not willing to invest time/resources – Insufficient quality of data/database

Table 1: SWOT analysis

Table 1 shows a SWOT analysis (Strengths - Weaknesses - Opportunities - Threats) for our plan. Strengths and weaknesses relate to the proposed system itself, while opportunities and threats put the plan in perspective with external factors.

4 Accomplishments

More than initially expected, the progress of our project was impaired by the COVID-19 lockdown in Denmark, which was extended several times throughout the time frame of the Forum. Nonetheless, we made promising contacts with the university and catering company, which allows continuation once the canteens reopen. We were especially successful in sharing our idea with stakeholders and in gaining wide media interest regionally and internationally.

In November 2020, our first step was to contact the Green Campus office of our university administration. Apart from concerns related to the current lockdown, the Green Campus team leader responded positively to our initiative and referred us to the canteen contract manager of the SCIENCE faculty, who is responsible for collaboration with the catering company. The contract manager seemed highly interested in our project and was very helpful with establishing contact with the operations manager of the canteen company, *Compass Group FS*. We learned that the caterer is already planning to implement more sustainability practices, which offered a basis for joining forces. Furthermore, the caterer indicated that it would be possible for us to access their food order data – an important requirement for creating a carbon inventory.

Unfortunately, in December, just when we had scheduled an online meeting with both contacts to discuss next steps, Denmark tightened the lockdown, forcing the canteen manager to go on leave. This situation persisted throughout the remaining time frame of the Forum and made it impossible to specify further plans. In the meantime, we conducted research on suitable CO_2e databases and developed the mathematical basis of the pricing scheme.

While we could not proceed with implementation, we received surprisingly wide interest in our idea. The University of Copenhagen press approached us for an interview, which resulted in a news article published in January 2021 on the university website [13]. This article has been re-posted by several news outlets in Denmark, China, and New Zealand. Furthermore, the article brought our project to the attention of *Kost og Ernæringsforbundet* [14], a Danish union for food and nutrition. In April, we met online with the editor of the union's magazine to discuss our ideas and experiences. It was great

to hear that our concept could also be relevant for their readership of food professionals, and the meeting concluded with the prospect of a magazine piece following the completion of this report.

Participating in the Global University Climate Forum also connected us with other student-led sustainability initiatives. In January, we were asked by MIT Denmark, a collaboration program between the Massachusetts Institute of Technology and Denmark, to pitch our idea to participants of their *Green Campus Challenge* [15]. We created a short inspirational video that was shared with student groups competing in the challenge.[5]

Monthly progress reports were submitted to the organizers of the Global University Climate Forum, ending with a short final report in May. According to the Forum, the proposals and monthly updates of participating groups will be featured in a publication to be issued at the next climate conference (COP26) of the *UN Framework Convention on Climate Change* in Glasgow, UK [16].

5 Outlook & Conclusion

According to a survey by *Kost og Ernæringsforbundet*, 57 percent of leaders in Danish public kitchens say that more knowledge is needed to make their food services more sustainable [3]. This fits to the main lesson learned from our participation in the Global University Climate Forum: there is a demand for our solution, from catering companies to university administrations and fellow students. Throughout the past months, the COVID-19 pandemic has been very challenging, both for our project and for the food service industry in general. It is unfortunate that the mandatory leave of the caterer prevented any concrete future planning. But now that public life in Denmark has a perspective of re-opening, a major obstacle for the implementation of our project may soon disappear – while the urgency for climate action is greater than ever.

Therefore, we have strived to lay a solid foundation for a successful future of our project. Since the current team members will soon graduate, we hope that this work provides a guiding roadmap and inspiration for the next generation of engaged students at University of Copenhagen and beyond. Likewise, we hope to have convinced caterers of the value our plan could add to their business.

Uncertainties and risks of implementation may best be addressed with a pilot trial, where consumer surveys are collected and the new system is tested for a limited time period. In addition to providing crucial information for further steps, such a pilot project would offer an exciting testing ground for open research questions [17]: is increased awareness of the climate impact of foods sufficient to change people's consumption behavior? Or is economic incentive essential to induce a significant shift? How large should the price difference between the green and the red category be?

We believe that university canteens are ideal locations to explore these questions. Firstly, in a consumer role, students largely care about the climate crisis and are comparatively open to changing their habits. Secondly, many students are highly motivated to apply their skills to climate action. Students with experience in data science, for instance, can help catering companies measure their food-related GHG emissions and identify optimization potential. In turn, such work could be recognized as a project in practice for the students. Third, we think that universities as sites of learning should use their campus as a laboratory to innovate sustainable solutions. As an example, our free incentive-based model could be compared to the more regulatory alternative of "meat-free Wednesdays", an initiative that has previously been implemented at our university [8].

In our project, we have developed an actionable sustainability solution for buffet-style canteens, focusing on the specific case of our university canteen. However, the underlying concept is flexible

[5] Contact us (yeswecanteen@posteo.net) for a copy of the short video.

and can easily be adapted to other systems. Ideally, the impact of a consumer-driven shift will spread beyond the canteen, when consumers carry their sustainable habits home and into society. Global change is composed of the uncountable small steps of uncountable communities and individuals. Our hope is to have contributed one of these steps with our work as team *Yes we canteen!*

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