Combining carbon footprinting, monitoring, feedback, and rewards for a broad spectrum reduction of household induced greenhouse gas emissions

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Abstract

The study reported in this article (named CLIMATE BONUS) concerns the combined use of verified carbon footprints (possibly visualised through labels), personalised monitoring and feedback services to households regarding the greenhouse gas intensities of their purchases, and a reward system (bonuses) for consumers who manage to reduce the embodied emissions. The study assesses the accuracy and verification requirements and the harmonisation needs for the various information systems and their interfaces. This should culminate in a data strategy, in which a data acquisition, generation and co-ordination strategy and a data quality assurance strategy will be developed. Equally important, the study also assesses, via an own pilot, what the response of households (as consumers) can amount to and how the responsiveness to various incentives can be rated.

The paper provides an outline of the intended system, including its rationale. Subsequently, the paper focuses on the consumer pilot and the feedback from the participants. It also provides a brief impression of the expected overall economic effectiveness of the system.

Introduction

Although at the moment of writing the results of the UNFCCC Copenhagen meeting are still quite unsure, we regard it as wise to assume that a long period of steadily tightening greenhouse gas (GHG) emission reduction targets lies in front of Western nations and increasingly also for other nations. Reduction of GHG emissions in energy- and material intensive industries will remain very important. Yet, when household consumption is not addressed, aggregate demand for energy and material intensive products and services could be curbed insufficiently if at all. Therefore we expect that consumers will have to take on a bigger role in upcoming emission reduction strategies. There are already concrete signs of this, with energy efficiency policies for housing and appliances tightening in many countries (European Commission 2008; IEA/OECD, 2007) and the growing attention for promoting energy efficiency of newly bought passenger cars (emission related tax differentiations in the UK, the Netherlands, and Finland; old car scrapping premium in Germany).

The consequence of not seriously engaging the private consumer in future emission reduction efforts would be either an extremely ambitious and costly attempt to achieve extremely low emission intensities in heavy industries and thereby risking to boost 'carbon leakage' towards countries with less tight climate policy regimes or to fail to achieve substantial aggregate emission reductions (Homma, 2008; Peters, 2008).

Standard economic policy instruments, such as emission and fuel taxes, and green investment subsidies, may have limited effects either because the price signal does not effectively reach the buyer of the final product, which embodies the emissions, and/or other considerations dominate the decision making (for a given level of tax or subsidy) (Geller and Attali, 2005; Parry and Williams, 1999). Last but not least taxes may already be high, as is the case for transport fuels, and consequently further increases are relatively ineffective (Perrels, 2000). Therefore, next to redressing and reinforcing existing instruments

the adequate involvement of household consumption requires new instruments that combine information provision, market transparency, positive feedback, and the spurring of the market entry of low emission alternatives. In the next sections will be explained why the *combination* of features is important.

The envisaged emission reductions entail in fact fundamental changes in the production-consumption systems as we know them, often referred to as 'sustainable transition' (e.g. Tukker et al, 2008). There is an emerging literature around transition processes (e.g. Kemp and Rotmans, 2005, Rotmans, 2006), which stresses that a lot of facilitating frameworks and processes are needed ion order to get such a fundamental change going. The comprehensiveness of the change and its timeframe, make detailed (long term) planning less useful, as long as there is an agreement on main goals and targets. On the other hand there seems to be growing need for information and co-ordination facilities. Also Stern (2007) stresses the importance of the transition process, notably in connection with technology transfer and continued innovation. The combined carbon footprinting, monitoring, and feedback system envisaged in the CLIMATE BONUS study (see next section) can also be regarded as a form of implementation of the transition facilitation process.

The paper is built up as follows. After outlining the CLIMATE BONUS study the paper continues with explaining why a particular combination of measures has been selected - within a voluntary – gradually expanding – framework instead of a national system of personal carbon credits as was considered in the UK (e.g. Defra, 2008). This is followed by a discussion of the scope of products, which is currently covered by the CLIMATE BONUS system and the possible extensions of that scope. The current and future scope of reported effects is also discussed. Subsequently some impressions are provided about the pilot study. The paper concludes with a preliminary reflection based on first results. A separate text box explains the concept of (various quality levels of) carbon footprints.

The project in brief

The key purpose of the project CLIMATE BONUS, in which five Finnish research institutes[1] co-operate, is to assess the possibilities and effectiveness of a combined feedback and bonus[2] system for households, which incites them to consume in such a way that greenhouse gas (GHG) emission are reduced and incites retailers to offer a product portfolio that advances the choice for low GHG solutions by households. The principal product groups involved are foodstuffs, home energy, transport fuels and transport services, with special reference to foodstuffs. So far, other product groups (than the aforementioned ones) are included at a superficial level.

In order to enable a properly functioning and credible monitoring and bonus system the development of the underlying information system is indispensable. In this context appropriateness and credibility mean that the data system[3]:

- has a meaningful coverage of products and product groups, such that a sufficiently large and commercially feasible emission reduction potential is addressed
- is transparent regarding origin of data, accuracy levels of resulting carbon footprints, and tractability of calculation procedures (i.e. tractable for 3rd party verifiers)
- enables and encourages to steadily increase the number of products for which accurate product specific carbon footprint assessments have been carried out

A comprehensive product specific carbon footprinting system has to be established, including verification, common calculation rules, and updating facilities (e.g. Carbon Trust. 2006; see the Text Box). At the consumer side product and purchase information, including carbon footprints, as well as a user friendly monitoring system for the cumulated embodied emissions of consumer purchases should be available. This system should also be able to inform on the acquired rewards (bonus points), earned on the basis of a reduction in embodied emissions as compared to a reference level. One of the challenging features of the envisaged system is that right from the start it should be able to provide consumers with emission information of a sufficiently wide range of product groups, whereas the generation of product specific carbon footprints develops stepwise. This necessitates that different levels of precision and hence different levels of allowable product comparison are handled within one system. The motivation to cover a wide range of product groups right from the start is based on the prospect that otherwise the observed changes in the monitoring system will often be very small[4] (Perrels et al, 2008). Eventually this goes back to the theory of mental accounting (e.g. Thaler, 1999).

In addition to rewarding consumers for achieving reductions in the emissions embodied in their quarterly or annual purchases, new low emission product alternatives could be endowed with temporary product specific bonuses in order to spur customers to reconsider their choices. Furthermore, it could be considered to add a bonus system at the supply side, such that retailers or product chains can receive a bonus (i.e. via fiscal mechanisms) in case they have been very successful in mediating emission reduction bonuses to households. The latter idea, even though not elaborated to date, would reinforce the innovation incitement effect which the overall system is supposed to engender. In the study phases reported in this article only a simplified bonus system related to the development of the emission intensity of recorded purchases was included in a consumer pilot (see also next sections). Other aspects of reward systems and reward systems for producers were to some

1. Government Institute for Economic Research VATT (coordinator), Technical Research Centre of Finland VTT, Finnish Environmental Institute SYKE, Agrofood Research Finland MTT, National Consumer Research Centre KTK; Furthermore, the following companies participate in the project: Kesko (retail group), Nokia, Stora-Enso (paper/timber/packaging), Elisa (telecommunication), HK Ruokatalo (food processing), Tuulia International (software solutions). TEKES (Finnish Funding Agency for Technology and Innovation) is the main financier of the project. See: http://extranet.vatt.fi/climatebonus/

2. Bonus (card) systems, also known as loyalty card system, are typically run by retail chains. Rewards can be given as points (convertible into money within the same chain), but can also be given in the form of rebates or in the form of entitlements to extra services or special products. The granting of bonuses is usually based on purchase behaviour (e.g. the more expenses the more points).

3. It goes beyond the scope of the current article to discuss these principles at length. The interested reader is referred to Usva et al (2009) and Perrels et al (2009a).

4. The relevance of that concern was indeed corroborated in the pilot phase of the study. See also later sections of this paper.

Text Box – Carbon footprinting in a nutshell[5]

The carbon footprint of a product tells how much greenhouse gas emissions the production of that item has caused, including the preceding production steps. In case of food it concerns the stages of production of supplies to agriculture (e.g. fertilizer), agriculture, food processing, transport between production stages, production of packaging material and packaging, warehousing, retailing, etc. Recycling of side products and reject material, as well as the occurrence of joint production phases will complicate calculations due to (calculatory) negative flows and/or necessary allocation of jointly caused emissions over products downstream. In case of for example vegetables and fruit seasonal variations in the input of energy can be very substantial, whereas also the country or region of origin has often large implications for the size of the carbon footprint and its breakdown by production stage.

Roughly speaking carbon footprints can be distinguished in two categories. The first are the indicative product category level footprints or rather carbon intensity indicators which are for example used in connection with green bank and credit cards, and in calculators for web based carbon compensation services. In some cases these figures are based on input-output tables (which can give carbon intensities per value added at sector level), in other cases on simplified technical simulations (such as for air travel) and in the most fortunate cases on a mixture of LCA models and detailed input-output tables. This kind of footprints can be updated on an annual basis – at best, depending on the release of macro-level statistics. Seasonal and geographical variations are either impossible or extremely cumbersome to represent truly accurately. Admittedly, in different countries and companies there may exist different views regarding what constitutes an adequate level of accuracy.

The second category of carbon footprints proper purports to actually approximate the accumulated carbon emissions embodied in a particular product[6]. For a start, this requires process LCA per production stage, preferably validated by company specific measurements to provide upper and lower bounds (across companies and time) and in the best case product-brand specific figures and concomitant footprints. Provided all (key) producers are willing to co-operate in a common carbon footprinting information system with common calculation rules, it would be possible to issue certified carbon footprints. The certificate can include a reliability classification. In that case for products with premium classified certificates consumers could safely compare (similar) products regarding their carbon footprints.

In Finland detailed – close to real supply chain based – LCA studies have been carried out for cheese, potato flour, oat flakes and gratinated potatoes (Katajajuuri et al, 2004), beer (Virtanen et al. 2007), cucumber (Katajajuuri et al, 2007) and broiler chicken (Katajajuuri et al, 2007). In the UK the retail chain TESCO in co-operation with the Carbon Trust tries to develop carbon footprints for a whole range of products (consumables) (Carbon Trust, 2008). Also the French supermarket chains Casino and E.Leclerc have been and are testing carbon footprints (Perrels et al 2009d)

extent reviewed on the basis of available literature, but are not discussed in this article.

The current phase of the project, which runs until May 2009, concerns a pre-study in which a road map is laid out in which key challenges of the envisaged system are discussed. Such challenges include for example:

- data system design
- choice and monitoring of accuracy levels of carbon footprints
- verification procedures
- design of interfaces for consumers
- adequate incitement structures, etc.

During the pre-study also a small pilot was carried out in which consumers test a feedback system linked to their actual purchases over a period of four weeks.

Why this combination instead of personal carbon credits?

There is mounting evidence that the involvement of the retailer, being the interface towards the consumer, can enhance the effectiveness of emission reduction policies for households (Throne-Holst et al, 2007; Jackson, 2005). Furthermore, positive feedback such as rewards (bonuses), seem to be more effective than negative feedback such as sanctions and taxes (Andreoni, 1994), notably in case of less clear choice situations. For some time, in the slipstream of the establishment of the EU Emission Trade System (EU ETS), ideas about personal carbon credits were abounding (e.g. Fawcett, 2005). In the UK in particular serious policy preparation steps were taken regarding the development of a personal or household level carbon credit system, but eventually it was judged that such a system may incur very high operational costs and the various kinds of technical and administrative complications entailed significant failure risks (Defra 2008).

Cap-and-trade systems encompassing households may face significant political opposition as well as economic risks (Defra, 2008; and focused on transport: Stead, 2008; Perrels, 2006). The problem is that fiscal aspects of such a system require it to be directly in force for the entire country and to

5. The interested reader is referred to Wiedmann and Minx (2007) for a concise but accessible introduction to the concept. That report contains a reference list, from which deeper digging literature can be selected.

6. For an elaborate discussion on thorough carbon footprinting methods, see e.g. Usva et al (2009)

have a sensible coverage of product groups and sectors in order to prevent leakage. The consequence of such an instantly vast coverage in terms of consumers, products and sectors is that the system could easily fail for technical reasons and/or could entail unanticipated significant wealth transfers between social groups, which can lead to political failure of the system[7]. If such failures would occur, socio-political sentiments would make reintroduction of same or similar systems impossible for many years. Furthermore, compared to combined feedback and bonus systems cap-and-trade systems are not explicitly aiming at activating important mediators, by means of which households will get a better offer of low emission alternatives. This last issue also relates to the activation of innovation for low emission alternatives in and across product groups.

The above sketched considerations led to the conclusion that the intended system should be – at least initially – not mandatory, neither should it aspire a sweeping detailed product coverage right from the start. Instead it should allow for stepwise build-up in terms of product and sector coverage, consumer and producer engagement, and quality improvements in the accuracy and data system performance.

Key requirements of the envisaged system

In the previous section was discussed why the envisaged system seems to represent a less risky development pathway than straightaway aiming for personal carbon trade. Even though it can start with a subset of all expenditure categories and it can allow for a variation in emission data accuracy and aggregation levels (i.e. products vs. product groups), it should be sufficiently convincing and serviceable to incite at least a significant share of customers and retailers to engage in the system. Furthermore, the participation rate should increase over time, e.g. from an initial 12% to 60% of the households. Given earlier experiences with feedback systems (Perrels et al, 2009b) and the quickly abounding internet based carbon offset and calculation services (Hertwich et al, 2008) it was decided that the minimum ingredients should be (for further discussion see Usva et al. 2009; Perrels et al 2009a).:

1. ***credible data*** concerning carbon footprints at the level of individual product-brand combinations (what 'credible' means and entails will be discussed more elaborately below, credibility is a crucial feature)
2. ***a user friendly feedback system*** for households, preferably accessible via various channels, i.e. by computer and by mobile phone
3. ***a reward system*** for households, in relation to the achieved emission reduction of a household over a certain period; in addition reward system for retailers and/or product chains could be considered.

The credibility of the data is important in several respects. In the first place consumers get quickly unmotivated or at least confused, if well founded criticism concerning the validity of the carbon footprint figures spreads in the media. So, on the one hand the data underlying the footprints and the footprints themselves should be sufficiently reliable and verifiable to be anyhow taken into account. Yet, the challenge is still to introduce some degree of flexibility. When only highly accurate verified carbon footprints would be taken into account in the feedback system, the entire system may not take off.

A system of quality tiers could be introduced for the various footprints in conjunction with a verification system. Only good quality verified data enable the attribution of an (acknowledged) carbon footprint at the level of single product-brand combination (i.e. the 500 g package butterscotch cookies of brand Z). The medium and lower quality tiers would give indicative footprints at product group levels[8] fitting to their limited accuracy. Generally spoken, the less precise the data the larger is the product group. On the basis of a product specific lifecycle analysis an emission intensity indication (per kilo product) could still be given for a fairly narrow product group (e.g. 'lager beer'). In case of for example a so-called hybrid analysis (using both LCA and input-output analysis) product groups tend to get wider (e.g. 'greenhouse vegetables'). Only verified carbon footprints at product-brand level enable a sensible comparison between products. This notion links to the second reason for caring for high credibility levels, namely fair competition. Unsubstantiated claims regarding lower carbon intensity than alternative products can easily lead to litigation.

The effectiveness of feedback is greatly enhanced when the feedback is prompt, persistent (a period long enough such that the behavioural change can really settle), easy to interpret, and personalised (Perrels et al, 2009c). Internet based feedback seems to offer the best basic conditions to optimise the above mentioned features. Even though regular access to internet at home is not yet ubiquitous it has already a high penetration rate in many European countries, whereas the envisaged system needs still several years to actual market introduction. Furthermore, at market introduction consumer participation is not necessarily directly very high, but – in the context of a societal and technical learning process – is expected to grow to a sufficiently high level of penetration in three to five years. The present study draws on earlier monitoring and feedback studies applied to energy saving in households and to achievement of permanent changes in personal diets.

In the CLIMATE BONUS system feedback can be provided both via computer and via mobile phone. The computer is meant for overall monitoring of the emissions from registered purchases. In principle the mobile phone can provide that service too, but is in the first place meant for use in the shop (i.e. at the point of purchase instead of ex-post). The computer based monitoring is typically meant for reflective decision making, notably at higher aggregation levels and possibly encompassing more fundamental changes in consumption behaviour. The mobile phone supports detailed decision making, i.e. when a consumer wishes to compare close product alternatives. It remains as yet an open question how these levels of aggregation interact with respect to the evolution of a consumer's purchase behaviour. The experiences in the consumer pilot indicated that

7. Similar criticism has been (and is) levelled towards EU ETS. Yet, that system involves much less products and processes, as well as less sectors and actors, whereas the accuracy of emission attribution is crucially better than is the case for embodied emissions in consumer products.

8. It is preferable to reserve the term 'carbon footprint' for product or even product-brand specific emission intensities. For product group level indications the term emission intensity could be used.

both aggregate and disaggregate information levels are relevant (see next sections).

Carbon footprints, enhanced by a monitoring system, may serve a second purpose. If the retail sector manages to relay the evidence and projections concerning the informed choices upstream in the production chain, an effective connection between consumer choices and (innovation) decisions in the production chains could be created. In that case the carbon footprint monitoring mechanism has not only so-called static effects on emission reduction via changes in current choice portfolios, but also dynamic emission reduction effects via its feedback into the production chain. These dynamics can be further enhanced by embedding the carbon footprinting activities in a system of carbon management in product chains (cf. the Carbon Trust's programme 'Carbon Management in the Supply Chain'; Carbon Trust 2006)

The bonus feature is supposed to function as an additional motivator on top of the monitoring system. On the one hand the bonus system can assist to make participation in the carbon monitoring system more attractive. On the other hand it should assist to achieve more emission reduction than otherwise would have been the case. There is some literature on bonus or loyalty card systems (e.g. Gable et al, 2008; O'Brien and Jones, 1995), but a reward in relation to an achieved emission reduction is not entirely comparable to a reward system aimed at maximising outlays within one retail chain. Even though some lessons of the loyalty card systems could be useful for this case, such as the limited binding effect of such cards. Of course in this case from an environmental viewpoint it does not matter where (i.e. via what retailer) the rewarded emission reductions are realised, but there could be competition with other reward schemes promoting another societal benefit.

There a few sporadic studies on green bonus systems (e.g. Van Sambeek and Kampers, 2004; Verheyen, 2006). According to the findings of the few projects assessed, consumers can be split up in three groups when it comes to environmental-friendly consumption: (1) a small group of environmentalists, (2) a large middle group of consumers who are convinced of the need of environment-friendly consumption, but are not always acting in such a manner, and (3) a small group of consumers non-interested in environment-friendly consumption. It seemed that bonus schemes are an efficient instrument to confirm the consumption behaviour of the first group and to alter the consumption behaviour of at least a part of the middle group.

Scope of products and reported effects

From a household point of view in most EU countries the food chain constitutes the second or third largest cause of greenhouse gas emissions, the two other major causes being mobility and residential energy use (Hertwich, 2006; Nissinen et al. 2006; Weber and Perrels, 2000). Especially, in Nordic countries food is often the second largest (e.g. Mäenpää, 2005), as residential energy use is often based on no or low emission fuel options. In contrast to mobility and residential energy use the greenhouse gas emission from food production and consumption are much less obvious to the consumer. Furthermore, emission reduction options are more complicated to identify, provided other considerations such as health, diet variety, affordability, and taste are respected as well, whereas greenhouse emission reduction should not go at the expense of other environmental policy objectives. These multidimensional attributes complicate comparisons not only from the production perspective, but also from the consumption perspective. Effective climate policy tools for this area still need to be developed, even though there is an obvious interest in conjunction with 'greening of markets' (ASCEE Team, 2008).

In the CLIMATE BONUS project foodstuffs constitute the focal commodity group. In addition also emissions from domestic (home) energy use and passenger transport (own car and public transport) are take into account. Possible relevance of other products will be considered in follow-up projects. Eventually the ideal situation is that for virtually all food products verified carbon footprints are available. In the meantime we have to settle for a mixed situation in which for some products verified information is available and for others only product group level indicators, a so-called quality tier approach.

In the pilot test carried out during the project the internet based personalised GHG monitoring service distinguishes 21 food product groups for which a carbon footprint has been established based on earlier LCA studies in conjunction with consumer expenditure surveys. Furthermore, for transport fuels (gasoline and diesel), heating oil, district heat and electricity the Finnish verified figures for specific GHG emissions are used. In the case of district heat and electricity this is done on a regional and company basis respectively. Seasonal variations in carbon footprints in district heat, electricity and various foodstuffs have not been taken into account at this stage, but could be considered in future stages. For public transport emissions per passenger kilometre were obtained from the Finnish transport emission monitoring system run by VTT (LIPASTO). Pilot participants can indicate that they are using a green energy alternative, i.e. certified green electricity or biofuel. Also wood is still relevant in Finland as a supplementary fuel.

The system focuses on monitoring of greenhouse gas emissions, but for several reasons it could be worthwhile to extend the reporting scope. On the one hand reporting on other environmental impacts (acidifying emissions, nutrient flows, toxic materials, etc.) seems necessary. Among environmental policy officials in Europe there is a rising fear that the overwhelming precedence that climate policy has taken may go at the expense of other environmental policy goals. Another extension of the scope links to possible other interests of consumers. For example, the nutrition value of foodstuffs could be reported as well. In combination with (self)reporting on physical exercise this would provide a personal monitoring system for food intake and health. In Finland there exists already the so-called Nutrition Code[9] service option for clients of a supermarket chain. The structure of information provision of this service is quite similar to the structure used in the pilot of the CLIMATE BONUS study. Another option is to report the expenditures, so the household would get a household budget monitoring and budgeting tool. Furthermore, the combination of these types of information could provide additional value added, i.e. demonstrating that environmentally benign food choices not always coincide with healthy food choices or that an environmentally benign food basket not necessarily is more expensive.

9. The original Finnish name is Ravintokoodi.

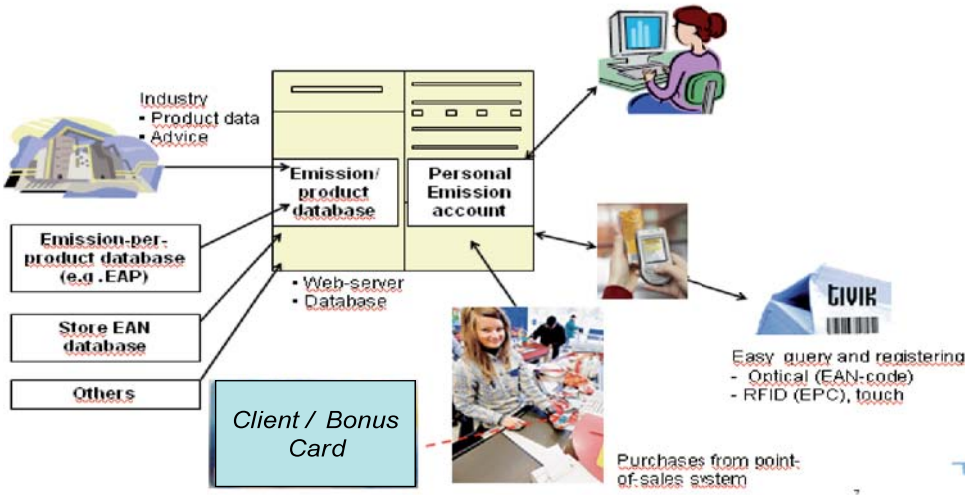

Figure 1. Sketch of the overall data system

These extensions appeal to attribute theory, meaning that consumers have different motivations for participation, and hence extending the range of attributes of a product or service expands the customer potential. Greenness may constitute different things for different consumers (Princen, 2006; Lehtonen, 2004). According to the judgement of a consumer it may relate to one or several environmental impacts, but it can also represent a wider notion of sustainability, also involving other aspects than environmental ones, e.g. (public) health or parsimony.

Impressions of the pilot

The pilot served two interlinked purposes. First, the technical functionality and lay-out of the user-interface of the internet based monitoring service was tested. This entails on the one hand reliable data transfer and on the other hand effective presentation (display) of results to consumers. Second, the pilot aimed to generate experience based consumer feedback about appeal, utility, usability and acceptability of the monitoring system. In due course could be tested whether the emission intensity of the purchases of participating consumers actually went down during the pilot period of four weeks. Obviously the technical and behavioural aspects are linked. Ineffective display of results will in all likelihood deteriorate the usefulness of the system for consumers.

The analysis of the outcomes of the pilot was still ongoing at the time of writing of this article, therefore only preliminary results, i.e. impressions, are provided in the discussion below.

TECHNICAL FEATURES OF THE USER-INTERFACE

A demonstration version of an internet based GHG-emission monitoring and reporting service for households was developed to test in real world conditions how the linking, processing and display of information was functioning and how user friendly and useful the provided information turned out to be for consumers. The information functions consisted of registering consumer expenditures (either through an automatic linkage with the payment system or through information fed by the user; figure 1), linking emission estimates, categorisation of products and services, processing meaningful aggregates (cumulated purchases and emissions), and display of purchases and resulting emissions. The display of resulting emissions includes comparison with various reference groups.

The expenditure categories covered included three focal groups: *foodstuffs*, *energy use at home*, and *transport fuels* (for the own car) *and public transport*. In addition, a remaining group "other consumption" was included, comprising of 18 expenditure categories. For the latter group participants could voluntarily record expenditures.

In order to reduce the burden for consumers and to improve the reliability of data the preferred data entry is through a client card or bank card when the consumer pays the supermarket bill (figure 1). In that case data of all products of the monitored product groups are transferred to the monitoring service. In the pilot registered supermarket purchases concerned foodstuffs only. During the pilot transferred data included product description, product identifier (to allocate it to a product group), package volume, number of packages, date of purchase, and participant identifier. In later versions also product prices and the sum of the expenditures should be included. Systematic provision of shop specific product prices is a sensitive issue in the retail sector. Therefore, price registration was left out of the present pilot.

In order to be able to display cumulated emissions at various aggregation levels purchase information is combined with information on specific emissions (per kg product). With a few exceptions specific emissions were only available at product group level (e.g. cheese). Later on in the envisaged CLIMATE BONUS system the product emission data base should contain verified emission data, as much as possible at product/brand or specific product level.

The created demo-system allows households to monitor their cumulative greenhouse gas emissions (CO_2-equivalents) at various levels of aggregation of their purchases (i.e. four consumption sectors and product groups, fig. 2) and to compare scores or indicators with time windows and statistics based reference levels and those of a peer group (fig. 2). Purchases and the consequent emission effects were processed with about 2 days delay.

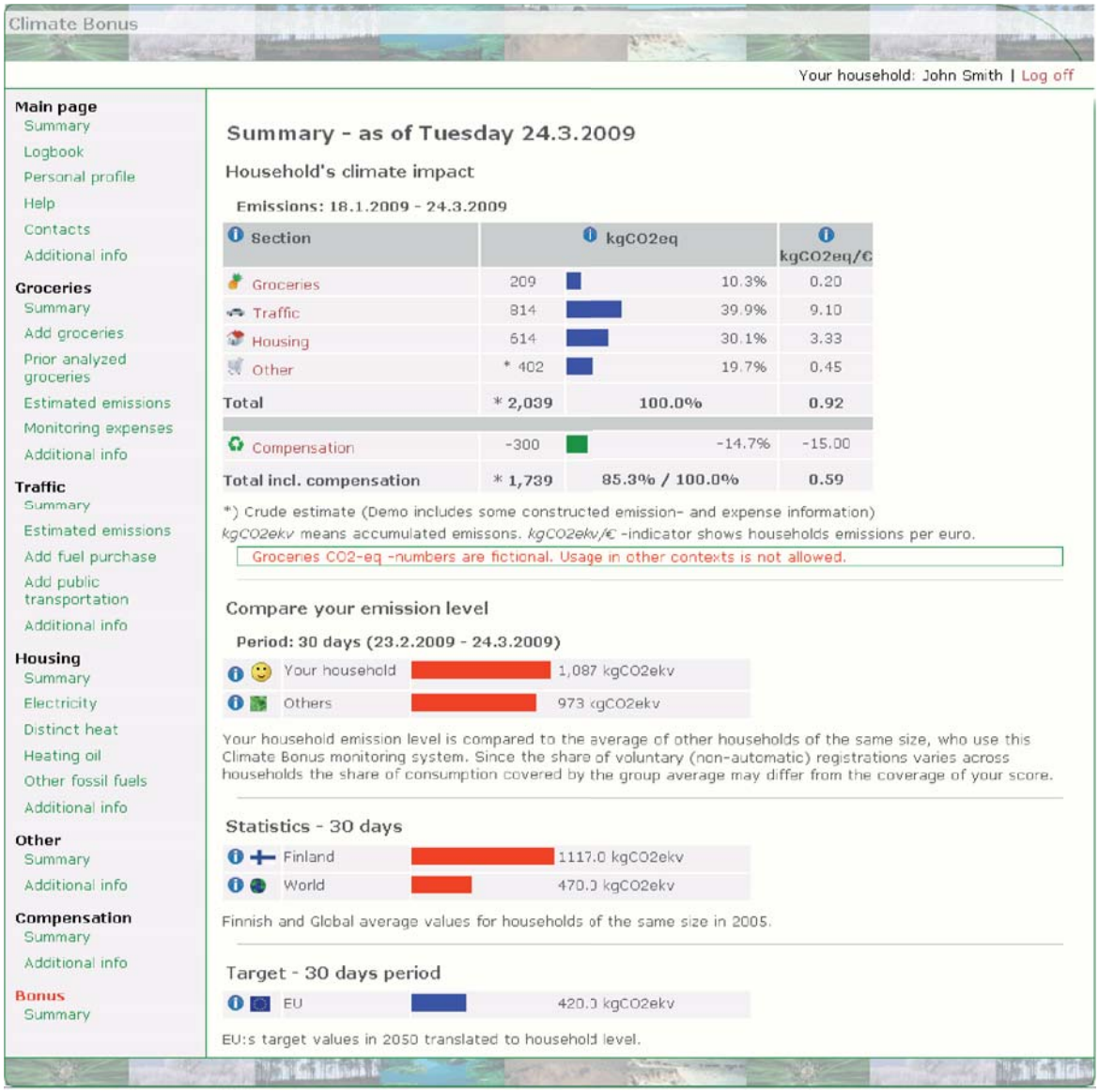

Figure 2. Screen dump of the monitoring interface – the summary page (NB! the original version operated in Finnish)

The demo version of the interface also included user registration procedures and conditions of use (related to privacy protection and definition of information ownership), specification of user-profiles (number of persons, type of residence, car model(s), option to specify recurrent trips). Summary reports can be obtained for overall emissions and %-shares by expenditure category for pre-specified periods (e.g. weeks) and – cumulative – for the entire monitoring period. Consumed fuels are registered on the basis of the number of refuelling (purchased litres). The system provides also an option to check every consecutive entry, i.e. a kind of logbook. The interface has also an option for background information on emission intensity per product group and references (links) to more information for interested users.

Next to quantity (purchased amounts in kg) and emission indicators (kg CO_2-equivalents) emission intensity indicators ($kgCO_2$-eq./€ ; $kgCO_2$-eq./kg purchase) were formulated. Euro -based information is partly collected through direct entries from users and partly from inferred unit prices per kg based on the 2006 Consumption Survey of Statistics Finland. Emission intensity indicators are useful for various kinds of comparisons, as they are scale neutral and less sensitive to temporal and inter-personal variations in purchased or registered amounts. Among others the system provides a comparison of the cumulated emission of the participating household of those of similar participating households during a certain period (fig. 2).

The second route for activity data registration utilised product specific bar codes (EAN) of the product packages and camera interface of the mobile phone (fig. 3) or manual entry of the EAN-number when using a PC. This route is capable of linking and registering "brand-specific" product information, but cannot "verify" that an actual purchase was realised as is the case when data entry is handled via a client card or bank card. The mobile phone option however enables checking of the specific emissions (or of other features) of individual products *in the shop prior to purchase*. In that case a consumer does not need to depend on product label information only. Yet, it requires that the requested data are present in a central product information

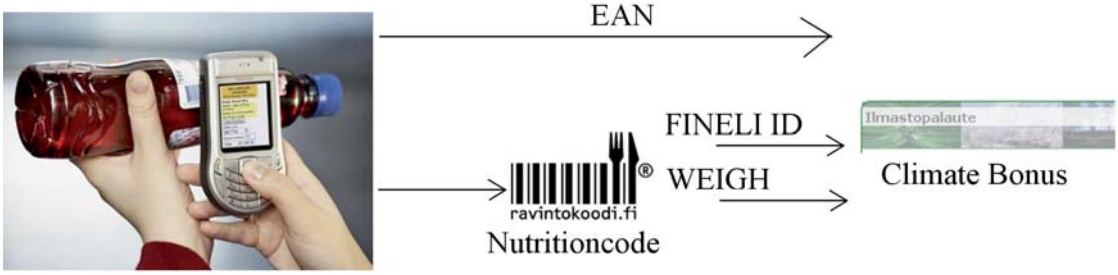

Fig 3. Optical registration of the product using directly entered EAN-number or barcode recognition capabilities of the mobile phone.

database (e.g. based on Environmental Product Declarations (EPD), see e.g. http://www.environdec.com/).

The third route is manual. Users enter their own activity data (e.g. kWh, litres, km, etc.) directly into the demo-interface. These data entries were designed in most cases to comply with the temporal and topical boundaries of billing and cost declaration practices for energy, travelling, etc.

The demo-version also offered the option to register emission off-set transactions (i.e. purchase of so-called carbon compensation services) and to account for that in the net emission burden attributed to the consumption of a participating consumer. The tested interface also included a simple reward system, so-called climate-bonus-points, which were awarded on the basis of a reduction of calculated emission intensity of the cumulated purchases in comparison to a pre-assessed personal reference level ('business as usual level').[10]

CONSUMER EXPERIENCES IN THE PILOT

The pilot was planned and carried out in close co-operation with the business partners of the CLIMATE BONUS project, especially Ruokakesko Oy and Tuulia International Oy. Ten K-Supermarkets in three areas were selected for the pilot: six are located in the Greater Helsinki area, three in Turku and one in Joensuu. Subsequently, consumers living (or working) within reasonable distance of the selected K-supermarkets were recruited to take part in the pilot. 25 participants were recruited from the Consumer Panel operated by the National Consumer Research Centre in Finland. They live either in the Greater Helsinki area or in Turku. Furthermore, another group of 10 participants was recruited in Joensuu: They are regular customers of the K-supermarkets.

The pilot was carried out from mid-January to mid-March 2009 and encompassed three phases:

1. An electronic questionnaire concerning characteristics of the participants, especially their purchase and consumption patterns and habits.
2. A trial of the demonstration version of the monitoring and feedback system (see §4.3) for a period of four weeks (19.1.-15.2.2009)
   - Both a PC version and a mobile phone version were tested.
   - Participants were asked to concentrate their purchase of foodstuffs on those K-Supermarkets that were taking part in the pilot.
   - In addition, participants could enter themselves foodstuffs bought from other shops, purchases of residential energy and motor fuels, public transport trips, as well as expenditures to other main consumption categories.
   - Participants were asked to follow the development of the cumulating emissions of the consumption of their households as displayed by the system, and in Turku and Joensuu also the accumulation of bonus points. On purpose one group was excluded from the bonus option to get indications about a possible differential effect between 'just' monitoring and monitoring plus the bonus option.
3. The assessment of the monitoring and feedback system (during and after the trial)
   - Participants were asked to fill out two electronic questionnaires concerning their experiences of and views on the system and its effects. The first questionnaire focused on participants' first experiences of the system, and the second covered all experiences.
   - After the trial period five group discussions were arranged (three in Helsinki, one in Turku and Joensuu; each group had different participants). They were employed to gain qualitative data on participants' experiences and views, and an in-depth understanding of the arguments underlying these viewpoints.

Even though four weeks of purchasing information of 35 households does provide some interesting quantitative information, the number of participants is too small and the first time experience possibly too experimental to allow for elaborate quantitative analysis of the recorded purchase patterns and resulting cumulated emissions. Moreover, at the time of writing the conjoint assessment of quantitative and qualitative information was not yet completed. Therefore the account below focuses on the feedback from questionnaires and group discussions with a few remarks regarding the quantitative results at the end. It should also be kept in mind that the pilot predominantly tested user experiences of pre-selected participants. In follow-up projects should be clarified what kind of households are prepared to use the service voluntarily under what kind of condi-

10. On the basis of the ex-ante declared household characteristics and using information from the 2006 Consumer survey semi-personalised average emission intensities (per kg. foodstuff) were established for each participating households. These attributed intensities functioned as reference levels to which the average emission intensity of the observed cumulated purchases were compared. Accounting for an uncertainty range of the intensities the reduction of the 'observed' intensity could produce bonus points.

tions. Similarly, also the mechanisms and features that keep up the motivation to use the service over a longer time span need still to be studied.

Overall, the participants found the idea of the monitoring and feedback system interesting. They were of the opinion that it was a new, innovative and thought provoking idea that aimed to tackle an important and topical problem. They liked the idea of personal monitoring of GHG emissions, and thought that it could be a concrete, everyday service for tracking the consequences of one's consumption. In as far as participants had doubts about the concept it had to do with actual establishment of the system: e.g. what kind of investments trade and industry are willing to do for the climate and the environment.

Most participants also thought that the monitoring and feedback system would be quite useful for their households. They thought that it could assist in evaluating the consequences of one's consumption, and even when making everyday purchase choices. In contrast *some* consumers aired doubts about the usefulness of the system. They thought that most of the information was already available through other channels, that using the system was too much of a burden, or that it would be useful only for a while, until the user has learned how to change consumption patterns such that the attributed emissions are lowered[11]. *Some* stated that emission information should be available in shops, in the context of the choice making situation(s).

The participants had many ideas as how to develop and improve the system. They stressed in particular the importance of user-friendliness, usefulness, reliability of the figures, and the way the monitoring service would be priced. Basically, they demanded that it should be easy to use and free of charge, and that the information the system provides should be useful to one's household. The consumers argued that in order to improve the usability, the system should be simpler and logical, and that information of all the purchases should register automatically into the system.

The participants' views concerning the required levels of information within the system (i.e. product level, product subgroup level, etc.) were split. *Some* of the participants thought that in principle the information should be more detailed than in the demo version, i.e. it should include accurate GHG emission data on each specific brand-product. *Others* were content with the information level of the demo version or accepted even cruder estimates of GHG emissions. Food products and transportation were the consumption categories for which more accurate and detailed information was desired[12]. It is important to stress that the need for detailed data, does not mean that higher aggregation levels wouldn't be equally important (notably with respect to the link between overall achievement and motivation).

The option to provide rewards (bonuses) for emission reduction achievements aroused various kinds of responses., generally airing some reservations about the significance of such an option (i.e. whether it influences behaviour decisively). Furthermore, several participants stressed that the provision of such an option should come hand in hand with the expansion of the supply of low emission alternatives on offer in the shops. While risking to make the judgement of the reward option even more confusing, it could be added that the quantitative results (the registered purchases and cumulated emissions) give reason to wonder whether the participants in Turku in fact did respond noticeably (in their purchases) to the bonus option, whereas the Joensuu participants generally did not. Possibly the mere existence of a bonus system has some effect – at least for some consumers, regardless of the exact workings of the reward mechanism. With respect to the potentially conflicting indications between qualitative feedback and observed changes in purchases recent insights from psychology and behavioural economics may assist in the interpretation. These insights point at the fact that ex-post argumentations of the actor to clarify a certain action are often quite unreliable. In other words not only stated intentions (to consciously perform or not to perform a particular action) may have limited predictive value (Ji and Wood, 2007), but ex-post clarifications seem to be more like ex-post justifications (of a past action or its absence) than proper explanations (Dijksterhuis, 2004; Dijksterhuis et al, 2006).

During the four weeks pilot period the overall average emission intensity of the cumulating food purchases decreased by 5%, meaning that the emission intensity ($kgCO_2$-eq./kg foodstuff purchased) of four weeks purchases was 5% lower than the average emission intensity of the first week only. However, considering both the weekly variations in the amounts and composition of purchases and the significant variation in the development of the individual intensities it cannot be certified that it would be a statistically significant change. The reasons for this indecisiveness are the small test group, the short test period, and the problems (learning time) of the participants with respect to grasping and using all monitoring information effectively. However, considering the significant variation across households regarding cumulative intensities of food purchases (the highest is approximately four times the lowest; and still a 50% range remains when skipping the extremes) there seems room for on average 15% ~ 20% reductions in emission intensity of food purchases for the greater part of the households without implementing far reaching measures. To get this reduction potential exploited consumers should indeed see that it makes a difference (as the reported feedback seems to indicate). From this can be inferred that a system such as CLIMATE BONUS could fill in this need. In this context a reward (bonus) system may assist to boost the propensity to change purchase choices and/or ignite the change process.

Costs and addressed potential

In a large supermarket chain the number of products on offer easily exceeds the 50.000. Furthermore, different chains partly offer different brands (for the same products), which boosts the figure at a national level, and even more so at an international level. All in al in case of a relatively restrained selection of products subjected to product specific carbon footprinting the number of products could already amount to 5000 to 10000. In case of a pan-European ambitious system the number could rise beyond 100.000. Obviously a strict national handling of such

11. Obviously in that case the system would nevertheless have served its purpose.

12. In fact for transportation more accuracy was in principle already possible in the demo version, but required more information entry from the participants (cf. the stress on automated data feeds).

amounts of carbon footprints would result in significant cost per country and also entail duplication of efforts. Simple back-of-the envelope calculations (see Perrels et al 2009c) based on Finnish and European household expenditures on foodstuffs indicate that the effect of larger markets is very important to get the cost-effects per product down to absorbable levels (e.g. below 0.1% of the consumer expenditures on foodstuffs). Next to this market size effect also the existence of international supply chains are a reason to pursue international co-operation and common approaches for carbon footprints.

Scale economies and joint cost elements in generating footprints can be expected to be significant, which implies that much lower average unit costs are by no means unlikely. The realisation of carbon footprints would spread out over several (e.g. 3–5) years, which would attenuate the annual cost. Furthermore, learning effects in later years will contribute also to unit-cost reduction. As a preliminary crude indication could be stated that the decrease of average product specific footprint unit-cost below 10.000 Euro (or the evident prospect thereof) may suffice to reinforce the pace of uptake of carbon footprints. In addition to the initial data generation and system set-up costs there are also costs for maintenance and updating, but these are expected to constitute less of a threshold with respect to getting the system launched.

When combining the crude estimations of costs with the earlier mentioned preliminary estimation that a fairly easy achievable emission reduction per household of 15% ~ 20% for 2/3 of the households would be feasible, a crude assessment of the (static) economic efficiency with respect to application of the CLIMATE BONUS system to food purchases by Finnish consumers can be given. The result of these assumptions would be that 2 ~ 3 million ton CO_2 equivalent could be reduced. If the reference price of EU ETS emission allowances would be 25 Euro/ton (a typical level used for scenarios up to 2020/2025), the reduced amount represents a value of 50 ~ 75 million Euro (per year, assuming persistent changes). Inclusion of home energy and transportation in the monitoring system would definitely enhance the potential.

Conclusions

There are three sets of factors that by and large determine the effectiveness of the envisaged CLIMATE BONUS system, being (1) the accuracy, comprehensiveness, and tractability of the recorded emissions per product chain, product group, etc., (2) the appeal and incitement effect of the monitoring and feedback service for consumers, and (3) the deployment strategy of the system in conjunction with product-market strategies of products and product groups included in the system.

The tested demo-version of the internet monitoring system for households showed that such a service can be developed and does appeal to consumers. The ergonomics of the system has to be improved, whereas more options for personalisation of the monitoring service seem to be relevant, also with respect to the organisation and display mode of the information.

Consumers regard the offered service as potentially useful. However, wide spread participation in the system and more intensive use do require high standards of user-friendliness, whereas also reliability and credibility of the system are crucial to engage consumers successfully for a longer time. In practice this means among others that automatic registration by means of loyalty cards or bank cards is an important prerequisite for achieving wide spread use. Furthermore, the participants indicated that the provision of the monitoring & feedback system should go hand in hand with expansion of a low emission product portfolio in shops; otherwise indeed consumers may start to put the credibility of the system into question.

The inclusion of a reward system for consumers who succeed in reducing the emission content of their purchases was also studied, albeit only to some extent. It is however as yet unclear whether, how and to what extent it is promoting changes in shopping behaviour *on top of* the effects of monitoring information on the cumulating emission contents of purchases.

Both for reasons of cost reduction and for reasons of data quality assurance the coverage of the data generation system with respect to participating companies and retail chains should be large.

Virtually all participants in the pilot were of the opinion that the monitoring and feedback system should be adopted by as many retail and service chains as possible. Insufficient coverage in this respect bears a significant risk that the uptake of the system among consumers remains low.

The preliminary exercises provide a prospect that the entire CLIMATE BONUS system has potential to pay off in terms of social-cost benefit analysis. The challenge is however to mobilise this social-economic benefit in such a way which is also commercially a sensible endeavour. Among others this mobilisation depends on the way the CLIMATE BONUS system would be fitted to the existing climate policy portfolio or vice versa how the climate policy portfolio would be tuned to the CLIMATE BONUS system.

The combination of services discussed in this paper should be understood as a long term development, as a part of the implementation of a sustainable transition. It is even strongly recommendable to exploit learning trajectories and not to push too quickly for (mandatory) widening of the scope of products and/or reported effects. Nevertheless, we expect that eventually the combination of reported effects, appealing to environment, health, and budget management can provide multiple benefits for consumers and producers against reasonable cost. Yet, indeed one of the challenges to be met is necessary reduction in the costs of the system, notably with respect to producing and maintaining of product specific carbon footprint supporting databases.

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