Green Gang vs. Captain Carbon

Integration of automated data collection and ecological footprint feedback in a smartphone-based social game for carbon saving

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***Abstract*—The serious game "Green Gang vs. Captain Carbon" aims to promote pro-environmental information and action. We present the game design in regards to user interface, automated data collection on everyday trips and household electricity consumption, and on ecological footprint calculation. We report the results of a pilot test with power users in Austria.**

Keywords—serious game for carbon saving, behavioral change, ecological footprint, data collection

I. Introduction

Everyday consumer activities in private households contribute substantially to carbon emissions in western industrialized countries. Building on established intervention techniques for behavioral change (self-monitoring, feedback, team cooperation; [1]), we present the serious game "Green Gang vs. Captain Carbon" (available in German language on http://game.greengang.at). The online game aims to promote pro-environmental information and action through a combination of quizzes conveying practical knowledge and game missions instigating trial behavior, focusing on energy saving in mobility, household energy and food consumption.

The game leverages recent developments (i) in market penetration and technological capabilities of smartphones, allowing intuitive user interfaces and automated data collection on mobility via geolocation, (ii) in smart metering, allowing continuous data readout of household electricity consumption, and (iii) in visualization techniques established in ecological footprint calculators and smart metering pilot studies.

II. Game Principles

The game aims to provide a simple tool for private households to engage in carbon-saving activities. Players are motivated by positive feedback on personal achievements as well as by comparison and competition among players and guilds.

Quizzes on the environmental impacts of everyday habits are used to convey basic knowledge on behavioral options. Subsequent game missions target specific behaviors in increasing difficulty from easily implementable actions (e.g., changing electric bulbs to fluorescent lamps) to actions requiring extensive reorientation in daily routines (e.g., selling one's car; [2]). Quizzes and missions are unlocked in the game adaptively to the individual player's capabilities and progress.

After each mission and in case of changes in household facilities/appliances, the ecological footprint is updated dynamically. Player may compare their progress to their own game history, to reference values (e.g., an average household), and to other players/guilds. Game missions are framed by the narrative of a struggle between the Green Gang (the players) versus Captain Carbon (the carbon-intensive lifestyle).

III. User Interface

The game features a distinctive surface with constant visual key elements (see Fig. 1). The user interface is designed for easy player interaction. Elements with high emotional impact most favored by users are presented on the main game screen. As the game is implemented both as an app and as a mobile optimized web page, usability has to take varying display resolution and options for device interaction into account. To conform to lower display resolutions, key elements are retained as background images, while abandoning extra graphic content. Making the game available via smartphone aims to strengthen the emotional link to the game, since a smartphone is a very personal device with strong emotional impact [3].

To further increase the emotional response of our gamers we use a strong positive iconic language and feature highly visible group achievements. Complex game mechanics are

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conferred via simple user interface elements. With growing proficiency with the game, additional features are unlocked with new options to enter more complex data or to complete more complex missions, thus gaining more rewards. Therefore complex gaming is slowly introduced and the learning curve is optimally supported.

IV. Data Collection

To calculate the ecological footprint, data from users in the fields of mobility, housing and food consumption are needed. As a detailed footprint demands considerable effort in data entry, users may decide for themselves how precisely they wish to specify their behavior in order to receive a more realistic ecological footprint.

To reduce respondent burden, automated data collection and preset default values are preferred. However, some data on consumption frequency and household/building facilities has to be entered manually. Default values are based on the behavior of an average Austrian citizen. For example, the average occupancy rate in public transportation is determined by a transport model. Default values allow users a preliminary self-assessment and minimize barriers in game access.

For automated tracking of travel behavior ([4], [5]), a smartphone app (iOS) tracks all individual routes during an entire day using A-GPS, WLAN, and GSM sensors for geolocation. The user starts or stops the app with one-click. Transport mode and occupancy rate are supplied manually. Duration and distance of the route are measured by the app in real time, correcting raw GPS data via a filter algorithm for outliers, so to increase accuracy in distance estimation.

Furthermore we aim to include electricity consumption data from smart meters. Automatically collected data circumvents unreliable or biased self-reports. Users have the option to edit entries if automatically collected data is wrong or incomplete.

V. Footprint Calculation

Feedback is given to users by showing them their personal ecological footprint based on the Sustainable Process Index methodology [6] and CO_2 life-cycle emissions. For every category (mobility, housing and nutrition), life cycle based background data is calculated to educate users on the environmental impact of their daily activities.

Users start with an inventory in order to define themselves in relation to the average Austrian citizen. Regarding mobility, players record trips via smartphone app or enter trips in a trip diary, in a more detailed game level also supplying number of passengers and type of fuel. The trip data is projected to annual travel performance. To assess the housing footprint, players are asked for parameters like type and size of housing, type of heating and electricity consumption. Again in the next game level the user may provide more detailed data, for instance the individual electricity mix. Compared to mobility and housing, the assessment of food consumption is by necessity less comprehensive, since detailed information would require extensive manual data entry of grocery bills etc. The user outlines his or her preferences on the dimensions “Biological

Fig. 1. Main game screen.

vs. conventional food”, “Meat consumption”, “Regional products” and “Seasonal products”.

Users receive life cycle based footprint and CO_2 emission results based on their personal achievements in game missions. Footprint and CO_2 results are given as quick view on the left-hand part of the website (Fig. 1) and as detailed results as well. New users start from a predefined average footprint respectively CO_2 profile. More precise user data input is gathered through accomplishing missions. It initiates a re-calculation of the footprint and gives immediate user feedback.

Detailed results depict a user’s initial footprint and his progress through achieving mission targets. In addition, users are able to see how much they improved their footprint in their last mission. It shows also the potential of footprint reduction, if the user keeps up his behavior during the mission for the entire following year.

VI. Outlook

We report the results of a pilot test with power users in Austria, which represents the initial stage of the game’s realization. We discuss user reactions regarding usability and data quality.

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