‘Electric City’: Uncovering Social Dimensions and Values of Sharing Renewable Energy through Gaming

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Abstract
With the advent of Smart Energy Systems and Energy Cooperatives in the Netherlands and elsewhere, sharing of renewable energy within neighbourhoods is likely to gain wide prominence in the near future. Today the concept of ‘Energy Sharing’ is often limited to householders ‘selling’ their surplus of locally generated energy to the energy grid. Rather than shared locally, transporting energy back to the grid results in a loss of energy through the power lines. The research aims to understand present and future social dimensions and values of energy sharing from a people’s perspective. In this paper the Energy Management game ‘Electric City’, is presented and results from gaming sessions.The game serves as a platform for informants to reflect upon values and expectations associated with Energy Sharing.

Author Keywords
Serious Games; Gaming; Sharing; Renewable Energy

ACM Classification Keywords
H.5.m [Information interfaces and presentation]: Miscellaneous; K.8.0 [General]: Games.

Introduction
With the emergence of Smart Energy Systems and Energy Cooperatives in the Netherlands and elsewhere, sharing of

renewable energy within neighbourhoods is likely to gain wider prominence in the future. The current form of sharing of renewable energy is better described as 'commodity exchange', i.e. households 'trading' surplus of locally generated electricity in energy market [8]. The householders receive financial benefits in return for the trade. This limited view neglects the potential for social sharing [7, 8]. Based on research of [2, 8, 11], the research defines 'Energy Sharing' as 'people-centred distribution and circulation of renewable energy within neighbourhoods'. The work presented here focuses on social dimensions of Energy Sharing and explores the attribution of the concept in everyday life of people. The goal is to design product service systems for Energy Sharing while contributing to ongoing discussions (e.g., [4, 7]) and initiatives (e.g.,GridMates[1], Shifft[2], Buurkracht[3]) on combining local distribution of renewable energy and interactive technology.

There are two challenges facing the research and development of concepts for sharing local renewable energy, namely: (a) Technologies for Energy Sharing are in nascent stages and infrastructure for Energy Sharing is not present in the real world. Therefore the following design question arises: how do we design for Energy Sharing services where the technological infrastructure is not present in real world? (b) Participants also considered Energy Sharing to be a combination of two abstract concepts of 'energy' and 'sharing' and hence difficult to reflect upon during interview sessions. Hence, the question: how do we facilitate our informants to reflect and discuss on Energy Sharing services of future? Games and gaming were utilized as a medium to address these challenges.

Goal of the game and the gaming sessions
In this paper we present 'Electric City', a prototypical Energy Management game that is being iteratively developed. The game and the gaming session aim to offer a platform for informants to reflect on and discuss Energy Sharing. The game provides a safe environment that enables the exploration of values and attitudes towards sharing renewable energy. Preliminary findings are reported from two gaming sessions conducted with two groups of students.

Related Works

Games encompass systemic qualities that enable players to play within boundaries of the rules of the game [9], or even challenging them. When considering consequences of gaming beyond the context of the game, gaming sessions may serve multiple purposes [6], including game as a research method. Here the game is the platform for the playful interactive experience [1], i.e. the gaming, which contains or releases valuable information through player interaction [10]. In order to derive meaning from these interactions, facilitators must observe and mediate the gaming experience. Examples of earlier work involving games as a platform to research human values, include Castri et al. [3] who modeled energy sharing behaviour through social interaction in games. Leygue et al. [5] used games as triggers to create awareness of energy consumption. In the current research, 'Electric City' provides a rule set that triggers interaction and a mind set for discussion in the gaming experience.

[1] http://www.gridmates.com/
[2] http://shifft.com/
[3] https://www.buurkracht.nl/

Figure 1: Electric City game on tablet

Figure 2: A player's view in Electric City

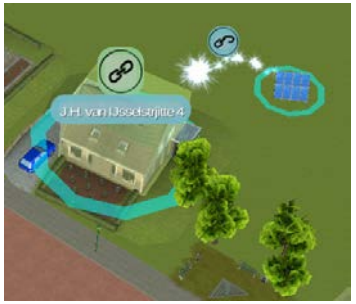

Figure 3: Animation indicating connection between a resource generator and a house

Game Description and Design

Electric City is a resource management game to be played in a turn-based gaming session by two to five players. The current version of the game is played using an Android tablet (Samsung Galaxy Tab 4 with Android 4.4.2). The game is built using 'Unity3D', a game development platform. The 3D models and animations are developed using '3DS Max' software (Figure 1, Figure 2 and Figure 3).

The storyline of the game is in the genre of survival games, where players are residents of a neighbourhood on an island. The individual goal of a player is to secure and manage three resources (electricity, food, and water) essential for survival of his/her house. In the current version of the game, there is no common goal for all the players. Players are encouraged to play the game as they would in real life. The concept of 'sharing' is not explicitly introduced to the players. A player who may chose not to share resources with their neighbours is not penalized in the game.

There are six 'turns' in the game. During every 'turn', each player gets four action-points. Action-points are needed for completing activities, such as, claiming a resource or (re)distributing resources to houses. A player can see his/her resource status but not of other players. At the end of a player's turn the tablet is passed on to the next player. During the gameplay, players are allowed to talk and converse with each other (face-to-face communication). A player gets eliminated from the game if his/her house is without resources for two consecutive turns. A player can secure and manage resources in the game by: a) building resource generators and (b) managing distribution of resources by negotiating with other players.

Building resource generators

Three resources (Electricity, Food, and Water) have limited number of generators: (a) Electricity: Two micro wind mills and two solar farms, (b) Food: Two greenhouses and two fishing boats, and (c) Water: Two dew collectors and one water treatment plant. At the start of the game, a player must claim resource generators to become 'owner' of the generator. Claimed resources are visually represented using a colored band that is assigned to each player.

Managing distribution of resources

Players can negotiate and discuss with each other to manage resource distribution to deal with scarcity or surplus of resources. Players can request for resources from other players through oral communication. A player can alter resource distribution through the digital interface (Figure 4 and Figure 5). The available distribution modes are: divide resources, donate resources without expecting anything in return, barter, and swap a resource in exchange for another resource.

Design process

The game was conceptualized, designed, and developed in collaboration with a student game design team at NHL University of Applied Sciences at Leeuwarden in The Netherlands. A user-centered design process was followed that consisted of periodic field-visits to neighbourhoods of Achter De Hoven and Hempens in Leeuwarden. These neighbourhoods served as an inspiration for visual elements and style in the game.

Gaming session set-up

Two gaming sessions were conducted with students at NHL University of Applied Sciences in Leeuwarden. The first gaming session (Session-1) was conducted with five players who were part of same study program and

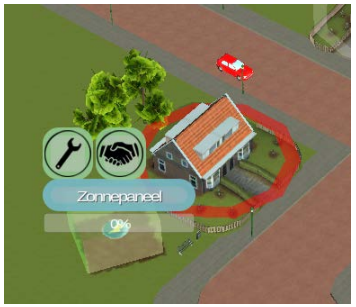

Figure 4: Interface to make connections with other players

Figure 5: Interface to manage resource distribution

self-reported to be socially connected to each other. The second gaming session (Session-2) was conducted with four players who were from different study programs, and self-reported to be not connected with each other.

Gaming sessions were set-up for a duration of one hour and forty-five minutes. The gaming sessions were conducted in a closed meeting room and were recorded on video, photo, and audio. Each gaming session was divided into three stages. The first stage was 'briefing' where players filled informed-consent forms and pre-game questionnaire. The second stage was 'play' where players played the game. The third stage was 'debriefing' where players completed post-game questionnaire followed by semi-structured interview and group discussion. Apart from the players, the other participants in the sessions were: one 'facilitator' and three 'observers'. The facilitator directed the sessions. The observers noted their observations during 'play' session and conducted semi-structured interview and group discussion during the 'debriefing' stage. Please see Figure 6, Figure 7 and Figure 8.

Data analysis
Qualitative data analysis was based on the audio recordings from the sessions. These recordings were transcribed and open-coded to assign emerging themes. These emerging themes were further discussed with researchers and a session was organized with the student team to cross-check the observations.

Results and Design Implications

In this section, we describe some key results from the two gaming sessions.

Gaming and identifying different concepts for sharing
The gaming sessions were effective in stimulating players to think and reflect upon different abstract concepts for sharing of renewable energy. During the debriefing sessions, players conceptualized various ideas such as: leaching, bartering, trading, stealing, pooling, donating, bargaining, offering, requesting, and free giving. Given the context of the gaming session, players were able to comfortably reflect and discuss various preconditions and requirements of renewable sharing services both in the game world as well as in the real world.

Importance of reciprocity
For all the players, reciprocity was an important and required feature of sharing. The players shared resources with expectations of getting something in return. Many players claimed that receiving a return was one of the key drivers for sharing but further clarified that the return was not limited to tangibles (like food, water) but could also consist of intangibles. The participants listed many intangible things that would qualify as an appropriate return, including maintaining or improving social status, friendship, building better relationship, and doing a favor. Some claimed that the transient nature of gameplay kept their focus on tangible things in return, while for sharing resources in real life intangible things would also play an important role. These notions of reciprocity are diverging from some theoretical views on sharing as 'non-reciprocal' [2].

Familiarity
In Gaming Session-1 ('familiar' group), there was lot of enthusiasm, discussion and negotiation between players for sharing. Players moved around during the session and felt comfortable in seeing and discussing strategies for sharing. In contrast, Gaming Session-2 ('unfamiliar' group) lacked

Figure 6: Gaming Session 1

Figure 7: Setup of Gaming Session 2

Figure 8: Students playing the game during the Gaming Session 2

dynamism, interaction between players and did not share resources in the game as much as the earlier group. One player played the game without receiving or giving any resources to any other player. Therefore familiarity between players influenced sharing in various ways. The players claimed that it is easier to share with people whom they trust and perceive as 'nice' or 'good'. Players also stated various examples from their real life where pre-existing relationships and perception of their neighbour influences existence or absence of sharing. Many players stated that for sharing between non-familiar people a prior 'agreement' or 'contract' would be needed before sharing could happen. This finding opens a design direction to explore and include in future versions of the game.

Visibility
Players asserted that they are more likely to share in both the game-world and in the real-world with neighbours whose well-being is known to them, such that they understand how sharing is going to benefit the neighbour. Players raised concerns for abuse of a shared entity by the receiver. Visibility of benefits due to sharing is likely to encourage participants to share again. In the current version of the game, a player cannot see resource status of other player. Widlok[11] emphasized the importance of the role of witness in supporting sharing in hunting and gathering societies, i.e. visibility of sharing by people who are neither 'giver' or 'receiver' of sharing. A next version of the game could include an option for players to make their resource statues 'visible' to other players.

Surplus, scarcity, crisis and common goal
Players identified that having a surplus of resources was an important precursor for their willingness to share. Similarly, scarcity of resources was observed as an important factor for a player to request others for sharing. Usually, the player facing scarcity of a resource took the initiative for sharing by announcing his situation to all or requesting an individual player. Players felt having a common goal or a common crisis that affects all the players would increase their willingness to share with each other. Players reflected on how a common cause (goal or crisis) in their real world brings the neighbourhood together. In the current version of the game, a common goal or crisis was not included. In the subsequent version of the game a common goal or crisis will be introduced to investigate its effect on sharing, especially for the 'unfamiliar' group.

Influence of sitting arrangement
During the gaming sessions, the players sat in a linear sitting arrangement. This sitting arrangement influenced sharing in the game-world. The players sitting next to each other discussed matters more easily as compared to players sitting at the extreme end of the arrangement. In the next gaming sessions, a circular sitting arrangements will be included as an experimental variable.

Discussion and Future Work

The 'Electric City' game was shown to serve as a relevant research platform or tool to engage and encourage players to reflect upon the abstract concept of Energy Sharing and to uncover requirements for renewable energy sharing product and services of the future. The players comfortably discussed various preconditions and requirements of renewable sharing services both in the game world as well as in the real world. The game provided an environment that allowed the presentation of sharing contexts that do not yet exist in their real-life. The debriefing sessions provided a way to triangulate observations and probe certain themes in detail. The game and the gaming session generated both quantitative

and qualitative data that could be suitable for mixed-method studies by integrating gameplay actions and discussions among participants to uncover values behind sharing decisions. In subsequent studies residents of single dwellings, capable of generating renewable energy, will be recruited as participants. The observations and findings from these gaming sessions will be cross-checked by ethnographic field-studies on sharing of other entities (not necessarily energy) within the neighbourhood.

In the next version of the game common goal and crisis will be included as a variable. Additional scenarios that involve seasonal, environmental and social factors creating conditions of scarcity and abundances will be included in the game. A 're-play' functionality will also be included to enable game played back during debriefing sessions, as a means to stimulate discussions among participants and assist the player in describing the course of actions taken during the game. There are many concepts, such as gifting, donating, renting, that could not be readily observed in the gaming sessions and thus will be made more explicit as optional strategies which can be chosen in the next version of the game.

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