The efargo game:
A playful way to achieve city-wide energy efficiency

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ABSTRACT

Games in general and pervasive games in particular have the potential to create community, action and participation around a purpose. Pervasive games exist at the intersection of game life and ordinary life. If the "magic circle" (Montola, Stenros, and Waern 2009) of a game is the boundary separating the game from ordinary life, pervasive games expand the space, time and social circle of game life into ordinary life and vice versa. Due to this quality, pervasive games have the potential for purposeful play i.e. using the pleasure motivations of gaming to achieve goals that may benefit communities. This paper furthers this author's contention from a previous publication (Srivastava 2016) that pervasive gaming is particularly suited to the purpose of closing the energy efficiency gap (Hirst, Brown 1990). The energy efficiency gap is the failure of individuals and organizations to adopt environmentally beneficial behavior with proven outcomes (Lee Ann Head 2014). Bringing the pleasure of a game to the space of ordinary life and combining it with the purposefulness of energy games, and implementing it at the city-scale, this paper presents the design of a pervasive game called efargo that harnesses game characteristics to achieve a positive shift in the energy-use behavior of people who are simultaneously city dwellers and gamers. The paper concludes with a brief discussion of game results which is currently in its second week of a nine-week implementation period.

Introduction

The City of Fargo, North Dakota is participating in the Georgetown University Energy Prize[1] (GUEP) to reduce energy use (gas and electricity) in residential and municipal sectors. GUEP is a nationwide competition to improve the energy efficiency of cities with populations ranging from 50,000-250,000 people. The competition duration is from January 2015 to December 2016 and will measure efficiency improvements in partnership with local utilities against the baseline energy use established during 2013 and 2014. Partnerships in this two-year effort, titled efargo, include North Dakota State University, the City of Fargo, and the two local Utilities (Cass County Electric Coop and Xcel Energy). This author is leading the efargo effort through which several programs are being proposed to add renewable sources of energy and increase energy efficiency in the municipal and residential sector. Included in this work is the design and implementation of a pervasive energy game called the efargo game.[2]

According to the Energy Information Administration, North Dakota ranks the highest in total energy expenditures per capita overall ($10,540 per capita in 2013), fourth highest in total energy consumed per capita overall (813 MBtu in 2013) and the highest in residential energy consumption estimates per capita (101.4 MBtu). Per a 2014 ACEEE report, energy efficiency is the cheapest method to provide Americans with electricity (Molina 2014). In addition, the Head,

[1] Georgetown University Energy Prize, https://guep.org/ (Accessed on 3/10/2016)
[2] See acknowledgements for the team members involved in the development of the efargo game.

Shelton and Stephens study of 2013 found that there is a direct correlation between the number of energy efficiency actions that people take and the amount of reduction in energy use and residential utility bills. They found that it takes a minimum of five energy efficiency actions to make a perceptible difference to utility bills. Some actions that require greater investment and effort such as weatherization, result in greater reductions on utility bills.Pervasive games allow ordinary life actions to be understood in terms of game goals, thus incorporating ordinary life in the game play. If the "magic circle" (Montola, Stenros, and Waern 2009) of a game is the boundary separating the game from ordinary life, pervasive games expand the space, time and social circle of game life into ordinary life and vice versa. The efargo game was designed such that every community member who became a gamer would expand their understanding of space (i. e., places, or more particularly homes), time (seasonal impacts) and social circles (people whose actions determine the amount of energy used) as units of energy use and therefore actionable in terms of game goals such as the prevention of energy waste, increase in energy efficiency and promotion of energy conservation. McGonigal describes pervasive games as those that "explore urban identity, critique habitual behaviors, and seek to construct experimental social structures" (McGonigal 2006; 2007). The pervasive nature of the efargo game has the potential for purposeful play, i.e. using the pleasure motivation of gaming to achieve goals that may create an aware and active community around the purpose of reduction in resources spent on energy use. In addition, the efargo game may be categorized as a Serious game (games which have more than an entertainment purpose) as it educates and trains people about energy efficiency in homes (Michael and Chen 2005).

The efargo game attempts to harness game characteristics such as voluntary participation, an avenue to do satisfying work, ability to succeed based purely on skill and knowledge development in the game, have social connection with others, and the chance to be part of something meaningful (McGonigal 2011), and the investment of only very limited municipal resources (Jaffe and Stavins 1994) to achieve a positive shift in the energy-use behavior of people but also to sustain the interest long enough to make an impact in their utility bills. At a larger scale, the efargo game aims to create an active community that can get engaged in the establishment of environmental policy at the municipal scale based on the writings of Poplin and Ferri that gaming can promote active, responsible forms of citizenship, promote more participative urban design and bring playfulness into the process of public participation, (Poplin 2011, 2012)(Ferri 2012).

The efargo game (#efargogame) was launched on February 23rd, 2016 after several months of research and an iterative design process that started in January 2016. It is currently in its second week of a nine-week play cycle. The following pages briefly describe the concerns of the design process, then describe in more detail the game environment, objects, goals, rules and gamers of the final design. Conclusions reflect on the emerging results of this early stage implementation.

Considerations during design process

Reality, Meaning & Play

The iterative design process that involved concept development and critique of several concepts of the game designs (Figure 1) was rooted in a discussion of Harteveld's Triadic Game Design concept of Reality, Meaning and Play (Harteveld 2011). He allows that to act on these issues concurrently during the entire design process would be impossible, which is true of the

efargo game design experience. The design of Reality within the game allows the game to connect to something familiar in the real world with game components sharing some of those characteristics. Meaning in a game comes from the achievement of value in the game such as knowledge acquisition, skills development, attitude or behavior shifts, data collection, or other means by which value can be determined.

Eco-feedback and designed playfulness

The Play component allows the game to incorporate qualities of immersion and fun. This is a particularly important aspect in a pervasive game with a serious purpose because game play in the digital environment and the real world requires players to move from one to the other which can be disruptive to the immersive quality. Fun and immersive qualities can be achieved through actions, adventures, role-play, puzzles and strategies within the game design per Harteveld. Froelich asserts that there are several persuasive technologies with the purpose of providing monitoring and feedback in order to persuade people to engage in individual or group behaviors that reduce impacts on the environment (Froelich 2014). These are termed *eco-feedback* and examples include easy-to-understand information presented in a memorable way as close as possible to the time and place of environmental choice; comparison between people and groups that motivates action; incentives and disincentives; setting commitments and goals that are challenging yet achievable; and feedback that is both motivational and informational. Froelich further distinguishes between eco-feedback and games with the concept of designed playfulness which includes competition, narrative, uncertainty, unpredictability and fun in addition to other persuasive technologies.

Extrinsic rewards lead to intrinsic motivations

In addition to the components of Triadic Game Design, eco-feedback and designed playfulness, the efargo game iterations were critiqued from a point of view of intrinsic and extrinsic motivations and the potential ability of the game to convert short-term extrinsic motivations to long-term intrinsic behavior change (Froelich 2014).

Efargo Release 1.0 (#efargogame)

The following description of the efargo game's design is based on Poplin's game elements, i. e., environment, objects, goals, rules and player (Poplin 2011, 2012). Poplin's categories are extended to include (a) game narrative; (b) game tools are required by community members to play the game to have access to rewards and incentives; (c) game rules, i. e., how the game play is presented to gamers so as not to become a barrier.

Game Environment

The efargo game is primarily played in the city of Fargo, North Dakota. The city of Fargo is divided into seventy-one community blocks based on U. S. Census block boundaries. Gamers who are not residents of Fargo are allowed a game path that engages approximately 80% of the game play but excludes crucial aspects of the game environment such as presence on the game dashboard, eligibility to win weekly prizes ($50 gift certificate to the hardware store), receipt of local news announcements and participation in local community events related to the game play.

Game Objects

Pursuant of the goals in the GUEP competition which is measuring residential and municipal energy use, the efargo team analyzed the past two years (2013 and 2014) baseline energy use data. Residential energy use makes up 83.14% of the municipal and residential energy use in Fargo. In addition, North Dakota ranks highest in residential energy consumption estimates per Capita (101.4 MBtu) nationally. The game is thus specifically targeted towards the reduction of energy use in the residential sector. As such, homeowners and renters of all residential typologies such as single family homes, duplexes, townhomes, apartments are the subjects of the game. Of residential typologies the predominant typology in Fargo is rental apartments, making up 57% of the housing stock. This is typically a difficult group to engage due to their limited control over their building or apartment. In addition rental bills that include utility costs result in occupants not having knowledge of how much is actually spent on energy costs.

While the home is the focus of the game in the first six of nine weeks, the play expands to spaces outside the home in the latter parts of the game. This expansion serves the purpose of the home being the most actionable and therefore educational unit of game play. The learning from the home about various aspects of energy efficiency creates awareness that can then be translated into more social and complex spaces such as places of work, gathering, education and entertainment. Ultimately this expanded awareness is utilized by the game to have individual community members or groups become active in issues of energy policy by engaging directly with the municipality through an app offered by the municipality for community engagement which includes conversations and polling. Therefore the game is designed to expand the environment from the home to public spaces to municipal engagement.

Table 1. Structure of the efargo game “action tokens” with the “challenge levels” and detailed point system described for the lighting action token.

	ACTION TOKEN	BLOCKS / CHALLENGE LEVELS		POINTS
WEEK 1	KEY			280
	LIGHTING (28%)			
		Read para + take quiz (color temp, energy use and life of LED lights)	10	
		Replace (5) bulbs most used interior light bulbs with LED.	20	
		Post via hashtag #efargogame.	30	
		Replace (3) exterior light bulbs with LED.	40	
		Replace (5) more interior light bulbs with LED.	50	
		Replace holiday and landscaping lights with solar-powered LED lights.	60	
		Replace at least 75% of your bulbs (interior and exterior) with LED.	70	280
WEEK 2	SPACE HEATING			280
WEEK 3	WATER HEATING			280
WEEK 4	ELECTRICAL			280
WEEK 5	CONTROLS			280
WEEK 6	SPACE COOLING			280
WEEK 7	SOCIAL			280
WEEK 8	Energy and The CIty!			280
WEEK 9	CELEBRATION			280
		TOTAL		**2800**
		WASTE A WATT BONUS POINTS		800
		BONUS POINTS: FOR SOMEONE WHO COMPLETES ALL CHALLENGES		400
		GRAND TOTAL POSSIBLE POINTS		**4000**

Game Narrative

The game narrative is centered around the typical good-versus-evil story. An evil character called Waste-a-Watt thrives on wasted energy while community members are the heroes or champions defeating the character. The more energy wasted by the community the stronger he grows. Even though there has been no controlled experiment conducted with the efargo game in terms of playing with or without a narrative, it is evident that the narrative and Waste-a-Watt character has caught people's imaginations in the community. Initial caricatures produced by the efargo team[3] were presented to elementary and middle school children at an Earth Day 2014 event at the Fargo zoo called Party for the Planet. The children generated several versions of the Waste-a-Watt character (Figure 1). Some of these drawings were then combined and developed into the current Waste-a-Watt character by the efargo team. Initially, the Waste-a-Watt character was only meant for a parallel efargo effort called the K-12 Challenge, a competition to reduce energy use in schools using gaming strategies. The reason to incorporate it into the game was twofold: first, it gave the game a central thematic concept that was easy to communicate in a concise manner, and second, it was evident that the combined impact of the story, the design and the name had energized the K-12 Challenge.

Figure 1. Narrative of the efargo game (Waste-a-Watt).

Game Players or Gamers

Energy-saving actions, social expansions, timing, information and strategy are cornerstones of individual or group (household) and voluntary play in the game. Gamers can join at any point during the nine-week game period and use the game tools and objects to engage the game environment to reach the game goals. In doing so, gamers are asked to assume various roles such as observers, learners, teachers, storytellers, action-agents (handy person), idea generators (designers), information providers and ultimately activists in the game. Depending on when the community member becomes a gamer, they will have a choice of action tokens to select and play. , The strategy would involve making a choice of which tokens to play, how many tokens to play simultaneously, and which tokens are most appropriate for their home to be taken to the highest levels of play resulting in greatest points earned. The simultaneous play of tokens clutters the game board path to higher levels and Waste-a-Watt bonus points also

[3] Initial Waste-a-Watt sketches were completed by Mackenzie Lyseng and Mike Christenson

potentially diminish the investment of time and effort in each token. Hence, the gamer will need to first learn about the various tokens (getting educated in energy saving potential of their home) and in the process decide the greatest needs and priorities of their home thus creating the best strategy for their own play.

As part of the play, gamers are incentivized with points to answer quicksurveys. . The surveys ask the gamers about time and financial investment, their level of awareness about energy use, difficulty in game play, engagement with the game, entertainment potential of the game based on their own experience etc. Gamers are also incentivized with Waste-a-Watt character and bonus points to answer questions that asks them about their concerns, ideas, reportage about problems they have identifies, or issues they would like to bring to the attention of the gamer community at large. This is where they become the reporter and idea generator. The game designers hope to crowd-source the community as to what future actions the municipality might take in terms of energy efficiency. Gamers are also asked to engage their social networks through traditional, digital or social media as story-tellers and teachers, describing how they have played the game in their household and share their successes or ask for help from the community. These stories shall create the visual and literary narrative of the game play.

In later part of the game (the final three tokens) the game will expand socially to incentivize group participation and create an activist community around the idea of engaging the municipality to adopt and enforce energy efficiency policy. The last three tokens are the Social token, the City token and the Celebration token. The Social and the Celebration tokens bring the community together in active groups while the City token involves these active groups or individual gamers engaging city commissioners, officials and mayor using the City's reporting tool to communicate ideas and concerns about energy efficiency at the policy level. For example, according to DSIRE[4], North Dakota ranks last among all U. S. states in the provision of financial support instruments that encourage energy efficiency such as tax incentives or PACE programming. The City of Fargo does not have any such incentives at the local level either, although the local affordable housing program has a weatherization component.

Game Tools

Game Tools allow people to play the game. The efargo game includes a web-based digital game board (Figure 2) that allows people to engage the game. The game may be accessed on desktops, laptops, tablets or smartphones. The game board has several parts such as the player's dashboard that tracks results, the tutorial area that teaches people how to play the game, , the communications box that guides them through game sequences and interactions, the Help area that allows people to ask the game designers for help, and the map area (that replaces the tutorial from time to time) that shows the performance of the City as a whole based on the Community blocks. Tools within the game are action tokens and challenge level blocks that allow gamers to make progress within the game. Since this is a community project and the computer-based game board might not be accessible to all community members, game kiosks have been set up at public libraries to allow people access to the game and also receive help if they need it. At these kiosks, a dedicated computer terminal is available to allow community members easy access to the game. In addition, efargo team members were physically present at the library for two hours every week to help community members sign up for the game and learn how to navigate the interface.

[4] The Database of State Incentives for Renewable Energy, http://www.dsireusa.org/ (Accessed on Mar 10, 2016)

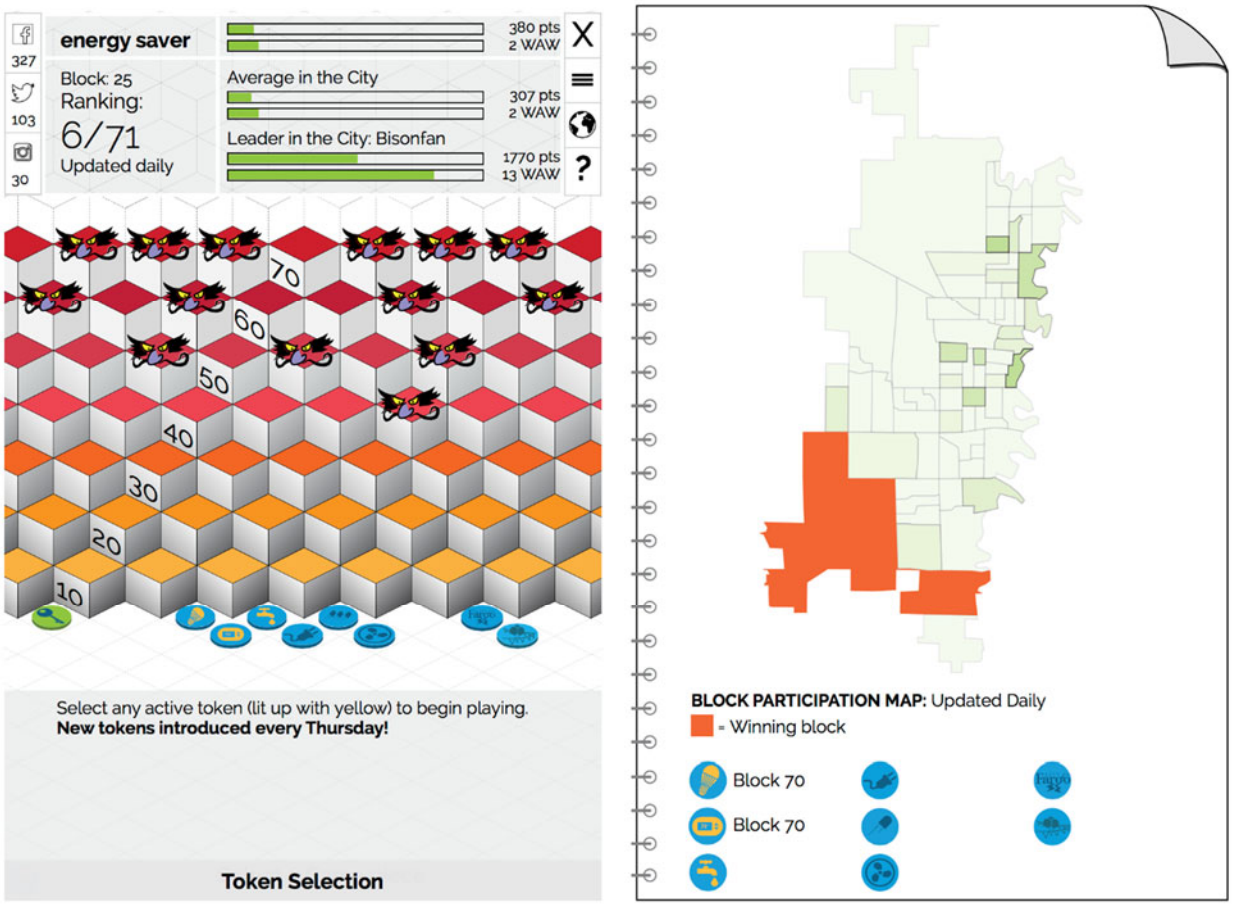

Figure 2. The efargo game board, dashboard, communications box, tokens, challenge block levels and mapping.

Game Play

During the nine weeks of play an energy action token is released by the game designers every week (Table 1). Each token represents an energy issue or sector that has elements of waste that can be prevented through game play. For example, there are tokens for lighting, space heating, water heating, devices, and cooling (Figure – tokens). Each token has to be selected and then moved by a gamer to climb challenge levels represented by blocks. Each level (made up of seven blocks) is associated with a level of challenge or difficulty. The hierarchy is arranged such that the first three levels (Levels 10-30) are mandatory and easier to complete and the next four levels (Levels 40-70) are optional with greater difficulty. Level 10 (the first level) presents information and quizzes the player about the information presented. Level 20 includes an easy action item associated with that token that is typically a low-cost or no-cost energy-saving effort in their

home which is not time or knowledge intensive. Level 30 asks people to share their participation in that week's token through social media or traditional media (phone, email, conversation), inviting friends, family, and most importantly neighbors to participate. Levels 40-70 ask gamers to complete energy-conserving action items that have increasing levels of difficulty, requiring more time, effort, cost or preparation for a greater number of points. Gamers are tempted towards

these higher levels due to two related incentives. First, the game graphics include a hiding Waste-a-Watt in some of the blocks at higher levels which translates to bonus points. The action associated with the Waste-a-Watt capture is relatively easy such as answering a about energy efficiency ideas that gamers know about that they can share with other gamers. Second, the game includes weekly rewards (a $50 gift certificate to a local hardware store), given to a randomly selected gamer from the Community Block with the highest score. For more discussion of this please refer to Game Rewards and Incentives.

Game Rules:

Game rules essentially describe game play to the gamer and hence a very important consideration in the game design. Several ideas were considered during the design of the game. Version (a) involved giving the gamers a list of rules prior to game play that they would need to read. Version (b) made the registration and tutorial part of the game play, allowing gamers to earn points as they registered for and learned how to play the game. However, this approach presented some technical difficulties about how to register game points in the database without first having created a database cell for the player through a registration process. What emerged was a convoluted, repetitive interaction that allowed people to interact with the game board as they signed up. In the end through team tests, it was decided that this approach, though ideal in terms of creating a barrier-free process of game play through immediate immersion, was technically difficult to solve within the time and resources available to the team. Approach (c) that combined a separate sign-up sequence and then immersion into the game play through a key/unlock token was ultimately adopted into the final game design. In this design the whole sequence of play, game interface, map of the game board, including the player dashboards, etc., were introduced through the key/unlock action token. The potential barrier inherent in this approach was that the gamers were engaged in the digital environment but not completing any action in ordinary life that would lead to energy efficiency. The benefit was that the process that allowed data collection through quick surveys was separated from the sign-up sequence and incorporated into key/unlock game play allowing players to earn points as they understood the interface.

Game Goals

The game goals are twofold. First, the game is designed to overcome the informational and behavioral challenges that create the energy efficiency gap and ask gamers who are community members to become energy efficient. The City of Fargo has targeted a 5/5/5 goal. The first is an overall 5% reduction in energy use in the city, the second is a 5% reduction in utility bill costs for all participating community members and lastly a 5% increase in renewable energy sources in the City. The game targets the first two by aiming to create an aware community that will overcome the energy efficiency gap in their own spaces. In addition, the game team is also tracking the residential energy use of the City that will determine whether the game goals were achieved.

Second, the game is acting as a research study with a sample of potential hypotheses listed below.

Energy Savings:

1. Pervasive energy games can engage citizens at the urban scale and accelerating energy savings behavior in communities.
2. Pervasive energy games are effective tools for introducing energy-saving behavior

and energy-saving strategies.

3. Pervasive energy games are effective tools in creating expansions, in this case expanding the understanding of time (seasons), space (buildings) and society (people) in terms of energy use.

Civic Engagement:

1. Pervasive energy games are an effective tool in creating an activist community for policy shift that will promote energy-use reduction and energy-waste prevention.
2. Community-based energy game can facilitate the building of an engaged community around (a) energy waste related problem-detection, (b) energy-use solution-creation and (c) civic actions that reduce energy use and energy waste.

Game Design Impacts:

1. Individual actions in environments controlled by individuals (such as homes) have better chance of reaching game goals than complex community-based actions.
2. Narratives/stories create more engagement in certain demographics. (Waste-a-Watt).
3. Low-cost actions that do not require an adjustment to current behavior are more readily accepted and successful than those that are no-cost but require behavior shifts.
4. Scale of Challenge has a detrimental impact in game play with fewer players participating in higher levels of challenge.

Demographic Analysis:

As part of the game and the Georgetown University Competition, the Utilities in the City of Fargo are providing the team with energy use data by census block.

1. Are there census blocks with a greater preponderance of specific residential typology (apartments, historic buildings, affordable housing) that are more active in the game than others?
2. How do income, age, housing type impact participation?

Limitations of the game and related factors:

Game awareness

Prior to and during game play audience awareness of the existence of a game is a crucial factor of its adoption rate. Community members being aware of the game as a freely available and easy-to-use tool is a fundamental factor of the game's success. As such this should be a fundamental consideration of the game. How will the targeted community be made aware of the game? For the efargo game, the funding of the game created an unforeseen problem for creating game awareness. The efargo team at North Dakota State University is grant-funded by municipal and state programs. As such these grants are dedicated to the research and design of the game. Marketing expenses are not allowable. The City of Fargo acted as Champion and community liaison for the research and design team. However, funding for marketing from the City for unproven research was difficult to justify. The outcome of these funding limitations is that the availability of the efargo game is primarily being communicated through one press event organized by the City, social media, small local events and word of mouth.

Game design and alignment between modality and audience

Games where the target audiences have wide-ranging demographics require multiple modalities of play that can cater to the various demographics for successful game adoption. For example, currently, the efargo game can only be communicated to community members via an online platform. Anyone without a device which can access the internet is excluded from the game. Even within the section of the community that has access to and facility for website browsers, the game does not work universally well on all web browsers. For example, the efargo game as coded (due to time and resource limitations) has had difficulty running on Internet Explorer. After Google Chrome, Internet Explorer has the highest usage share of all browsers which creates another major barrier. As a result, the target audience that may be persuaded with the game play to adopt energy efficient behaviors narrows down. Given that the design and research of the efargo game is based in a University, the IRB review ruling resulted in minors not being able to access the game. As a result one of the demographics that the game was meant for (ages 13-18) was excluded from the game play creating a major barrier to the game adoption rate. Therefore the target audience and aligned modality or modalities of game play should be an inherent factor of game design. If resources are limited then there needs to be designed alignment between game modality, target audience and marketing effort.

Privacy and data collection

The central purpose of the efargo game is the bridging of the energy-efficiency gap. If the game is successful, it should result in a reduction in energy use among the gamers. Since the object of game play is a home there are several privacy concerns with the collection of energy use data. As a result the energy data collection is being conducted at a community block level based on census boundaries which on average consists of a thousand homes or more. Unless the game awareness-creation, game alignment between modality and audience and fine-grained data collection can be established through the game, direct correlations between efargo game play and results cannot be established. Therefore, the current game is designed to measure participation rates rather than direct impacts on energy use.

CONCLUSIONS

Given that buildings use nearly 40% of energy produced and that the current building stock will make up 50% of our built environment in the future, it is imperative that we act at large scales to make existing building stock more efficient. Pervasive energy games that make ordinary life actions part of game play are a way to create community engagement in a fun structure.

In the first eight weeks of public game play, more than 300 players signed up from 71 blocks. Almost 100 players signed up from cities other than Fargo and about 58 players have not specified either a Fargo block or another city. By the time this paper is presented more data regarding the variables that impact participation will be available and analyzed for presentation. Data being collected includes energy use data from the Utilities, game participation data from the game database, surveys of the gamers.

The game is designed to create playful engagement through game components like competition based on game prizes, goals and incentives. Per the game design, community blocks (based on Census Block Groups) compete with each other for weekly recognition. Random selection of the weekly winner from the block with the highest point score for that week

encourages neighbors to build community around the idea of energy conservation and ask their neighbors to participate, thus increasing their own chances of winning the weekly prize ($50 gift certificate to the hardware store). Anticipation of the final grand prize (NEST thermostat) awarded to the person(s) with the highest score in the city, also introduces game characteristics of heightened emotions and engagement around the idea of conservation. The game allows gamers to don various hats during game play, injecting a sense of fun in the participation. Some of these roles include becoming a learner, teacher, story-teller, advocate, handy person, activist and strategist. These play characteristics of role-play, territory based competition, engaging narrative, uncertainty, unpredictability and fun essentially differentiate it from Froelich's eco-feedback which are strategies to persuade and motivate community members towards energy conservation behavior. Finally, at the end of the game, through the data collection and analysis effort, we hope to address the issue that designing urban-scale serious and pervasive games based on the characteristics listed above have the potential to impact behavior and create cultural shifts based on the idea that play is an essential higher human need (Rodriguez 2006 based on Huizinga's Homo Ludens)(Hejdenberg 2005) and that the quality of play is an essential part of games which are structured around game narratives, environments, objects, goals, rules, players and tools.

Even though the game lasts only nine weeks in its first version, the long term measure of the robustness of the game will be the conversion of short-term extrinsic motivations such as the game prize, translating into a long term intrinsic motivation of becoming an active community around pro-environmental behavior patterns. Bringing the pleasure of a game to the space of ordinary life and combining it with the purposefulness of energy games, implementing it at the city-scale, this paper presents the design of a pervasive game called efargo that harnesses game characteristics to achieve a positive shift in the energy-use behavior of people who are simultaneously city dwellers and gamers to overcome the informational and behavioral challenges of the the energy efficiency gap and adopt environmentally beneficial behavior with proven outcomes (Lee Ann Head 2014)

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