Exploring critical scenarios of algorithmic energy distribution with the Karma Kettle Game

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Fig. 1. Karma Kettle: accumulate variable "karma points" by choosing to store, share or use energy according to different contexts

The Karma Kettle game allows people to experience critical scenarios of distributed energy transactions, which rely on networked batteries and algorithmic transactions. The connected kettles allow individuals to visualise the state of a local grid and choose to use, store or push energy back to the grid, receiving or losing karma points according to the degree in which their actions contribute to balancing the state of a local grid. The points, however, fluctuate according to each player's profile, which is defined based on the UK Census for energy consumption, which breaks down energy expenditure by parameters such as income, ethnicity, region, and sex. Join us to understand opportunities and critical issues raised by these systemsm but be careful not to get into negative Karma!

CCS Concepts: • **Human-centered computing → Systems and tools for interaction design**.

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1 INTRODUCTION

In most part of the Western industrialised world, energy provision relies on national, centralised, grids. However, new technologies such as programmable batteries and algorithmic smart contracts have been increasingly explored to support a shift to Distributed Energy Systems, which are often seen as able to provide a) a more robust infrastructure that relies on a network of producers rather than a single energy source and central point of failure, b) more flexible and competitive markets that incorporate a wide range of producers and 'prosumers', and c) their ability to incentivise production of energy through sustainable resources [15].

However, underlying these systems are data-driven models designed to gauge demand, predict usage, regulate storage, and seamlessly balance energy, often in the background of people's awareness. These models add complexity to these systems and although their invisibility is often deemed important to sustain ease of use, it also hinders understanding and may result in issues of individual and social acceptance [14, 16].

The Karma kettle game aims to make people aware of this complexity, by introducing a participatory system of energy storage and distribution through which people can test the influence of algorithmic profiling in energy transactions. The game depicts a variable 24h scenario (compressed to a few minutes) that illustrates fluctuating levels of energy availability in a local grid.

Participants can then use their personal energy-storing "Karma Kettle" (see Figure 1) to respond to these scenarios, choosing to use, store or send energy back into the grid. Their actions result in the accumulation of positive or negative "karma" points, which are awarded according to how much the actions helped or hindered balancing energy in the network. Most importantly, the karma points of each kettle are subtly influenced by algorithms based on the profiles of participants, which are set at the start of the game. At the end of the "24h" round, the player with the highest number of points wins.

2 RELATED WORK

HCI researchers have long engaged with energy-related themes, with initial research focusing on energy feedback (e.g. [1, 8, 9]) and nudging behaviour towards energy saving (e.g. [3, 5, 6]). In 2012, Pierce & Paulos [11] suggested that themes such as smart grids, peak demand response, and distributed energy technologies offered great opportunity for exploration. Since then, there have been attempts to deliver information on the availability of highly variable renewable resources [10, 12, 17]. Costanza et al. [4] explored a scenario in which washing machines autonomously scheduled time slots to do laundry based on predicted energy costs. Through their work, they recommended balancing user control and delegation of agency. Failure to do so has been recognised by others too as potentially compromising utility and trust [2, 7]. Speculative design has been used to engage people in debates concerning algorithmic profiling and distributed energy systems [14], and there has been numerous participatory methods to investigate values around energy usage [13]. In our previous research, we used the Karma kettles in a longer-term study to understand how people negotiate agency with algorithms in order to balance energy withing a local network situated in a block of flats in Edinburgh, UK [15]. This study has been published at DIS in 2020 [15]. The Karma kettle game extends the applicability of the Karma

kettles to engage people in issues around algorithmic profiling based on parameters from the UK energy usage census, and by providing a playful way of exploring these issues through a critical installation.

Fig. 2. Karma Kettle game setup

3 GAME SETUP AND THE KARMA KETTLE

The game is comprised of a screen, two energy-storing kettles and a set of scenario cards. On the screen, participants can see the state of a highly variable grid, through a two axis graph that displays energy availability in the local storage (the two kettles) and the overall grid.

The Karma Kettles were originally designed to explore different levels of participation in distributed energy systems [15]. Interconnected, they mimic a scenario of domestic energy storage and local distribution, which allow people to track how much energy is stored in regional batteries (e.g. their neighbourhood) and how much energy is available in the overall grid (the energy display also changes to show the amount of energy stored in the kettle every time an action is performed). Using a dedicated dial in the centre of the kettle dashboard (see Figure 3), people can choose to store energy (and therefore contribute to increasing the amount of energy available in the regional storage), push it back into the grid (and make it available for others to use), or c) use the stored energy to boil water. To activate these actions, they rotate the dial to select the desired action, and press a button to confirm the action.

A certain number of karma points is connected to each action. The points vary from -9 to 9, according to the state of energy in the grid and in the regional storage network. They indicate when an action benefits or hinders the health of

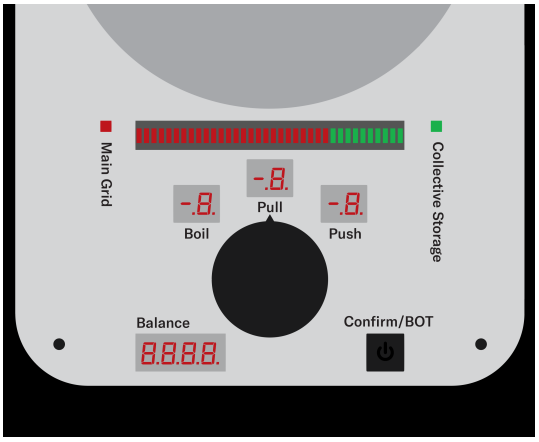

Fig. 3. Karma Kettle dashboard

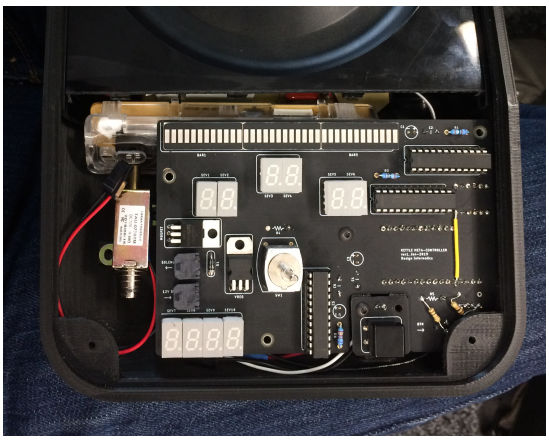

Fig. 4. Karma Kettle Tech

the energy system (see [15]. For example, a scenario of high availability in the grid and low regional storage would give a high, positive score for those who decide to store energy, a scenario of low availability in the grid would give a higher score for those who decide to push it back into the grid, etc.

The kettles were built by adapting existing BOSCH cordless kettles. A dedicated PCB was produced around the Adafruit Feather (M0 Wifi) to enable the functions described above, while the boiling mechanism of the original kettles was left intact (see Figure 4). For the purpose of this demo, and due to health and safety concerns, the heating mechanism of the prototype kettles will be disconnected.

We chose to use kettles (e.g. rather than other domestic devices such as washing machines) not only because of its high energy consumption, but also due to its ubiquity and cultural connotations in the UK.

4 GAME RULES AND ALGORITHMIC PROFILING

At the start of the game, participants set their profiles based on parameters of region, ethnicity and sex. Based on these parameters, and, as explained above, based on how much actions contribute to balancing energy in the grid, the system attributes different Karma points to actions of using, storing or pushing energy back to the grid.

The amount of energy in the grid and local storage changes constantly within a 24h scenario. Energy variation in the main grid is dynamically defined based on tracked data from the GridWatch.co.uk (GB Electricity National Grid demand and output per production type in different areas). At each interval, participants can pick a context card and decide if they would like to boil water, store energy, or send it back to the grid. At the end of each 24h round, the player or group of players with the highest karma score wins.

For the game, we included a new level of complexity where profiling algorithms modify karma points based on predictions of how particular groups would operate. This profiling was based on UK Census data from 2019, 2020 and 2021 which breaks down energy expenditure by income, ethnicity, region and sex. The general modification rule is proportionally lowering the reward values and increasing the cost values of positive and negative actions to the profiles that have a higher energy consumption patterns and vice versa to the profiles that have lower energy expenditure patterns. This illustrates an instance of potential systemic biases originated from algorithmic profiling.

Fig. 5. Dashboard screen

By experiencing how points assigned to actions can change based on assumptions of sex, region and ethnicity, players can start questioning how such algorithms could potentially contribute to moving away from or locking groups into particular patterns of consumption.

5 CONCLUSION

Since renewable energy produces more volatile supplies, their successful application and expansion depend on technologies and infrastructures that can help smooth out peaks and troughs of supply. These can offer both opportunities to promote new ways of engaging with energy (e.g. sometimes requiring more rather than less usage to balance oversupply), as well as risks of algorithmic biases. The Karma Kettle game provides a playful starting point for the HCI community to start exploring these possibilities with a critical lenses.

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Video Links for review

Demo: https://youtu.be/Q78UGGm6zYk

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