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Digital game enables active user participation in SmartGrids

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Computational awareness can promote sustainability and efficiency in electricity use by encouraging cooperative and collaborative user participation.

Recently, the worldwide electricity distribution and supply network underwent major changes to satisfy the increased demand for efficiency, reliability, and sustainability. SmartGrids use information and communication technology to underpin the network's infrastructure and performance. Specifically, SmartGrids are concerned with policy demands to address global warming and carbon dioxide emissions and consumer demands for low and competitive electricity prices. Important issues in the use of SmartGrids include security, smoothing out peak demand, increased generation from renewable resources, and (more importantly from our research point of view) active user participation.

The optimization of the energy system depends on consumers' behaviour and interactions with new technologies. However, the role of the consumer tends to be ignored by SmartGrids, as their design presumes that users will somehow adapt to new technologies. In fact, the main problem that arises from the electricity distribution network's evolution is the disregard of the user-infrastructure interface. Instead, Smart Meters are essentially imposed as controlling and distributed sensors reporting to a monolithic, central control system. Thus, we are proposing an innovative user-infrastructure interface for SmartGrids to enable active user participation. This infrastructure implements a serious game—a digital game, simulation, and virtual environment for learning or fun—that encapsulates Ostrom's principles for enduring institutions,[1] data visualisation, and Smart Meters.[2]

To engage users with the new infrastructure, we need to increase their awareness of electricity consumption. To do so, we provide them with comparative feedback for monitoring and controlling electricity consumption on a frequent basis.[3] Information visualization through comparative feedback triggers users' memory by simply displaying features and images.[4] Thus, we can also assist the user by processing raw data into an understandable form of information, as well as by giving advice on how to interact with the infrastructure to save energy. Modelling a human-structured environment (SmartGrids) as an institution, or organizational structure for coordinating the activities of a set of individuals, enables users to enact different roles according to their goals. Specifically, in the prosumer role, the user makes choices about electricity prices, which energy provider to buy electricity from, and whether to sell her/his energy surplus back to the grid. In the citizen role, the user may be concerned about the impact that his/her consumption profile has on the environment or may be interested in setting and meeting policy goals. As a practitioner, the user may be concerned about activities for storage and local developments. And in the role of stakeholder, the user may participate in local investment decisions. Therefore, assistive awareness should take under consideration the above roles, whereas data visualisation enables the users to better understand and configure the different rules that constitute the institution in which they take part.[2]

Figure 1. *Example of a 3D serious game scenario.*

We advocate serious games as the interface for engaging users with SmartGrids. Serious games (see Figure 1) purpose is not only to entertain and have fun, but also to assist with learning and help users develop skills such as decision-making, long-term engagement, and collaboration. They are experiential environments where features such as thought-provoke, inform, or stimulate are as important, if not more so, than fun or entertainment.[5] Serious games are engaging as they enhance

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learning by teaching users a specific skill or by encouraging them to take part in real-life activities in which they were not interested before or lacked the confidence to try. In our work, the games can be used to train consumers to use electricity in a sustainable way, which can reduce carbon dioxide emissions and help reduce the cost to clean clothes and dishes.

In our game, Ostrom's principles for enduring institutions[1] can be encapsulated and visualized through the same infrastructure interface. Particularly, a user needs a membership to access a virtual environment, which is defined by the game (principle 1). Different rooms can provide information visualization for comparative feedback as well as voting mechanisms to allow users to configure the game rules (principles 2 and 3). Smart Meters can play the role of monitoring agency (principle 4). At several points in the game, users can be rewarded or sanctioned depending on their actions in order to achieve the desired goals (principles 5 and 6).

The most important contribution of the game is to promote sustainability and efficiency in electricity use by encouraging cooperative and competitive behaviour in SmartGrid users and, thus, increasing interaction and collaboration among them. We also aim to increment user awareness towards energy consumption. To do so, we will provide comparative feedback to grid participants through Smart Meters to help them better understand electricity prices, resource allocation, and investment decisions. Overall, these issues could help to shift the peak demand in electricity consumption and, thus, allow us to make better predictions of consumers' behaviour.

As ongoing work, we continue to develop a serious game for users to develop the skills they need to undertake a meaningful and active role in Smart Grids. Moreover, we will evaluate the benefits of our approach with real users.

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