COMP2213: Interaction Design
Hand-In # 4 (version 1):
Prototype Video and Evaluation Report

Due date: 13 January 2023

Group 20:
Alin Formusatii (aaf1u20@soton.ac.uk)
Juzheng Bai (jb1u20@soton.ac.uk)
Bagir Bazarov (bb1u20@soton.ac.uk)
Daniel Braghis (ddb1u20@soton.ac.uk)
Logan Gibson (lg2n20@soton.ac.uk)

University of Southampton

Low-Fidelity Prototype: SpolarTech

a smart home system for managing renewable energy for residential use

Description of Prototype

User-centered approach driven by participants' responses

P4: "if you go to work in the day, you abandon a lot of clean energy"; P2: "I can't actually look and see what my energy consumption is." ; P2: "So in order to use that, to have that discretionary usage, we would need to be home."; P1: "Having to run everything during the day is a little bit of a faff to be honest"; P3: "More access to the information about what, what, what energy I'm producing, and how much of it I'm using"

Deployment procedures (design)

REQUIREMENTS & ARCHITECTURE

Prerequisites and design functionality

The user has solar panels, either they installed themselves or it comes with the house (as per UK household new builds).

The user has either:

1. Smart devices that are compatible with other applications such as "Smart Life", which in turn, allows users to use it with Google/Alexa
2. Non-smart devices that can be plugged into smart plugs

For additional functionality, there is an option for the integration of Switchbot to help turn on devices that do not have smart features. This is to improve usefulness which fosters user engagement and satisfaction (Hubert et al., 2019; Marikyan et al., 2019).

Switchbot is a small box you stick onto any appliance (Quin, 2022) allowing for remote control (similar to Al-Kuwari et al. (2018)). This can integrate into other smart-home apps like Smart Life and can then be used with Google/Alexa. Switchbot functionality would require the Switchbot hub.

App objectives:

The design diagram of the proposed energy management system is shown in Figure 1 (Appendix 1). In this system the solar panel is connected to a photovoltaic panel multimeter, with capacity to connect to Wi-Fi to allow for the information to be assimilated by the smart system.

App's deployment features:

1. Connects and retrieves parameters from the multimeter
2. Integrated with Smart Life to pull/push routines to and from Smart Life.
   Routines can be set up and deployed via Amazon Alexa app thus utilising pre-existing technologies
3. Connected the wattage from the multimeter so that it can then be used as a trigger to power routines in the Smart Home app.
4. Estimates provided based on weather predictions (similar to: Skeledzija et al. (2014)).

Deployment procedures (user)

INSTALLATION & SET UP

Set up of the required devices

LINKED DEVICES SET UP

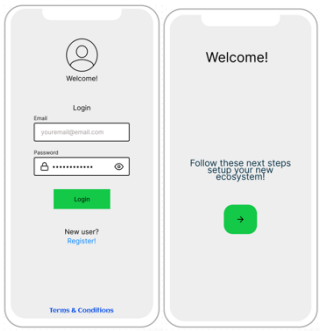
The following steps should be taken to prepare the required devices prior to the App set up:

i. Multimeter (requirement)
ii. Switchbot functionality (optional)
iii. Smart-plugs plugged into the relevant devices (optional)

APP SET UP

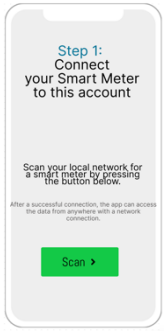
The initial registration and app configuration* is based on self-completion (see Figure 1).

Account registration



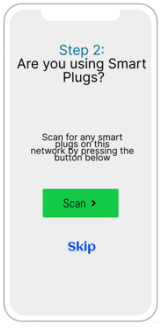
Upon initial installation, the user is required to register a new account. The account details can be used for future logins.

Step 1. Smart Meter connectivity



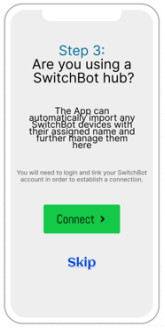
An option to scan user's local network to connect with their Smart Mater account.

Step 2. Smart-plug integration



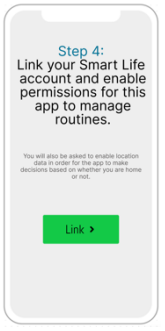
An option to identify which smart plugs or switches are associated with which devices. Can be done either by entering the wattage usage of a device or by entering a device name and selecting from a list. This allows to assess power usage needed for each device.

Step 3. Switchbot hub integration



An option to connect Switchbot devices to manage directly from the app.

Step 4. Smart Life integration



Routines managed through Smart Life integration.

Figure 1. Screen shots of our cloud based mobile application depicting user set-up journey

**App support.* Guidance videos that explain how to set up and use the Switchbot and smart-plugs if not using smart-devices.

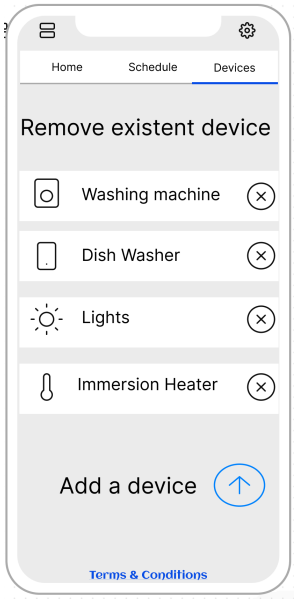
SpolarTech APP CONFIGURATION

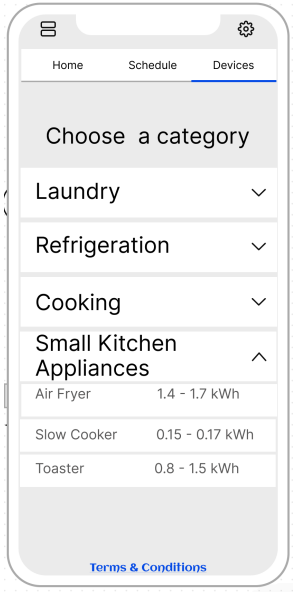
The features of SpolarTech were designed to address the need for smart energy management systems, flexibility and insight as indicated by the literature review which was further confirmed by our own findings. Each design step reflected the needs of potential users that were identified from our interviews. Below we present several features of the proposed app from a user perspective.

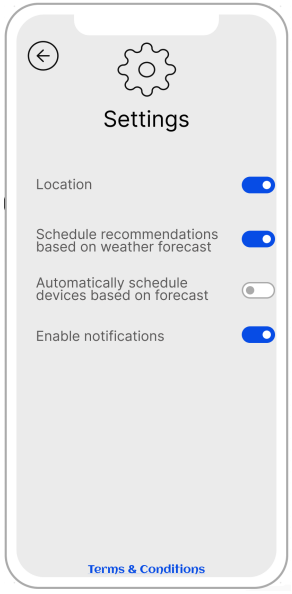
The user has the option to manage their linked devices directly through the app. This includes adding and removing appliances as needed. Each linked device is a part of a specific category which would allow the user to gain further insight into what household activities consume most/least energy. The lack of access to information was identified a key issue among our interview participants. Thus, the proposed feature addresses the apparent limitation related to insight and PV energy consumption.

The app calculates the electricity saved based on user input rate, or average market rate and let the user know how much money they saved that week/month/year on electricity based off of the appliances they've run. Future versions could include translating this into carbon emissions saved to promote renewable energy. This feature in line with our participants' responses who expressed the need for insight and remote management solutions to efficiently control household energy consumption.

To take advantage of the full capabilities of the app, it is recommended to enable location data sharing. In order to comply with the Data Protection Act 2018, the collected data will be securely stored on protected could servers. Adhering to the transparency in our design, the users are required to opt-in to enable this feature. This supports user confidentiality where no data is collected without the users' knowledge. This is informed by the growing privacy concerns (Kokolakis, 2017; Liu, 2014).



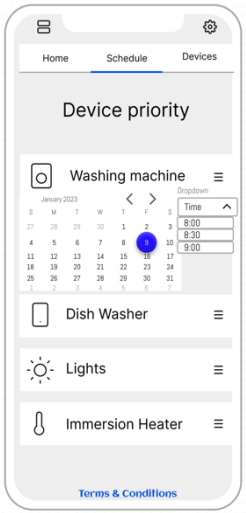


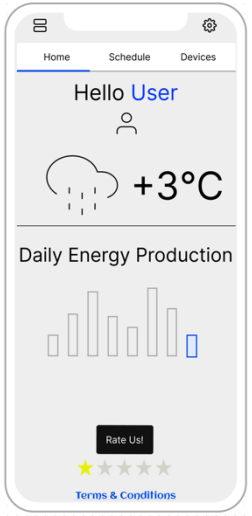


CASE STUDY *Routines and weather forecasting*

Due to work, school, and other commitments a large proportion of adult population spends much of their daytime hours outside of their houses. This leads to considerable waste of clean energy and the need for solutions. As such, the proposed prototype is designed to address this issue by offering remote management system that utilises solar power energy.

The user could set up conditions for device priorities, for instance, prioritize dish washer only on Mondays, or only after 2pm. Or to always prioritize smart devices over the smart-plugs in case user forgets to set them up. The user could also deselect certain devices if desired and retain that priority list. The user selects options on whether they would want to have solar power only, or whether if weather conditions change, they are happy to have a combination of both, or to keep the usage at 80% solar panels, or whichever combination/conditions best suit the user.





The user receives notifications about what appliance they suggest should be run that day based on the weather forecast and past usage of the app. The user is also able to remotely schedule when and what appliances should be run based on their priorities on that day.

Evaluation and further considerations

The proposed prototype was critically evaluated based on feedback provided by a focus-group. Overall, the objectives of the proposed solution were clearly apparent and regarded as feasible. The reviewers identified the need for the users to still having to prepare the appliances to be run (e.g., pre-loading a dishwasher) and the need to adapt a lot of already existing devices to smart technology. This is accurate, yet the number of connected devices is likely to vary among the users with some only connecting the most important appliances. The set-up/app configuration were also identified as potentially complicated to some users (e.g., elderly). For this reason, guidance videos would be provided to assist the installation. Despite the apparent limitations, the prototype was regarded as dynamic, practical, and clever. Future versions should focus on strengthening the security measures around smart meter connectivity (see Table 1).

Existing features & future directions. The app has the capacity to learn the pattern of usage of electricity from the devices and weather forecast to make decisions when it might be best to start using a certain device, and check this with the priority the user set. The app should be able to check past usage and see that on given days when the sun showed a similar intensity, this is what the wattage output was from the solar panels. It could also check for devices which have not been run relatively recently according to past-patterns and suggest that they run this device via push notifications. The app could calculate user savings based off of how much the solar panels were used that week/month/year. Over time the accuracy of the system should improve

EVALUATION REPORT

Procedure for evaluation

The evaluation procedure employed focus-group involving 4 members of another coursework group. The procedure involved a presentation carried out by one of the team members addressing the stated problem followed by design framework of the proposed prototype. The next step included Q&A phase where the feedback from the reviewers was obtained. Follow up questions were used to initiate further inquiry into specific areas of interest. In particular the use of open-ended questions assisted with developing a deeper understanding related to potential limitations of the app. The feedback was transcribed verbatim with main themes extracted to inform areas for improvement and future directions.

Results and conclusions

The summary of the findings were grouped under six themes (see Table 1). The main strengths related to the app offering a suitable solution to the problem thus meeting the overall objective of prototype. In addition, the reviewers identified the app as easy to use due to clear and simple UI set up where only the key information is presented. Overall, the reviewers expressed that the app appears dynamic, practical and clever which aligns with our objectives. There is however some room for improvements, especially in the area of security. The reviewers also expressed some concern about having to rely on different technologies to configure the app. This requires certain knowledge and competency which some users may not possess. While we already provide app support in terms of videos that help to guide the users through the installation process, perhaps providing more direct support may be beneficial. Finally, the design of the system requires the users to pre-prepare their appliances in order to run efficiently. We knew this was a known prerequisite related to some appliances (e.g. washing machines, dishwashers) and special reminders will be provided to the users to ensure that the devices are ready to be used when needed.

Table 1. Main review comments obtained as part of a focus group involving four individuals with background in product design and understanding of design principles.

Positive comments	Areas for improvement / future consideration
Offers solution to the problem Concept is very grounded with proof to back why this product would help people Easy to understand what it is trying to solve Really like in the prototype how the steps are broken down on how to get it to work, that is very useful, it is like a soft-landing in an app. It isn't assumed it is intuitive, it is explained how it is to work best *Usability* I like how the steps are broken down. In the app, it makes ease of use a lot easier *General attitude* Like the idea, practical and brilliant app Dynamic Systematic, practical and clever Rally like the idea, a solid 8/10	*Security* Concerned it doesn't have any security stages. Anyone could link into the smart meter, access smart appliances. *Technological requirements and knowledge* Reliant for users having up to date technology ▪ Like the washing machine, a high-tech washing machine could connect to the plug ▪ Based on the users technology, and assuming they would have technology to use it and turn it on and off It is not user friendly when it comes to old people. Because they already have such a difficulty with technology, adding a new smart technology could make their life harder. *Requires appliance preparation* Since it automates the turning on of machines depending on the weather. What would happen if it automatically turned on the washing machine when it is empty? How would you take that into account. What would happen if it automatically turned it on when it is empty?

REFERENCES

Al-Kuwari, M., Ramadan, A., Ismael, Y., Al-Sughair, L., Gastli, A., & Benammar, M. (2018). Smart-home automation using IoT-based sensing and monitoring platform. 2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG 2018),

Hubert, M., Blut, M., Brock, C., Zhang, R. W., Koch, V., & Riedl, R. (2019). The influence of acceptance and adoption drivers on smart home usage. *European Journal of Marketing, 53*(6), 1073–1098.

Kokolakis, S. (2017). Privacy attitudes and privacy behaviour: A review of current research on the privacy paradox phenomenon. *Computers & Security, 64*, 122-134. https://doi.org/https://doi.org/10.1016/j.cose.2015.07.002

Liu, Y. (2014). User control of personal information concerning mobile-app: Notice and consent? *Computer Law & Security Review, 30*(5), 521–529. https://doi.org/10.1016/j.clsr.2014.07.008

Marikyan, D., Papagiannidis, S., & Alamanos, E. (2019). Smart Home Technology Acceptance: An Empirical Investigation. Digital Transformation for a Sustainable Society in the 21st Century, Cham.

Quin, C. (2022). Reviews-Consumer Technology. Gadgets: Huawei Watch GT 3 Pro; Traintrackr London Underground; SwitchBot Curtain Rod 2; Garmin Varia RCT715; Prêt à Pousser Multo; Big Potato Moop. *Engineering & Technology, 17*(7), 68-69.

Skeledzija, N., Cesic, J., Koco, E., Bachler, V., Vucemilo, H. N., & Džapo, H. (2014). Smart home automation system for energy efficient housing. 2014 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO),

APPENDICES

Appendix 1: Block diagram for SpolarTech, a solar panel energy management system.