eMeter: An interactive energy monitor

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Abstract
In this work, we propose an interactive load monitoring system that provides instantaneous feedback of the energy consumption on household and device level. Therefore, we extended the capabilities of a smart electricity meter and developed a mobile phone interface that enables users to monitor, control, and interactively measure the consumption of their appliances. The system allows for identifying the biggest energy guzzlers and helps users decrease their energy consumption.

Keywords
Energy use, visualization, interaction design

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ACM Classification Keywords
H5.2. Information interfaces and presentation: User interfaces

Merging smart meters and mobile devices
Timely consumption feedback and guidance with respect to effective measures are keys in enabling users to change their behavior and decrease their energy consumption [1]. For users, it is desirable to know how much single appliances consume as well as to have the information at hand when needed. A monthly feedback provided through the energy bill is not sufficient [2]. Existing off-the-shelf products, such as LCD panels or intelligent power outlets that depict the energy consumption in near real time seem more promising. However, many users do not take advantage of such existing solutions mainly for two reasons. First, the products require a complex installation, and second they do not allow for instantaneous feedback on the consumption of an individual appliance.

To solve this problem, we developed a system consisting of a mobile phone interface and a backend infrastructure that lowers the barrier to get involved in home energy management. It not only provides real-time feedback, but also allows the user to interactively measure and compare the consumption, costs, and efficiency levels of individual devices on a portable user interface. Furthermore, since based on smart electricity meters, the system becomes easily applicable in every

household once smart meters are introduced. We wanted the user interface to be attractive, easily-accessible and to provide functionality that motivates the user for a long period. Thus, our application provides the following major functionalities. It shows the overall energy consumption of the household in real time (fig. 1 left) as well as the historical consumption on a daily, monthly, or weekly basis. Furthermore, the system allows for the user to interactively measure the consumption of any appliance or set of appliances in the house and thereafter allows personalization of the measurement. Finally, it shows an appliance summary that provides an overview of the consumption, the costs, and corresponding equivalents per measured appliance (fig. 1 right).

The backend architecture of our prototype is based on three independent elements (fig. 2). The first monitors and logs the energy consumption by the sensors of the smart meter. The second element, the gateway, consists of a parser, a database, and a tiny web server. To acquire the logged data from the Landis + Gyr smart meter E750 on a continuous basis in real time, the Smart Message Language (SML) [3] parser automatically polls the meter's

figure 1. User interface accessing real-time metering data

data and stores it in a SQL database. In order to enable interoperability with other applications, the web server offers access to the gateway's functionality and the smart meter's sensor values using URLs. This approach originates from the Web of Things [4], where connectivity to the functionalities of real-world devices is exposed using a REST API. The last element is the visualization interface. It uses the functionality provided by the gateway to access the data base and to dynamically present real-time information about the energy consumption.

Future work will address in more detail an evaluation of the prototype and an analysis of the potential to automatically recognize previously measured appliances.

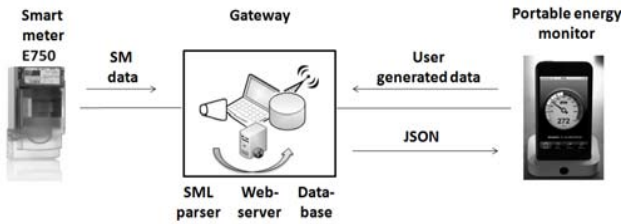

figure 2. Smart meter communicating with the mobile UI

References

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