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Minimizing storage costs by substituting centralized electrical storage by thermal storage at the end user, also suppling balancing power for grid operation

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Abstract

Many processes in industrial and domestic applications require heating or cooling at certain steps of a process. Even if the process itself cannot be shifted towards periods of high PV output (which would be favorable), the heating and cooling necessities can be carried out via an inexpensive thermal storage instead of a costly electrical storage. Examples are: distillation units, washing machines, dishwashers, coolers, freezers. The resulting "shiftability" of power consumption can be a business model by offering that availability of load dispatching on the balancing power market.
An example using PCM as cooling storage for refrigerators that has been investigated: A focus of this paper is the use of that load shifting ability to provide balancing power. Another emphasis is on the protection of individual consumer data: To keep the state of use of each individual consumer (actually: interactive consumer or "prosumer") anonymous, but still performing the sales of balancing power, the orders for load-dispatching can be transmitted via transmitted via a regional, non-individual broadcasting message within the GSM network. Demonstrating DSMs capacities, abilities and limits concerning domestic applications is an important task to prepare large-scale implementation and to convince stakeholders. To reaching that goal, several realistic DSM scenarios for cooling applications and freezers have been developed with the prerequisite that DSM activities are supposed to be without comfort losses and without restrictions for consumers while the limits for lower and upper temperature for food are maintained.

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Keywords: DSM; load management; load shifting; PCM; thermal storage; balancing power

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1. Introduction

Many processes in industrial and domestic applications require heating or cooling at certain steps of a process. Even if the process itself cannot be shifted towards periods of high PV output (which would be favorable), the heating and cooling necessities can be carried out via an inexpensive thermal storage instead of a costly electrical storage. Examples are: distillation units, washing machines, dishwashers, coolers, freezers. The resulting "shiftability" of power consumption can be a business model by offering that availability of load dispatching on the balancing power market.

An example using PCM as cooling storage for refrigerators that has been researched at our chair. In Germany, refrigerators and freezers account for 3.6 GW of electrical power that would be available for load management if they all would be equipped with PCM and suitable control units. Even if only 10 million new refrigerators were equipped (each consumes approximately 100 W during its active operation period), this would account for 1 GW of load control with high availability at little extra cost. Considering that modern refrigerator are equipped with microcomputer and some kind of data interface (e.g., EE-Bus), the addition costs are limited to software modifications. If thermal storage would be available for 8 hours only (state-of-the-art refrigerators even achieve more than 48 hours), that would be equivalent to 8 GWh of electrical storage, which is equivalent to the capacity of the largest pumped-hydro-power plant in Central Europe, Goldisthal which had construction costs of 620 mio € [1]. Taking that as a reference, each individual refrigerator has a value for substituted storage of 62 €. A focus of this paper is the use of that load shifting ability to provide balancing power. Another emphasis is on the protection of individual consumer data: To keep the state of use of each individual consumer (actually: interactive consumer or "prosumer") anonymous, but still performing the sales of balancing power, the orders for load-dispatching can be transmitted via transmitted via a regional, non-individual broadcasting message within the GSM network (see Fig. 1).

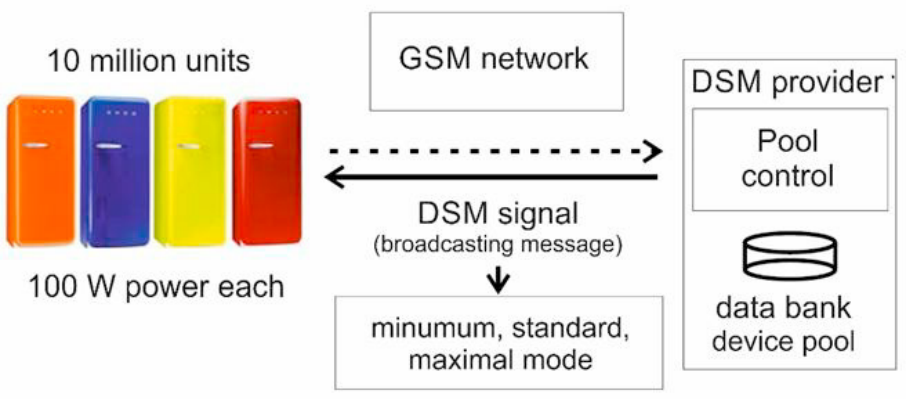

Fig. 1. Example for distributed load management to overcome storage necessities: Communication structure for influencing load by turning on/off cooling units (equipped with latent cold storage).

Demonstrating DSMs capacities, abilities and limits concerning domestic applications is an important task to prepare large-scale implementation and to convince stakeholders. To reaching that goal, several realistic DSM scenarios for cooling applications and freezers have been developed with the prerequisite that DSM activities are supposed to be without comfort losses and without restrictions for consumers while the limits for lower and upper temperature for food are maintained.