Off-grid energy management system

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ABSTRACT

The Meteoriihi exhibition centre is disconnected from the main power grid, and it produces all energy it needs locally by means of wind and solar energy, having a diesel generator as a backup system. Energy is needed for lighting, computer systems of the co-located star observatory by Vaasa Andromeda, audio-visual equipment of the exhibition and for heating. Off-grid system must maintain the balance between consumption and production on its own, which can be demanding, especially when the energy is produced mainly by using intermittent renewable energy sources. The Meteoriihi energy system contains a batteries for balancing production and consumption, and a diesel generator to provide backup energy, but in addition a flexible demand side management is also needed. The demand side management is most useful for consumption which requires a lot of energy and is not too time critical, like heating, which requires most energy during cold seasons but can be time shifted when needed. Typically electrical heating appears as a one big load which can be switched on or off. This switching creates a huge stepwise increase or decrease of load, which may cause degradation of the quality of electricity, and may be difficult to compensate with renewable energy production. Therefore the heating elements should be better adjustable to serve as flexible controllable load to help maintaining energy balance instead of endangering it. This can be achieved by having several smaller heating elements which are switched on and off sequentially, according to the current power situation or using inverter controlled heating elements or heat pumps, which can be continuously controlled. The purpose of this work is to implement an energy management system for Meteoriihi, including demand side management by heating control, using LabView programming environment. The system is tested by using measured solar irradiation, wind speed and outside temperature of the area and the heating control supporting demand side mnagement is tested in a laboratory by using a polystyrene scale model of the building and a PWM controlled heating element.

