

Article

Energy Management for an Air Conditioning System Using a Storage Device to Reduce the On-Peak Power Consumption

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Abstract: To reduce the on-peak electrical power consumption, storage devices are widely performed with the help of an energy management system. According to IEA, residential air conditioning consumes 70% of the electricity, increasing by 4% every year. To minimize peak power consumption, thermal energy storage (TES) can be used to store cooled water for the air conditioning system. An efficient chilled water tank was designed and computationally investigated. Three-dimensional cylindrical tanks were simulated with seven different heights to diameter (H:D) ratios. At first, the temperature changes in a chilled water tank during discharging and charging periods were studied. An 11-hr charging period was carried out during the off-peak time at night, while the discharging period was 13 h during the daytime. Under time constraints regarding peak and off-peak periods, a tank with an H:D = 2.0 can only be used for 13-h discharging. Then the chilled water was simulated with a set temperature of 4 °C during the charging. This resulted in the system being usable for six days, after which it had to be stopped for longer charging. A storage tank with an H:D ratio of 2.0 was found to be suitable for an air conditioning system. If six days of operations (one day off) were used, it could save 15.38% of electrical energy consumption and 51.65% of electricity cost. This saving leads to a 5.55-year payback period.

Keywords: energy management; green batteries; energy saving; on-peak power reduction; efficient air-conditioning

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1. Introduction

Urbanization and digitalization increase global power consumption, and most nations depend on the conventional power-generating methods [1,2]. Non-renewable-based power generation techniques are economically reliable though it increases global warming and depletion of natural resources [3–5]. Pollutions from conventional power generation techniques majorly increase global temperatures and climate change [6]. Several nations are encouraging to implement the renewable-based power generation techniques to minimize the consumption of fossil fuels [7–9]. However, replacing conventional power generators is always a difficult option, especially for developing countries [10,11]. The initial investment in replacing conventional power generator with renewable energy systems is comparatively high; considering this issue, several nations are providing subsidies to promote renewable energy [12,13].

For developing countries, peak demand is an energy difficulty facing a higher peak every year. Well-planned peak demand must be carefully emphasized. For example, in 2019, Thailand expected 197,335 GWh electricity consumption (4.5% increase) and about 32,000 MW peak demand [14]. Climate change is one of the reasons causing higher peak demand. For Thailand, the average temperature is predicted to increase by 1.74–3.43 °C by 2080. This would result in a 1.5–3.1%, 3.7–8.3%, and 6.6–15.3% increase in peak demand

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