

Development of an Intelligent Energy Measurement Device for Buildings

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Abstract— Depletion of nonrenewable energy resources and increasing energy demand have raised the importance of energy efficiency recently. In order to achieve an energy efficient future for the next generations of humanity, conventional devices having low efficiency should be replaced with intelligent devices possessing high efficiency. Owing to internet of things (IoT), classic devices have been converted to intelligent devices which can be remotely accessed, monitored and controlled by utilizing ubiquitous sensors. In this paper, a low-cost intelligent energy measurement device (iDev) is aimed to design in order to compute and store electrical energy consumption into a database by an embedded card, namely Arduino which measures voltage, current, frequency and power factor. When a traditional device is connected to the proposed iDev, the device turns into an intelligent device that is remotely controllable. As a result, if a whole building is equipped with the proposed iDev, it is considered that a large amount of electrical energy will be saved for a better and livable Earth.

Keywords— Energy Measurement, Intelligent Device, Smart Building, Energy Saving, Energy Efficiency, Energy Management

I. INTRODUCTION

Energy is an indispensable necessity for human life. Technological developments, which push imagination limits of mankind, have caused an increase in energy demand. The rapid depletion of fossil fuels has enhanced the value of energy by making energy efficiency and energy saving compulsory. Dependency on fossil fuels has not died out completely because of the fact that the amount of energy production from renewable energy sources does not cover the whole demand. Utilization of advanced technology with an ascending trend indicates that increase in energy consumption will proceed in terms of future expectations.

Expanding awareness related to conscious consumption becomes more of an issue in order to avoid a future energy crisis. It is meaningless to estimate how much energy is saved without measuring how much energy is consumed. In such a case, it is impossible to mention about energy saving or energy efficiency. It is probable to determine the energy consumption amount of a

device by carrying out measurement of the used device. Evaluating the measured values and creating scenarios with respect to the results of these evaluations are essential steps in energy management. By energy management, while energy saving is realized by preventing from unnecessary use of existing energy, energy efficiency is also provided by consuming less energy simultaneously

Energy consumption of devices should be kept under control 24/7 continuously. Auto-measurement of energy consumption amount via a computer is important from the point of view of data integrity. The requirement for controlling itself constantly has led to the emergence of "smart" and "intelligent". These concepts are used interchangeably in the literature. As a result of the measurements, saving scenarios should be identified by creating energy consumption profile of each device. Energy savings should be accomplished without lowering current living standards. Control and management by developing intelligent systems rather than direct human controlled inspections will increase the efficiency [1].

When energy consumption is investigated on a sectoral basis, it is seen that buildings have a significant place. In the investigated studies, buildings consume 40% of annual energy cost in U.S., and 30% of energy consumption is wasted [2], [3]. The energy consumption of buildings during the whole life cycle is responsible for 40% of total European Union energy consumption too. In addition, greenhouse gas emissions since buildings account for 36% of EU's total CO₂ emissions. Future projections indicate that in 2030 buildings will be responsible for 35.6% of primary energy use in the world, and continue to maintain its importance [1], [4].

Thanks to the construction of smart buildings and production of smart devices, more efficient utilization of energy sources has been provided. Furthermore, owing to embedded software programs, self-operating systems have been devised without the need of expensive computers. New intelligent systems have been developed by adding data storage units and the Internet, and this new system is named as the Internet of things (IoT) in the literature. Non-intelligent devices are turned into intelligent

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