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Plug Load Monitoring over various devices to implement Energy Conservation

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I. Abstract

The energy meter is an electrical measuring device, which is used to record Electrical Energy Consumed over a specified period of time in terms of units. These energy devices collect the data intern to provide a specific analysis of energy consumption, for the analysis of energy conservation over the study on different devices of different models and under different working phenomenon. We present insights obtained from this study using plug loads including the study of design process. This paper even convey the information regarding the collection of energy meter data and internal functionality involved in it to build up a less expensive plug load monitoring device.

II. Introduction

Nearly all everyday products have an impact in terms of energy, especially when you consider their energy requirements across the whole life-cycle: production, use and end-of-life. In many cases the use phase is dominating. Electronic devices usage became a very prominent thing every individual's life intern causing consumption of energy to a very lot extent. Develop efficient strategies to produce data over a longer period to have an analysis on the device performance and to estimate the usage of every individual device. As of today, the world is facing an energy crisis. The petroleum rates have risen, electricity is getting costlier, and resources are getting depleted. Examples of plug loads in an academic institute are computers, monitors, printers, copiers, projectors and so on. Plug loads are spread across different categories, therefore they are difficult to monitor and control because of their use for diverse functions. There is a need for detailed accounting of usage pattern and energy information of these MELs. This would help building managers develop efficient strategies to reduce the power consumption during peak times. These devices consume significant power in standby mode which is known as vampire power or phantom load. The phantom load of different devices can be measured from the metering study. Policies and strategies can be developed for these devices to reduce wastage of power.

III. Study Objective

The main objective of our study is to analyze the plug load energy data and identify the energy consumption and usage patterns of the plug load devices. This study will enable us to develop efficient policies and strategies in the institute to reduce the plug load energy consumption.

IV. Proposed Method:

- Calculate the energy usage of devices over a specified time period.
- Estimate annual energy use of devices including variability from typical for that device type. (i.e. distribution of annual energy use for a given device type)
- Calculate average load shapes for different day types (day of week, weekday vs. weekend).
- Estimate the time in power mode for devices over a specified time period.

This analysis task is to calculate device energy use over a specified period, estimate the annual unit energy consumption of the device based on the specified period of metering, and provide an error bar for the estimate. The analysis method selected is driven by the need to provide an error bar on the final estimate. The simplest method of performing an energy estimate would be to take the sum of all of the power measurements over a period and multiply by the time per sample.

V. Design of energy meter

The energy meter device would be working according to the program in the controller i.e. once the device is plugged in to the power supply the device will be in the active stage. Depending on the interrupt for every 1/30 second the data get collected in the data records in STPM10 (energy meter chip). The raw data at the registers get converted to

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different data types which are multiplied with multiplication factors to obtain the data as energy current and voltage. The obtained data is stored in the external memory (EEPROM 24C512) with regular time intervals i.e. for every ten minutes. External RTC is in support to submit the date and time with internal CMOS battery to update the time even after being in off state. All these functionalities are carried out with the controller commands to the interfacing devices .The user can collect the data to PC through RoHS TTL-232RG cable.

VI. Results

As per the working of device results are obtained and graphical representation with the summarized data. One minute summarized data for duration of one day to monitor the category computers, displays and imaging devices. The analysis task is to estimate the energy consumption over a period of complete one day with time interval of one minute. To depict the data to be clean and analysis to be fine-tuned to monitor minute difference in the device performance we took the data with less time interval. Each device is set up with a meter id to maintain the data in the database for a longer duration without any distraction. The study is categorized to collect the data into five different categories i.e. Displays, Computers, Imaging, Networking and other appliances. The devices are shuffled into different categories, continuous one day date is collected for each device and average energy is calculated with respect to time and to create the confidence intervals over a period of one year.

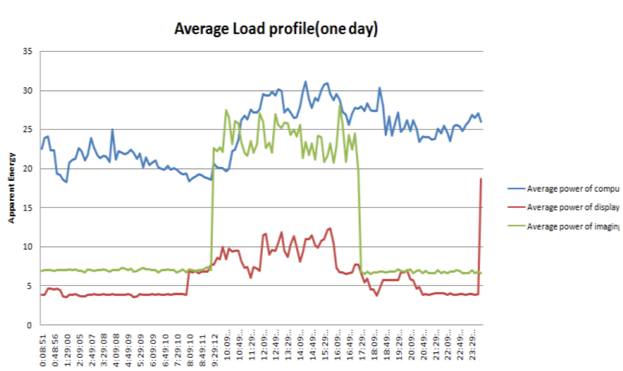

Fig 5: Average Load profile

5.1 Calculate Device Energy Usage:

Insights with an overlook of graph (average load profile for one day): As per the estimated graphs imaging devices are under the sleep mode for longer time i.e. if the energy consumption is zero then the device would be under off state, but the imaging devices are under active. On an average outlook of the graph the data is depicted to be with less apparent energy for display devices, each and every device is left under sleep mode for a longer even if it is left over without any work.

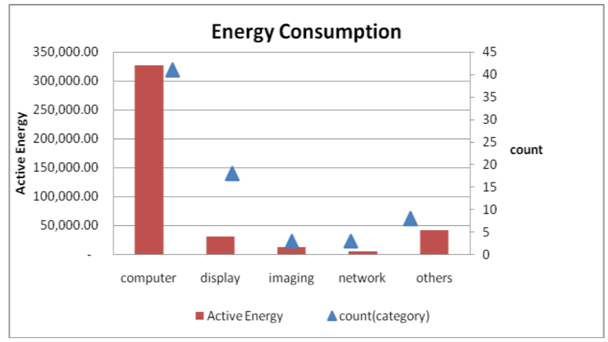

Fig 5.1: Energy consumption with respect to count

5.2 Histogram Analysis

Computers are under the maximum usage over a period of one day, and even these are also left under sleep mode when not used. Ultimate thing to be notified is that devices left under sleep mode also consume energy.

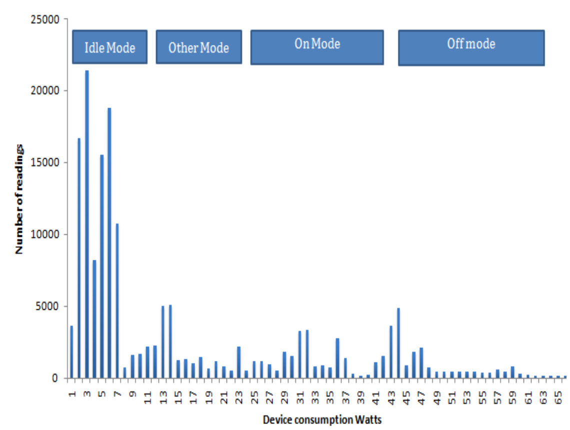

Fig 5.2: Histogram

This analysis task is to take time series data and generate an estimate of the power levels and time in mode for the off, low power (sleep), and on modes. When energy is used in a mode or modes that do not fit this three state model, this energy is lumped into an "other" mode. The other mode may consist of multiple discrete power levels and the energy use is then simply added for the extra modes. To take time series power data and identify modes, a week of power data is selected, and a fine grained histogram is performed.

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Product	Mode	Max(W)	Min(W)	Avg(W)
Integrated PC	On	42.2	28.768	35.1904
	Idle	30.5922	27.588	28.51075
	Suspend	4.572	4.332	4.4171
	Hibernate	4.334	3.876	4.257104
IBM display	On	47.0916	41.496	44.87063
	Idle	42.9768	39.925	41.7809
	Suspend	7.5537	7.3056	7.38186
	Hibernate	7.5537	7.3056	7.394242
Hpdv6	On	38.0325	31.6986	33.70847
	Idle	32.9329	27.8905	19.58501
	Suspend	6.008	5.0293	5.592417
Zebronics CPU	On	63.0729	45.2128	51.14181
	Idle	46.1622	44.304	44.77306
	Suspend	7.98	7.2768	7.422166
	Hibernate	7.524	7.2768	7.367196
Coffee Machine	On	1762.77	570.489	1553.817
	suspend	6.7396	3.9576	4.74483
HCL Cpu	On	82.2464	55.404	50.0073
	suspend	20.4433	12.7512	13.24986
Zenith Cpu	On	37.9424	30.0168	31.17567
	suspend	13.446	11.8404	12.83349
Dell 14R CPU	On	54.79	30.004	34.6126
	Suspend	6.3457	5.8672	5.9987
HP laserjet pro	On	968.423	228.715	760.4038
	Suspend	42.6522	7.399	9.171547
Zenith 21” display	On	19.9317	18.7206	19.3619
	suspend	7.2459	6.8967	7.0187

Table 5.2: Product with power consumption

VII. Conclusion

The plug load data analysis has provided us with valuable insights about usage patterns, and device energy consumption in an academic institute. Plug loads were accounting for a significant amount of energy usage in the academic institute. The high power consuming and inefficient plug loads were identified. The strategies for reducing plug load consumption were suggested.

VIII. References

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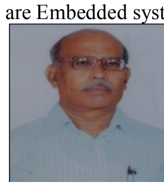

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