CREATING THE STANDARD FOR SPECIFIC ENERGY CONSUMPTION AT PALM OIL INDUSTRY

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Abstract *-- There is currently no standard for the Specific Energy Consumption (SEC) in the palm oil industry. SEC is a value that can be used as an indicator to measure the optimization level in the use of energy. Indonesia as one of the largest palm oil producing countries requires a standard for energy intensity in the palm oil industry. SEC in palm oil mill is defined in the amount of energy per unit of production (kWh/kg). The classifying method that has been used in this study is K-means cluster analysis with the measurement samples in 14 palm oil mills for 12 months of period. This study has suggested the SEC standard for Indonesian palm oil industry and it is expected to be SEC reference for other studies in the palm oil industry.*

Keywords*: SEC, palm oil, energy*

Abstrak *– Saat ini, tidak terdapat standarisasi mengenai konsumsi energi spesifik atau Specific Energy Consumption (SEC) di dunia industri minyak kelapa sawit. SEC adalah ukuran yang dapat digunakan sebagai indikasi untuk mengukur tingkat optimum dalam penggunaan energi. Indonesia adalah salah satu negara penghasil minyak kelapa sawit terbesar yang membutuhkan standarisasi tersebut untuk mengetahui intensitas energi pada industrik kelapa sawit. SEC pada industri kelapa sawit didefinisikan sebagai suatu jumlah energi per unit produksi (kWh/kg). Beberapa metoda klasifikasi yang digunakan pada penelitian ini adalah Analisis cluster K-Mean dengan sampel pengukuran 14 buah pabrik minyak kelapa sawit selama periode 12 bulan. Penelitian ini menyarankan standar SEC untuk industri kelapa sawit Indonesia dan diharapkan dapat menjadi referensi untuk penelitian,*

Kata kunci*: SEC, minyak kelapa sawit, energi*

INTRODUCTION

Energy supply crisis is now becoming a strategic issue in the national development. Growth in energy consumption as a result of increasing population, industrialization, transportation and welfare of the people is causing the imbalance between the energy demand and supply. Meanwhile, the main energy source such, as fuel oil and natural gas, has increasingly been depleted and the utilization of alternative energy yet optimized, so we need significant efforts in earnest to harness energy wisely and efficiently.

Energy conservation is the use of energy efficiently and rationally, without prejudice to the use of energy that is absolutely necessary. Efforts that we can do in energy conservation at all stages of utilization, involve the use of efficient technologies and the cultivation of energy-saving lifestyles. In practical terms the energy conservation efforts involve reducing the amount of energy used while producing the same or even better results. This effort can increase corporate profits, environmental value, national security, personnel security, and human comfort.

The initial step in the conservation of energy is the energy audit. The energy audit is a Specific Energy Consumption (SEC) among the outputs. The objective of the energy audit it self is to review the present energy consumption pattern and suggest ways and means for improving energy utilization by bringing about optimum energy balance and target for continuous improvement towards minimizing the SEC.

SEC standard formulation in this study is the result of processing the data obtained from energy audits in 14 palm oil mills throughout 2014.

PRODUCT OPPURTUNITY GAP

The identification of product opportunities should be the core force that drives companies. Product opportunity exists when there is a gap between what is currently on the market and the possibility for new or significantly improved products that result from emerging trends (Cagan and Vogel, 2001).

Figure 1. Scanning SETE Factors leads to POGs

A product that successfully fills a Product Opportunity Gap (POG) does so when it meets the conscious and unconscious expectations of consumers and is perceived as useful, useable, and desirable. Successfully identifying a POG is a combination of art and science. It requires a constant sweep of a number of factors in three major areas: Social trends (S), Economic forces (E), and Technological advances (T) (Vogel et al., 2005). In this paper we added one more factor, which is Environmental impact (E).

In the early stages of an innovation journey, we must identify opportunities with SETE factors for product opportunity gap. After that, we must understand opportunities by value opportunity on product attributes / specifications. At the last stage of product planning, we must build the product concepts.

SETE factors for product opportunity gap are: social trends: the trend of 'green lifestyle' which calls for the eco labeling of palm oil products, economic forces: how to give the value of sal, es in the global market with palm oil products that consume less energy, technological advances: trigger improvements towards energy efficient technology and environmental impact: setting the benchmark for the preparation of life cycle analysis (LCA)

While we get the opportunity value of the impact of societal influence connected to and addressed by the SEC standards, in which the people have environmental awareness. With the SEC reference standard, the people can identify mills that have high or low energy intensity. These SETE factors generates opportunities to set a SEC standards that can have an effect on the production process at the palm oil industry. The goal is to create an added value by identifying an emerging trend and to match that trend with the right tool.

LITERATURE REVIEW

The existing research in this area can be broadly viewed under two different perspectives of 'plant' and 'process' level. The first area, the 'plant' level perspective, has focused on the energy consumed by infrastructure and other high level services that are responsible for maintaining the required production conditions or environments. Examples of such energy consuming activities would be ventilation, lighting, heating and cooling within a facility (Moss, 2006). Energy management systems (EMS) are commonly used to monitor these activities (Somervell, 1991). For example, Boyd et al. (2008) utilises a statistical analysis approach to determine the manufacturing Energy Performance Indicators based on 'plant level' variables.

On the other hand, the research targeting the energy consumption at the process level has concentrated on individual equipment, machinery and workstations within a production system. Substantial research has been targeted to document, analyse and reduce process emissions for a wide range of available and emerging manufacturing processes (Devoldere et al., 2007) (Herman et al., 2007)

Overcash et al. (2009) along with a group of other engineers are working to produce an engineering rule-of-practice-based analysis of separate unit processes used in manufacturing and the information is collated in the form of a unit process life cycle inventory (UPLCI) which would help the evaluation of manufactured products through the quantification of various parameters including: input materials, energy requirements, material losses and machine variables.

In addition, the specific energy of various manufacturing processes was previously summarized by Gutowski et al. (2006). They had develop generalised 'equipment-level' energy models, using average energy intensities of different manufacturing processes to evaluate the efficiency of processing lines. However, the considerations of energy flows at plant or process level cannot provide an overview of ''how much energy is required to manufacture a unit product''.

This study, though, will focus on the result of energy audit at the palm oil industry when characterizing the specific energy consumption. The approach in this research is based on a product viewpoint with the aim of representing the amount of energy attributed to the manufacture of a unit product of Crude Palm Oil (CPO).

METHODE OF COLLECTING DATA

The audit process starts by collecting information about a facility's operation and about its past record of utility bills. This data is then analyzed to get a picture of how the facility uses—and possibly wastes—energy, as well as to help the auditor learn what areas to examine to reduce energy costs. Specific changes—called Energy Conservation Opportunities (ECO's)—are identified and evaluated to determine their benefits and their cost-effectiveness.

These ECO's are assessed in terms of their costs and benefits, and an economic comparison is made to rank the various ECO's. Finally, an Action Plan is created where certain ECO's are selected for implementation, and the actual process of saving energy and saving money begins.

To obtain the best information for a successful energy cost control program, the auditor must make some measurements during the audit visit. The amount of equipment needed depends on the type of energy-consuming equipment used at the facility, and on the range of potential ECO's that might be considered. For example, if waste heat recovery is being considered as in palm oil mills, then the auditor must take substantial temperature measurement data from potential heat sources.

The auditor collecting data on energy use, power demand and cost for at least the previous 12 months. Twenty-four months of data might be necessary to adequately understand some types of billing methods. However, in this study the data is collected for only 12 months of period.

Bills for gas, oil, coal and electricity should be compiled and examined to determine both the amount of energy used and the cost of that energy. This data should then be put into tabular and graphic form to see what kind of patterns or problems appear from the tables or graphs. Any anomaly in the pattern of energy use raises the possibility for some significant energy or cost savings by identifying and controlling that anomalous behavior. Sometimes an anomaly on the graph or in the table reflects an error in billing, but generally the deviation shows that some activity is going on that has not been noticed, or is not completely understood by the palm oil company.

CREATING THE SEC STANDARD

SEC is a value that can be used as an indicator to measure the level of optimization in the use of energy. Indonesia as one of the largest palm oil producing countries requires a standard for energy intensity in the palm oil industry. SEC in the palm oil mill is defined in the amount of energy per unit of production (kWh/kg). The classifying method that was used in this study is the K-means cluster analysis with the measurement samples in 14 palm oil mills for 12 months of period (168 data). SEC data used in this study are as follows in Table 1 and Table 2. From the SEC data, we can made a scatter pattern as depicted Figure 2.

Table 1. SEC Data for Plant 1 – 7

No.	SEC (kWh/kg)						
	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7
1	4.26	5.26	4.55	4.77	5.65	5.26	4.55
2	4.22	5.08	4.66	4.85	3.13	5.08	4.66
3	4.12	5.13	4.66	4.71	4.69	5.13	4.66
4	4.12	5.07	4.74	4.74	4.73	5.07	4.74
5	3.59	5.17	4.76	4.77	4.75	5.17	4.76
6	4.09	5.07	4.66	4.66	4.57	5.07	4.66
7	4.51	5.04	4.54	4.62	4.74	5.04	4.54
8	4.18	4.86	4.79	4.64	4.59	4.86	4.79
9	4.83	4.99	4.68	4.63	4.64	4.99	4.68
10	5.08	5.05	4.70	4.58	4.75	5.05	4.70
11	4.71	4.65	4.74	4.56	4.77	4.65	4.74
12	4.39	5.72	4.73	4.54	4.73	5.72	4.73

Table 2. SEC Data for Plant 8 – 14

No.	SEC (kWh/kg)						
	Plant 8	Plant 9	Plant 10	Plant 11	Plant 12	Plant 13	Plant 14
1	4.78	4.74	6.38	4.82	4.52	6.16	5.32
2	4.99	4.76	6.44	5.08	4.74	6.18	5,38
3	4.62	4.73	5.17	5.12	4.73	6.03	5.18
4	5.78	4.79	6.01	5.18	4.62	6.06	5.16
5	7.21	4.75	6.15	5.06	4.61	6.15	5.36
6	8.53	4.88	5.99	5.28	4.65	6.04	5.45
7	7.72	4.75	6.13	5,79	4.63	6.01	5.81
8	5.91	4.84	5.85	5.27	4.55	5.78	5.72
9	5.41	4.73	6.21	5.08	4.58	6.84	5.88
10	5.42	4.76	6.21	4.75	4.51	6.05	5.75
11	4.95	4.95	6.11	4.85	4.52	5.65	5.85
12	5.52	4.76	6.35	4.84	4.43	6.12	5.24

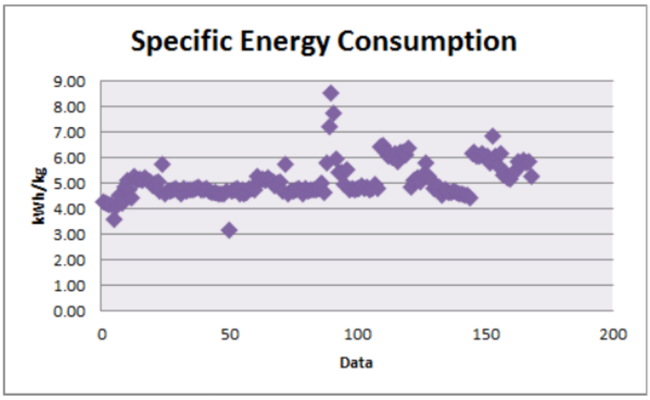

Figure 2. SEC Scatter Pattern

With K-means cluster analysis as a classifying method, at the initial stage we classified existing data into 3 clusters with the hope there would be three levels of the SEC; those are low, medium and high level of SEC. The initial cluster centers that were obtained are as follows:

- Cluster 1: 8.53
- Cluster 2: 3.13
- Cluster 3: 5.85

After 6 times of iterating, we obtained the final cluster centers as follows:

- Cluster 1: 6.16
- Cluster 2: 4.01
- Cluster 3: 4.84

The member in the first cluster is 38 data, the second cluster is 9 data and the third cluster is 121 data. Thus we can identify the SEC standards for palm oil industry which amounted to 4.84 kWh/kg with the low-value SEC (energy efficient) at 4.01 kWh/kg and high-value SEC (energy inefficient) at 6.16 kWh/kg.

CONCLUSION

Currently there are limited references which can be used in formulating energy conservation strategy and life cycle analysis. SEC standards in the palm oil industry are expected to be an early innovation towards the making of energy efficient technology and life cycle analysis in the palm oil industry.

REFERENCES

Boyd, G., Dutrow, E., Tunnessen, W., The evolution of the ENERGY STAR 1 energy performance indicator for benchmarking industrial plant manufacturing use, Journal of Cleaner Production, 16:709–715, 2008.

Cagan, J. and C. M. Vogel, *Creating Breakthrough Products.* Prentice Hall, 2001. (Cagan and Vogel, 2001)

Devoldere, T., Dewulf, W., Deprez, W., Willems, B., Duflou, R.J., *Improvement Potentials for Energy Consumption in Discrete Part Production Machines*, in: Proceedings 14th CIRP Conference on Life Cycle Engineering (Tokyo, Japan), 2007; pp.311–316.

Gutowski, T., Dahmus, J., et al, *Electrical Energy Requirements for a Manufacturing Process*, in: Proceedings of CIRP International Conference on Life Cycle Engineering (Leuven, Belgium), 2006.

Herrman, C., Bergmann, L., Thiede, S., Zein, A., *Energy Labels for Production Machines—An Approach to Facilitate Energy Efficiency in Production Systems*, in: Proceedings of 40th CIRP International Seminar on Manufacturing Systems. 2007.

Moss, K.J., *Energy Management in Buildings, 2nd edition*. Taylor & Francis, London, 2006.

Overcash, M., Twomey, J., Kalla, D., Unit Process Life Cycle Inventory for Product Manufacturing Operations, ASME International Manufacturing Science and Engineering Conference, West Lafayette, IN, USA, 2009.

Somervell D, (Ed.), *Educated Energy Management*. E&FN Spon, London, UK, 1991.

Vogel, C. M., J. Cagan, and P. Boatwright, *Design of Things to Come - How Ordinary People Create Extraordinary Products*. Pearson Education, 2005. (Vogel et al., 2005)