Energy

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INTRODUCTION OF AN ENERGY MANAGEMENT SYSTEM FOR SUGAR PRODUCTION: IMPLEMENTATION STRATEGY

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Abstract

The following paper reviews and suggests changes and innovations needed to introduce an Energy Management System (referred to as EMS) for sugar production. EMS is a frame of IT tools and processes that are aimed to analyze, monitor, control and optimize the usage of energy in a factory, office or a facility. The study assesses current energy practices in sugar production, proposing solutions that enhance efficiency and reduce energy waste. Through detailed analysis and real-world examples, this paper demonstrates how adopting an EMS can lead to significant energy savings and contribute to sustainable sugar production.

Keywords: Energy Management System, Sugar Production, Renewable Energy, Efficiency, EMS

Introduction

The main ideas behind EMS is to use hardware, software and operational strategies to analyze energy usage, control energy resources and use the gathered data to spot opportunities to decrease energy consumption and increase efficiency[1]. Introducing an EMS can bring benefits in economic, social and legislative scale. Firstly, analytical tools of EMS can assist in energy efficiency. The tools are necessary to decrease the energy waste and spot areas where energy consumption can be lowered, as a result directly influencing the cost of final goods. EMS provides data insights on peak demand and assists to manage schedules of production to minimize cost. Operational cost can be lowered as a result of suggestions based on data analysis tools, this in particular is in favor of energy intensive industries. On the other hand, one of the main topics to consider is Sustainability goals. Sugar production creates emissions and

consumes large amounts of energy, thus sustainability should be a priority for such productions. EMS is necessary to help to reduce the carbon footprint by using energy sources more efficiently. Last, but not least EMS can be a requirement from the government, in order to comply with regulations productions will need to establish EMS. As a result, introducing an EMS is a necessity for all production.

While introducing EMS for a sugar-producing company I will refer to my professional experience of working in sugar production in "Angren Shakar" company. I had a chance to work in a sugar factory in Uzbekistan, particularly in implementing technological advancements in machinery. During my work in the factory, I was able to closely observe and participate in machine installation to increase the effectiveness of the sugar packaging process. I worked with a specialist from a "Statec Binder" [2] company based in Austria. This collaboration provided valuable insight into the technological and logistic innovations in the field.

Methodology

This study uses a two-pronged methodology: a comprehensive literature review and the development of an adapted implementation strategy for an EMS in sugar production. The literature review focuses on existing research in energy management systems, sugar production process, and technological innovations in the field. Main production stages, such as extraction, purification, and crystallization, are examined to spot high energy consumption processes.

Based on this review, the implementation strategy was developed by analyzing the most energy-consuming steps in sugar production and evaluating the potential benefits of adopting EMS tools. The study, as well, focuses on the technological equipment used in sugar production and evaluates the potential benefits after adopting EMS tools.

It is essential to review the entire sugar production process, starting with the cultivation of sugar beets and cane. There are two products that are cultivated to extract sugar, these are beets and cane [3]. Main proportion of sugar, approximately 85%, is produced from sugar cane. Sugar cane is produced in tropical countries (Figure 1), making Brazil the biggest exporter of sugar in the world.

Once harvested, the cane undergoes washing and cleaning to prepare the raw material for production. The next step is purification, adding lime and carbon dioxide [4] to clean the sugar syrup from particles that could still exist. The next step is evaporation, as the solution still has more water than sugar. The process is done in vacuum

conditions. After this step is done, the sugar concentration in the extract is about 70%. This means that there is a watery mass with sugar crystals.

To get dry pure sugar the centrifuges are used. As centrifuges rotate all the mois(molasses) is extracted from sugar crystals, leaving nearly pure sugar as we are used to seeing every day. The last step is cooling and packing sugar into special bags.

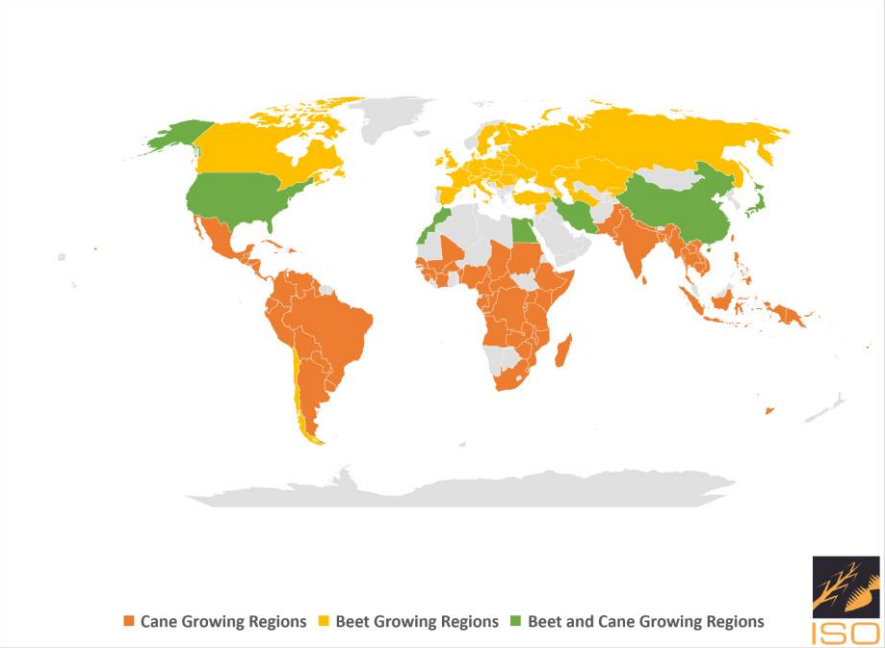

Figure 1- Map of Sugarcane and Sugar Beets growing regions

The case of *CMS Window Systems* serves as a strong example of successfully implementing an Energy Management System (EMS) in production[5]. CMS Window Systems is a leading manufacturer and installer of aluminum, PVCu, and timber hybrid windows, doors, and curtain walling. The EMS implementation followed several key steps, starting with the design of mechanisms for waste management. This not only reduced resource usage but also lowered the overall production costs. Additionally, the system improved the efficiency of equipment, minimizing material waste, energy consumption, and manpower requirements. Furthermore, the company optimized logistics and transportation, which significantly reduced fuel consumption. As a result of implementing the EMS, CMS Window Systems saved 9.2 tonnes of CO_2 emissions in 2015.

After reviewing the entire production process, it becomes clear that data collection is crucial for optimizing resource usage and improving energy efficiency. To achieve this, sensors must be installed at key stages where resources like electricity, gas, steam, and water are consumed. For example, fuel consumption meters and heat production sensors should be installed on the boilers that are used to heat the syrup, allowing for the tracking of both fuel usage and thermal energy output. Similarly, electricity meters

should be placed on centrifuges, which consume significant energy during the separation of sugar crystals from molasses, to monitor their performance and identify inefficiencies. Additionally, evaporation units require both electricity and steam meters to measure energy consumption and thermal efficiency during the concentration process. Crystallization machines, another energy-intensive stage, will benefit from electricity meters to ensure optimal energy usage. The data gathered from these meters can then be used for real-time monitoring and analysis, providing insights into resource consumption and enabling targeted improvements. Moreover, this system will support predictive maintenance by generating alerts based on actual equipment performance, reducing downtime and enhancing overall efficiency. Alongside hardware installation, it is necessary to consider software updates to EMS.

The first step of introducing an IT landscape would be the introduction of an industrial network. An industrial network is necessary to connect production mechanisms and energy monitoring equipment. The network will be used to control and gather data throughout all the equipment in the production. The main advantages of the industrial network include connectivity and operability of all systems to support the adaptation of innovative systems and assist the expansion of program change, allowing secure flow of data through the system and allowing to presentation of an operable database, decreasing the amount of time to transport and analyze the data and allows to make timely changes and solutions, allow to diversify type of data such as images and video material from the sites [6]. A single command unit of control will increase the effectiveness of the production. To complete these changes it is needed for a production to establish its wireless or industrial ethernet connection to have a complex and secure system. Ethernet connection will unite sensors, meters, and SCADA systems. The main reason behind choosing industrial ethernet is that this technology allows us to have a more secure and reliable connection. As a result, usage of this network will increase production scale, decrease the time of system changes, and improve the overall profitability of the production. One of the advantages of the Ethernet is that it allows communication with machines over huge distances in a matter of milliseconds, as a result increasing automation of the process without any human assistance needed. Ethernet allows to increase in the durability of machines as this system can be used to make diagnoses of the equipment. Usage of such a system will allow the operator to get up-to-date data about the equipment in seconds. It is believed that Ethernet is the best fit for industries with their harsh conditions.

After the software landscape is structured and implemented, lastly it is necessary to establish data servers. In order to effectively manage and store the data from meters,

equipment and sensors a centralized database supported by a private server is essential. This setup should be designed with readiness to future change, including additional sensors or expanded EMS functionalities as production increases. The centralized database will gather performance data of each machine, providing a comprehensive and real-time view of the entire production process. The access to this data can improve the quality of work and efficiency of management, maintenance, and finance. Supporting each decision of departments with crucial data analytics. Moreover, by integrating this system with Enterprise Resource Planning will improve the coordination between business operators and production.

To ensure data security, private servers should be combined with encryption protocols and secure ethernet connectivity to prevent unauthorized access. In addition, regular data backups and redundancy measures are necessary to avoid data loss during system downtime. The centralized system will also facilitate automated data processing, generating reports that are customizable for different stakeholders. By enabling real-time monitoring and providing automated alerts when performance thresholds are exceeded, the system will allow for proactive decision-making and swift responses to inefficiencies. The only step that will finalize the implementation of EMS would be data visualization and data presentation.

The final aspect to consider is data presentation, which is crucial for management and stakeholders. A key recommendation is to implement real-time dashboards displaying energy generation and consumption data. These dashboards provide immediate insights, enabling quick decision-making. Various IT tools and programming libraries, such as the Pandas library in Python, can be used to facilitate data visualization. Additionally, monthly reports with detailed breakdowns per production unit should be generated, allowing for a comparative analysis that makes performance changes measurable. Key Performance Indicators (KPIs) could focus on energy consumption per ton of sugar produced, providing a clear metric for evaluating efficiency improvements. These data presentation methods are considered the most transparent and effective within corporate environments [7].

Conclusion

Implementing an EMS in the sugar production process will bring significant improvements in resource efficiency, operational effectiveness, and overall sustainability. By installing sensors and meters at key stages of production such as on boilers, centrifuges, evaporation units, and crystallization machines, real-time data on

energy consumption and resource usage can be gathered. This data, when managed through a centralized database and integrated with IT solutions like SCADA and ERP systems, will not only enhance production efficiency but also provide actionable insights for reducing energy consumption, lowering costs, and minimizing waste.

In addition, the EMS will offer crusial tools for management by delivering real-time dashboards, detailed reports, and key performance indicators (KPIs) that allow for measurable improvements. The ability to monitor resource use and equipment performance will facilitate predictive maintenance, reducing downtime and ensuring consistent productivity.

Overall, the introduction of an EMS in sugar production is a forward-thinking step that positions the company for long-term competitiveness, enhanced operational efficiency, and reduced environmental impact. It paves the way for future adaptability and integration of new technologies as production processes improve and change.

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РЕЗЮМЕ

ВНЕДРЕНИЕ СИСТЕМЫ ЭНЕРГЕТИЧЕСКОГО МЕНЕДЖМЕНТА НА САХАРНОМ ПРОИЗВОДСТВЕ: СТРАТЕГИЯ ВНЕДРЕНИЯ

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В данной работе рассматривается внедрение системы энергетического менеджмента (СЭМ) в процесс производства сахара, в частности в производство сахара из сахарного тростника. В работе описываются важнейшие этапы производства сахара и подчеркивается необходимость сбора данных для оптимизации использования ресурсов и повышения энергоэффективности. В работе подчеркивается роль датчиков и счетчиков в мониторинге основных потребляемых ресурсов – электроэнергии, газа, пара и воды на различных этапах производства, включая нагрев, разделение, выпаривание и кристаллизацию.
Кроме того, в работе обсуждаются необходимые инвестиции в аппаратное и программное обеспечение, включая централизованные базы данных и меры кибербезопасности, для обеспечения надежного управления данными. В работе пропагандируются эффективные методы представления данных, такие как информационные панели в режиме реального времени и ежемесячные отчеты, для облегчения принятия обоснованных решений руководством и заинтересованными сторонами.

На примере компании CMS Window Systems в статье показаны ощутимые преимущества внедрения СЭМ, такие как сокращение потребления ресурсов и повышение эффективности работы, что в итоге привело к значительному сокращению выбросов CO_2.

В целом, данная работа служит всеобъемлющим руководством для заинтересованных сторон в сахарной промышленности, демонстрируя, как СЭМ может способствовать устойчивости и конкурентоспособности в мире, который становится все более энергозависимым.

ТҮЙІНДЕМЕ

ҚАНТ ӨНДІРІСІНДЕ ЭНЕРГИЯ МЕНЕДЖМЕНТІ ЖҮЙЕСІН ЕНГІЗУ: ІСКЕ АСЫРУ СТРАТЕГИЯСЫ

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Бұл жұмыс қант өндіру процесінде, атап айтқанда қант қамысынан қант өндіруде энергияны басқару жүйесін (ЭБЖ) енгізуді қарастырады. Бұл құжат қант өндірісіндегі маңызды қадамдарды сипаттайды және ресурстарды пайдалануды оңтайландыру және энергия тиімділігін арттыру үшін деректерді жинау қажеттілігін көрсетеді. Жұмыста датчиктер мен есептегіштердің негізгі кірістерді - электр қуатын, газды, бу мен суды – өндірістің әртүрлі кезеңдерінде, соның ішінде қыздыру, бөлу, булану және кристалдануды бақылаудағы рөлі ерекше көрсетілген.

Сондай-ақ, мақалада сенімді деректерді басқаруды қамтамасыз ету үшін орталықтандырылған дерекқорлар мен киберқауіпсіздік шараларын қоса алғанда, аппараттық және бағдарламалық қамтамасыз етуге қажетті инвестициялар талқыланады. Жұмыс нақты уақыттағы бақылау тақталары және ай сайынғы есептер сияқты деректерді ұсынудың тиімді әдістерін алға жылжытады, бұл басшылық пен мүдделі тараптардың негізделген шешім қабылдауын жеңілдетеді.

CMS Window Systems мысалын пайдалана отырып, мақалада CO_2 шығарындыларының айтарлықтай төмендеуіне әкелетін ресурстарды тұтынуды азайту және операциялық тиімділікті арттыру сияқты ЭБЖ енгізудің нақты артықшылықтары көрсетілген.

Тұтастай алғанда, бұл жұмыс қант өнеркәсібіндегі мүдделі тараптар үшін толық нұсқаулық болып табылады, ол энергияға тәуелді әлемде ЭБЖ тұрақтылық пен бәсекеге қабілеттілікке қалай үлес қоса алатынын көрсетеді.

Түйін сөздер: энергияны басқару жүйесі, қант өндірісі, жаңартылатын энергия, тиімділік, ЭБЖ