

PROVEN APPROACHES TO ENHANCE IMPLEMENTATION OF ENERGY MANAGEMENT SYSTEMS AT A LEADING OIL COMPANY

Hashim K. M.^a, Hassim Mimi H.^{a*}, Ng D. K. S.^b

^aSchool of Chemical and Energy Engineering / Centre of Hydrogen Energy, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia

^bSchool of Engineering and Physical Sciences, Heriot-Watt University, No. 1, Jalan Venna P5/2, Precinct 5, 62200 Putrajaya Malaysia

Article history

Received

12 May 2020

Received in revised form

13 August 2022

Accepted

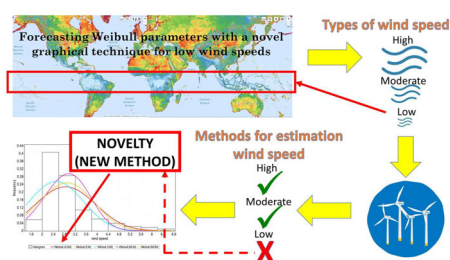
14 September 2022

Published Online

23 September 2022

*Corresponding author
mimi@cheme.utm.my

Graphical abstract



Abstract

Energy Management systems (EnMS) is an effective measure to manage energy utilization, drive for continuous improvement in energy performance and sustain business competitiveness. The public expectations i.e., greenhouse gas emission limits and zero liquid discharge will put additional burdens to oil companies. Many companies have initiated to deploy energy program in response to these concerns. However, impact of implementing the program has just been seen. Concerned companies are far away from achieving an appropriate expectations. Most of oil companies consider EnMS as an ambition, rather than an important criterion to be applied in all levels of the businesses. To overcome the abovementioned issues, this paper presents proven approaches to manage the energy efficiency. As for the primary objective, it presents a customized EnMS in enhancing utilization of energy resources. The customized EnMS has been established in accordance to expectations of international industrial best practices. It can be divided into: (1) establish energy visions, (2) select energy performance indicators, (3) identify energy improvement approaches and (4) monitor and manage energy performance tracking. In addition, case studies and best practices are also included in the customized EnMS to address the flexibilities. The second objective is to describe systematic tactics to expedite the effective implementation of EnMS. Tactics include: engage higher management commitment, subscribe to reputable standards, impels for energy savings and embed EnMS into existing management programs. Energy improvement tips are also included into comprehensive framework. Lastly, the third objective is to illustrate the customized EnMS at an undisclosed oil company.

Keywords: Energy Management Systems, Deployment and implementation approaches, Energy improvement program, Energy improvement measures

Abstrak

Sistem Pengurusan Tenaga (EnMS) ialah langkah berkesan untuk mengurus penggunaan tenaga, memacu peningkatan prestasi berterusan dalam penggunaan tenaga dan mengekalkan daya saing perniagaan. Permintaan orang ramai iaitu, had pelepasan gas rumah hijau dan pelepasan cecair sifar akan memberi beban tambahan kepada syarikat-syarikat minyak. Banyak syarikat-syarikat telah memulakan untuk menggunakan program tenaga sebagai tindak balas kepada kebimbangan ini. Bagaimanapun, kesan pelaksanaan program itu baru sahaja kelihatan. Syarikat-syarikat tersebut masih jauh daripada mencapai tahap yang dikehendaki. Kebanyakan syarikat-syarikat minyak

menganggap EnMS sebagai cita-cita, bukannya kriteria penting untuk digunakan dalam semua peringkat pengurusan. Selaras dengan perkembangan ini, kajian ini membentangkan pendekatan yang terbukti untuk menguruskan kecekapan tenaga yang mampan. Objektif utama, ia memperkenalkan EnMS tersuai dalam meningkatkan penggunaan sumber tenaga. EnMS tersuai telah diasaskan mengikut keadah amalan-amalan terbaik industri antarabangsa. Ia boleh dibahagikan kepada: (1) mewujudkan visi tenaga, (2) memilih penunjuk prestasi tenaga, (3) mengenal pasti pendekatan peningkatan tenaga dan (4) memantau dan mengurus peningkatan prestasi tenaga. Di samping itu, kajian kes dan amalan terbaik juga disertakan dalam EnMS tersuai untuk menangani fleksibiliti. Objektif kedua adalah untuk membincangkan taktik-taktik sistematik untuk mempercepatkan pelaksanaan EnMS yang berkesan. Taktik-taktik termasuk: melibatkan komitmen pihak pengurusan, melanggan piawaian yang bereputasi, mendorong untuk penjimatan tenaga dan menyerapkan EnMS ke dalam program pengurusan sedia ada. Ketua peningkatan tenaga juga dimasukkan ke dalam rangka kerja yang komprehensif. Akhir sekali, objektif ketiga adalah untuk mempraktikkan model EnMS ini di suatu syarikat minyak yang tidak dinamakan.

Kata kunci: Sistem Pengurusan Tenaga, *Deployment and implementation approaches, Energy improvement program, Energy improvement measures*

© 2022 Penerbit UTM Press. All rights reserved

1.0 INTRODUCTION

Managing energy utilization is becoming one of the major highlights in many international sustainable forums [1]. Certainly, energy management systems (EnMS) is an essential tool to manage the utilization of energy sustainability. Energy efficiency becomes an integral part of the business culture, and it simply means using less energy to perform the same tasks. In fact, systematic energy resources management will sustain the glory of oil companies and keep oil and gas sectors moving [2].

It is a concern that Carbon dioxide (CO₂) makes up the primary vast majority of greenhouse gas (GHG) emission through human activities. GHG emission is the major cause of global warming and associated climate change that pose a serious threat to human health, safety and survival. However, the demand of energy from oil industry has been growing rapidly since decades ago. Socio-economic development such as growing population, increasing urbanization, and rising incomes are major factors that increase the demand of energy. To halt this trend, Johnson [3] listed three business sectors that are required for dedicated focus i.e., industrial, electrical power plants and transportation.

Concerned oil companies have initiated effort in energy efficiency in order to meet societal expectations by thoroughly explore ways to save energy. Many governments have executed stringent measures on environmental, equipment specifications, and other social responsibilities. In current trend of oil industry, an energy management systems (EnMS) is becoming one of common initiatives that have been evolving since the late 1990s. According to the International Petroleum Industry Environmental Conservation Association (IPIECA), EnMS is a preferred tool to assist oil

companies in overseeing its energy utilizations [4]. The first revision of EnMS was released by International Organization for Standardization (ISO) in June 2011, and was revised in 2018. EnMS engages oil companies to follow a systematic approach in managing energy resources, by means of energy efficiency applications, energy supply security, energy use and consumption reviews, performance measures, as well as continuous improvement efforts [5].

Oil companies can determine the need for transition in adopting new challenging expectations, vibrant business paradigms or to continue pioneering state-of-the-art technologies. Despite the increase in energy utilization and societal expectations for effectiveness in energy conservation, it shows that EnMS is just a certificate for displaying in many companies [6]. A survey was performed in April 2015 by DNV GL – Business Assurance customer on 1557 professionals from all type of industries on approach toward EnMS. Overall survey findings showed that 57% of the companies had an established EnMS or any similar program in place [6]. However, progress had just started, and the concerned companies had yet to fully realize the benefits from EnMS implementation, as energy efficiency concepts had not been effectively implemented.

Concerned companies' higher management believe EnMS as a slogan, rather than a condition applying to their core businesses. Indeed, the main focus is to reduce expenditure rather than to ambition for excellence in energy utilization reduction [7]. The urgency is always on financial benefits rather than endeavor to optimize the utilization of resources [8]. In contrast, firming responsibilities from various levels within a company's units, establishing the exact tactics, executing action items, tracking and updating approaches as

necessary have yet to be adopted in a bigger span [9]. The full implementation of EnMS can be a major contributor to address those challenges [10]. Again, another survey was conducted by the Metrus Group, Inc. [11] on deliberately picked 122 worldwide corporation, to comprehend the relationship between energy expectations to visions as well as tactics. Results from the survey indicated that a wealthy corporation with clear vision and strategic planning tends to benefit the most. It is a valid statement as a successful EnMS implementation requires a firmed vision statement and enthusiastic deployment tactics, followed by actual field execution [5].

It demonstrates that having an established deployment strategy is one of vital stages to drive

for workable EnMS implementation. Effective deployment of EnMS is an interesting task that requires the highest level of commitments from respective personnel within the company. For example, there are two identified initiatives to push for successful energy efficiency in the Gulf Cooperation Council (GCC). They are; adopting energy performance indicators introduced by League of Arab States and deploying internationally recognized energy management practices. However, it has yet to be achievable to change the trends [12]. Identified challenges in area of concerns in achieving EnMS vision are listed in Table 1. These concerned were captured from a survey conducted on 22 members of the Arab League in 2013.

Table 1 Types of methods matched types of wind speed

Subject of Concerned	Remarks
Technical knowhow	Concerned oil companies are not informed of how to effectively conserve energy. Lack of knowledge in improving the common major energy users, e.g., gas turbines, boilers operations, motor load management, water and many other initiatives from industrial and non-industrial equipment.
Incentives	Arab Leagues indicated that current energy subsidy in the GCC provides little incentive to adopt energy efficiency and conservation measures. Similarly, due to low energy prices, savings from energy improvement initiatives will not be adequate enough to be justified under capital expenditure (CapEx) for profit improvement (PI) category.
Mind-share / company's priority	Energy efficiency has not been in the top focus of concerned oil companies. Many of them have yet to identify energy as a significant operating expenditure (Opex). Therefore, it makes implementation failure inevitable
Geo-political structure	Most oil companies owned organizations/facilities are scattered across large areas, making it difficult to fully manage energy efficiency and conservation programs.

Achieving the desired outcomes of EnMS is a challenge that requires the utmost level of arrangement, obligations, and a strong supervision from companies' management [13]. Several new benefits and potential opportunities can be realized by fully subscribing the right reference for EnMS. The main content of the proposed tactics includes proven EnMS steps, and a state of art deployment starter kit that can significantly impel the implementation pace of EnMS.

The paper presents a sustainable tactics that enhances deployment and implementation of an EnMS at concerned oil companies or any other interested organizations. The proposed tactics are focused by needs of the oil companies in achieving full expectations of EnMS, in which the main objectives are to improve energy utilization, minimize GHG emissions and Opex, and sustain business continuity [14]. Major phases related to the deployment approaches will be discussed in the next few sections. Several examples, case studies, and best practices will be presented to evident the nature of EnMS applications, and the progress made to eliminate or lessen any probable challenges.

2.0 METHODOLOGY

The proposed EnMS implementation tactics shall assist concerned oil companies to meet full

requirements of the recognized international standard of Energy Management Systems (ISO50001.2018), and other specific requirements e.g., corporate policy and host countries requirement. Consequently, it should be adaptable to accelerate for successful deployment and implementation of EnMS within a defined duration.

Initiating with collecting information and reviewing related references e.g., best-practices from industrial facilities, case studies, books, journal and related articles. Subsequently, any applicable information will be used to determine the most effective approaches and initiatives to enhance EnMS implementation. The next stage is to conduct thorough analysis of successful best practices and strategies applied by several leading oil companies. Finally, a case study for the successful implementation of the selected tactics at one of leading oil companies, located in Middle East will be included in the paper.

3.0 RESULTS AND DISCUSSION

The following sub-titles will describe the detailed mechanisms and define suitable tactics to improve EnMS implementation at the concerned oil companies. It follows with a case study at one of the leading oil companies.

3.1 Understand Challenges in Deploying EnMS

There are many common aspects that contributing the slow progress of EnMS implementation among oil companies [15]. According to the surveys conducted on 30 oil companies in Middle East, several major challenges in implementing EnMS were captured and summarized. Subsequently,

identified reasonable solutions were collected to address those obstacles and will be discussed in details in the next section. The findings based on the summarized impediments that thwart oil companies from achieving the full benefits of implementing the EnMS are listed in the first column of Table 2.

Table 2 List of typical EnMS implementation gaps and proposed tactics

Impediments	Proposed implementation tactics
Define clear corporate direction	<ul style="list-style-type: none"> • Identify tangible and intangible benefits by implementing EnMS • Specify clear relationship to respective business goals • Achieve energy policy and vision expectations • Seek commitment from higher management through regular updates
Gain commitments from; <ul style="list-style-type: none"> a. Higher management. b. Energy coordinator c. All critical positions in EnMS d. Employees and contractors 	<ul style="list-style-type: none"> • Present e-learning courses to senior and middle management • Embed roles and responsibilities of management, energy coordinator and its energy team in EnMS reference document • Introduce relevant awareness events such as e-learning courses, workshops, technical exchanges meetings, forums and conferences
Solve conflicting priority	<ul style="list-style-type: none"> • Seek appointment letters for energy related personal • Add energy activities in individual performance goal for each member of energy team
Enhance competency	<ul style="list-style-type: none"> • Develop list of recommended courses • Include detailed qualification of critical EnMS positions in the framework
Improve monitoring of energy data analysis, monitoring, corrective and preventive	<ul style="list-style-type: none"> • Specify energy performance indicators (EnPIs) • Establish data collection mechanism. • Simplify operating manuals
Reduce cost of implementing EnMS	Embed into existing companywide management programs
Drive full Implementation	<ul style="list-style-type: none"> • Gain momentum with other matured programs implemented by companies • Introduce self-evaluation assessment or review
Address pressure from society i.e. new product and legal requirements.	<ul style="list-style-type: none"> • Adopt the correct EnMS reputable standards, which; <ul style="list-style-type: none"> - Proven to lead for energy performance improvement - Simplicity to users - Align with other management programs such as environment management systems (EMS), safety management systems (SMS), total productive maintenance (TPM) and other matured programs • Share lessons learned and best practices

The surveys outline major tasks, e.g., well-defined corporate direction, dedications from employees and concerned entities, conflicting priority of energy teams, competency and awareness enhancement, and few other factors. Some of respondents were aware of the need to drive for EnMS implementation in concerned companies. Moreover, several respondents' feedback indicated that EnMS was not in their priority lists or strategic ambitions as their companies were concentrating in meeting production targets. In addition to their stringent target on health, safety, and environment (HSE) as well as reliability. In fact, some of them were ISO 50001 certified and had received regional and international recognition for excellent performance in energy related themes. However, they are lacked in planning to successfully implement the full scope of EnMS. Without dedicated effort, it makes implementation failure inevitable. Similarly, a lack of strong implementation tactics and clear vision will jeopardize the intention of EnMS and its benefits.

3.2 Identify Tactics to Gain Full Benefits of EnMS

The survey (Section 3.1) identifies that one of critical tactics to gain full implementation of EnMS is to

establish a clearly relationship to one of more company' strategic ambitions. Benefits of deploying EnMS and how it can contribute in achieving related strategic goals should be defined and communicated to respective entities. Business goals may vary among oil companies. The most common ones are to improve productivity by minimizing operating expenditure (OpEx) and reducing environmental footprints [10]. Several other advantages for adopting systematic EnMS follow [4]:

- Identifying obstacles and opportunities for improvement proactively.
- Gaining recognized international standards for managing energy resources utilization.
- Achieving applicable business strategic ambitions through well-structured EnMS.
- Specifying accountabilities and responsibilities in managing energy resources and users.
- Standardizing and enhancing major energy related work processes across the company functions.

- Enhancing asset integrity and reliability techniques and processes in related to energy.
- Mandating decision-making processes to include energy.
- Assisting in compliance with current and future voluntary and/or mandatory energy performance targets.
- Improving corporate image and credibility among customers, clients and stakeholders.
- Increasing energy awareness among staff members and contractors.

A successful EnMS implementation requires systematic tactics. Depending on companies' specific initiatives, the proposed mitigation tactics have been identified based on respondents' feedbacks as well as proven best practices captured from literatures. Identified implementation tactics are listed in column 2 of the Table 2 and summarized as per following;

- Form dedicated company's committee to oversee the EnMS implementation.
- Secure full engagement from company's organization.
- Subscribe to reputable and latest standards and requirements.
- Ensure the EnMS impels for energy savings.
- Embed EnMS into existing and matured management programs.
- Present a comprehensive framework template.
- Prepare energy improvement guidelines manuals.
- Describe performance monitoring plans.

Detailed on each of implementation strategy will be described in the following Section 3.2.1 to Section 3.2.7.

3.2.1 Formation of EnMS Steering Committee

Concerned oil companies shall establish a comprehensive Corporate Energy Management Steering Committee (EMSC) to establish a practical energy policy and to govern its implementation company wide. The EMSC, which shall be led by the corporate executive level and it consists of critical highest management positions representing critical organizations from maintenance, operation, technical, project management, and planning sectors. The EMSC shall meet regularly to monitor, track and guide the implementation of EnMS within multifunction's organizations. Major activities shall be taken are described in Section 3.2.1.1 to Section 3.2.1.6.

Higher Management Commitment

The corporate management involvement is essential to ensure adequate implementation of EnMS in all levels of the organization. The higher

management commitment can be seen in many forms. Firstly, EMSC is systematically leading the company to achieve the corporate energy policy's expectations. Secondly, EnMS seeks each applicable organization to establish site energy policy which must be aligned with the corporate policy. Additionally, the organizations' higher managements are required to appoint the energy coordinator and energy team. The energy coordinators directly report to the higher management to ensure better authorities and responsibilities [5]. Thirdly, regular EMSC review meeting is required to ensure the implementation on the correct direction.

Data Collection, Reviewing and Validation

All applicable organizations are required to report the EnMS status and performance to the corporate executive management through EMSC in quarterly basis. The data goes through several review and validation processes starting from organizations' energy coordinators and its higher managements, regional level, and engineering entity as an end user. All submitted energy data consolidated, analyzed, reported and presented to the EMSC, then to the executive management. For each review and approval level, corrective actions are taken to sustain the continuous improvement.

EnPIs Tracking and Online Solution

The crucial measurement of the organizations' energy performance is corporate EnPI. Thus, the corporate improvement is mainly based on the facilities efforts. In many oil companies, corporate EnPI is defined as the ratio between energy consumption and total production in ton (Mbtu/ton). The online corporate EnPI tracks and monitors against the targets in real-time. In case of offset, corrective and preventive action must be taken within reasonable timeframe. Oil companies utilize the solution to analyze the energy consumption of concerned operating facilities. Therefore, significant energy uses (SEUs) can be identified.

EnPI Target

At certain interval, organization's energy team calculates the overall energy consumption based on the planned production for the purpose of setting corporate EnPI targets. The submissions go through rigorous revisions and analysis from different levels of expertise to finally get approved by EMSC.

Obtain Financial Supports

At the company level, energy efficiency program has been included as one of the capital projects reviews stages. This is to ensure all approved projects are energy efficient, whatever applicable. At organizations levels, EnMS requirements and goals are major elements that are considered during the business planning cycle reviews. Organizations must

include the following energy efficiency plans during the business planning cycle review; energy improvement initiatives and projects to meet EnPIs targets, energy coordinators and team development and training, energy campaign and conferences, and contractor and purchasing process.

Knowledge Sharing and Recognition

The EnMS requires oil companies to organize energy awareness programs to all employees including trainings, workshops, conferences and campaign corporate wide or small scale within organization. These events encourage lessons learned, best practices development and benchmarking of energy performance internally or externally.

3.2.1 Capture Full Engagement from Organization

Successful implementation of EnMS is a new milestone that requires highest level of commitments

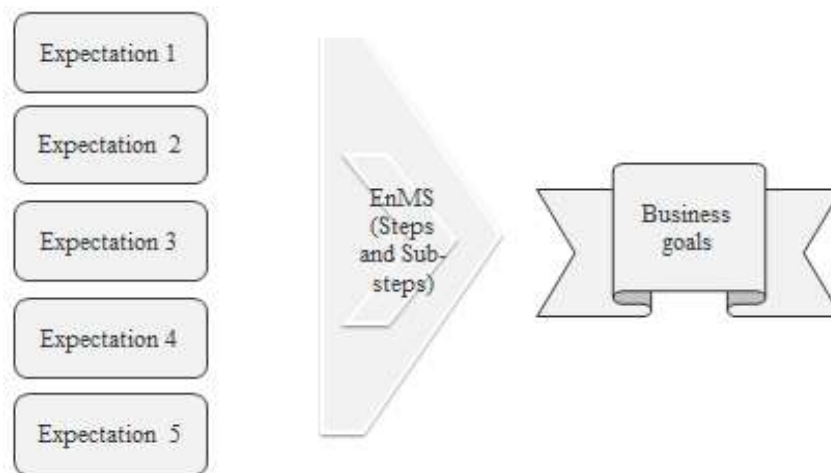


Figure 1 Linking between expectations, EnMS' steps and business strategic ambitions

The management of concerned oil companies should be persuaded on tangible and intangible advantages for implementing EnMS. They shall be informed that the main benefit of gaining the EnMS is to serve as an effective and sustainable process that can induce productivity. In addition, the EnMS pushes in enhancing environment performance by means of reducing GHG emission as well as natural resources intakes. Number of benefits can be captured with the embracing solid EnMS, which focuses in minimizing energy consumption in each process unit, area, or activity.

The firmed commitment from higher management is the key success of the program. Many measures can trigger management focus. Such measures are summarized in the feedback received from surveys, as well as by referring to lessons learned from proven sources. The main one is to link to most of the business objectives. In reality, aiming on energy conservation and efficiency efforts can tremendously reduce GHG footprint,

from the management of any concerned oil company. Energy should be considered as one of significant operating cost parameters, and the one that should be always important to management and concerned stakeholders [22]. Therefore, these expectations should be part of a viewpoint to the EnMS. According to the IPIECA [4], the EnMS shall consist of customized steps to address each applicable business goals of concerned companies.

To win the management buy-in, the concerned management should be provided with a clear linking of all related steps to defined business objectives, e.g., health, safety, environment, cost efficiency, reliability and profitability. With a clear objective, it can promote the importance of EnMS to the highest level at par with other matured programs, e.g., EMS, SMS, TPM, and several other programs. Figure 1 illustrates links between expectations, steps of EnMS, and each business expectation.

minimize release of hazardous emissions, pollution, and many other HSE impacts. In addition, EnMS will embed for improvement in energy utilization, reliability of services or products as well as cost and profitability [13].

3.2.2 Subscribe to Reputable and Latest Standards

The United Nations Industrial Development Organization (UNIDO) has decided that industries around the globe need to implement an effective response to climate change [17]. In 2007, UNIDO requested ISO to develop an international energy management standard as preferred reference documents. Subsequently, a committee was established in 2008 to draft the dedicated energy management standards. EnMS (ISO 50001:2011) was officially announced and published for global adoption in 2011 [18]. Since then, ISO 50001:2011 has become a major reference and has replaced

number of energy management related standards such as BS EN 16001 (British Standard for Energy Management), Superior Energy Performance (SEP) from American National Standards Institute (ANSI), Energy Star from USA' Environment Protection Agency (EPA) and other related energy efficiency practices [4]. In 2018, new revision of ISO 50001 (ISO 50001, 2018) was issued and published after incorporated feedbacks from implementers around the world [5].

Strengthen EnMS governance by subscribing to reputable and latest international standards of ISO 5000:2018. Management should be notified that gaining an ISO 50001 certification is evident to demonstrate company commitment to fulfill Conference of the parties (COP) 21 [19] in reducing GHG generation and other environmental impacts as expected by stakeholders. Tapping to recent well-structured practices, such as the latest international standards of ISO 5000:2018 is a well proven strategy measure to excel in energy performance.

EnMS' steps are accordance to Deming' Plan-Do-Check-Act (PDCA) cycle [20]. A brief description of EnMS related PDCA is listed per followings [4]:

Plan	Establish policy, assign functions and responsibilities, set objectives and targets, create a monitoring campaign, and define energy plans
Do	Fulfil policy requirements, implement energy plans, improved awareness and skills of critical personals and improve energy utilization performance.
Check	Track energy plan execution, monitor performance, assess progress implementation and conduct corrective and preventive action if required
Act	Conduct management review, recognize achievement, and gather feedback to enhance energy performance

Simplified EnMS steps and its relationship between each EnMS element as per PDCA cycle is concluded and illustrated in Figure 2.



Figure 2 Simplified EnMS steps and sub-steps [4]

3.2.3 Ensure the EnMS Impels for Energy Savings

Implementing the EnMS requires a continuous effort and commitment from the concerned oil companies [4]. Therefore, the review shall be conducted to ensure the concerned companies can advance significant benefits by implementing the EnMS. The first action to be executed prior engaging concerned oil companies is to check the applicability to EnMS as a pre-requisite. It is very important to ensure that EnMS will benefit them and will remove unnecessary allocation of resources. In additional, defining applicability of each company is important to ensure the EnMS is not overwhelmed. It will provide encouraging messages to the concerned organizations for their contribution in achieving the specific goals.

Applicability to the EnMS requirements can be determined based on the defined requirement, such as consumption limits, as indicated by Table 3. Several countries such as Malaysia, Australia, and Singapore have issued a mandatory requirement on EnMS participation for certain types of industries, including refineries, petrochemicals, and other production facilities.

Upon meeting the threshold limit as defined by respective companies, the development of energy policy and other steps and sub-steps as required by its adopted EnMS guidelines will follow. Subsequently, any applicable company shall proceed to establish EnMS in accordance to the subscribed standards or requirements.

Table 3 Threshold limit for implementation of EnMS

Country	Minimum annual energy consumption, GWhr
Australia	139 [21]
Singapore	15 [22]
Japan	12 (or 3000 kiloliter of crude oil*) [23]
Malaysia	6 [24]
ISO 50001:2018	No limit**[5]

Note: *HHV Crude oil (GJ/Kiloliter): 30

**Applies to companies that use energy and responsible for its cost and maintenance.

3.2.4 Embed EnMS into Existing and Matured Management Programs

The surveys in section 3.1 indicate that prior to a push for EnMS implementation in oil companies, strong efforts from all employees and respective contractors are required. In most oil companies, EnMS is not in the priority list or even mentioned in business goals, particularly in national oil companies. To embed EnMS as part of an aggressive management initiatives model is a preferred tactic that drives for drastic improvement progress. The model depends on specific company characteristics, such as political, socio-cultural, economic, technological, environmental, and legal application [25].

Finding from the surveys (Section 3.1) appears that EnMS is a required driving vehicle to ease supports from concerned company's entities. In this case, EnMS can be embedded as part of matured management initiatives models. A convincing push through common management platforms is required, e.g., total quality management (TQM), operational excellence model (OEM), reliability centered management (RCM), TPM or lean six sigma (LSS). This is a smart way to impel energy efficiency application within the company.

One of the leading oil companies located in Middle East has successfully improved the implementation of EnMS under the umbrella of OEM [13]. It is a proven methodology that induces overall success to this company by saving significant amounts of energy and reduction in tones of GHG. Subsequently, the company realizes the other intangible benefits that enhance their performance such as gaining competitive advantage in improving its business performance and becoming a reference company. Adopting OEM driving platform will benefit the concerned oil companies by means of the following:

- Standardization and enhancement of major work processes across the company functions.
- Minimize time spend during development, implementation, performance monitoring and governing the EnMS.
- Capture and dissemination of tacit knowledge retained by a few subject matter experts (SMS).

- Clarification of accountabilities and responsibilities to function within any applicable oil company.
- Enhancement of asset integrity and reliability techniques and processes.
- Engage full attention to all required expectations, processes, and business goals.
- Enhance resources utilization through consolidate compliance assessment on other matured programs.

3.2.5 Present a Comprehensive Framework Template

The framework template includes all relevant references as well as examples and be experimented for practicality. It has to be simple and provide a perfect description that can attract any applicable oil company to deploy EnMS effectively. EnMS implementation requires a strong commitment from the entire company. With allocation of adequate resources such as manpower, operating and investment cost to drive for improvement in energy performance.

The purpose of comprehensive framework template is to assist concerned oil companies to ease the time and effort in deploying and implementing an EnMS. Main contents of the proposed framework are a simplified EnMS steps and sub-steps in reference to ISO 50001:2018. The framework is embedded with proven deployment tips that can drastically improve the implementation pace of EnMS. Subsequently, by deploying a customized EnMS, it will drive the concerned companies towards integrating the relevant steps or sub-steps into its existing programs. Therefore, it will benefit each company in resource allocation, short cutting the introduction process and focuses on criticality.

With the introduction of a comprehensive EnMS framework template which includes checklists, typical EnPIs, plans and many other critical steps and sub-steps, it induces EnMS as one of excellent programs to be expedited. The established EnMS shall consist of necessary clauses to address identified business goals and to evident the criticality of it. The EnMS framework template provides a structured approach to achieve and sustain leading performance in their specific areas, while striving on effectiveness and profitability. Following a framework template is something that companies must attempt to adopt and start with. The truly successful ones are those who implement a comprehensive EnMS framework template effectively.

3.2.6 Prepare Energy Improvement Guidelines Template

Most oil and gas production facilities are technology-pervasive industries. These types of industries require high capital investment with highly diverse concerns including safety related impacts,

associated business risks, stakeholders' disapproval, and socio-politics of the hosting countries. The benefit of deploying new technologies and innovations shall balance the potential downside of a failure [26]. Inclusion of energy improvement guidelines with focusing on self-help and quick fix initiatives can partially reduce the gaps, and then strengthen it to pave the way towards improving companies' profitability.

Energy savings can be realized by focusing on initiatives, e.g., operational improvement, quick fix or an initiative that requires a high CapEx. Also having an energy improvement team (EIT) to explore energy savings opportunities. The team must exert rigorous efforts, including technical competency on energy related subjects, securing support from management, and establish reference guidelines. Ideally, the guidelines should be established based on energy improvement know-how, best-practices, lessons learned and well-known literature from internal and external sources, so that all significant energy efficiency concepts will not be missed out.

Examples of widely accepted energy saving initiatives are listed in Table 4. The implementation measures are preliminary, and further confirmations are required to be quantified. In fact, each identified initiative shall be evaluated promptly through the following subject items:

- i. Technical evaluation to ensure each proposed initiative is technically acceptable.
- ii. Operational evaluation to check for implementation practicality on each proposed initiative.
- iii. Simple risk analysis such as strength, weakness, opportunity and threat.
- iv. Incentives such as financial, GHG reduction and carbon trading program.
- v. Process safety management (PSM) review such as management of change (MOC), hazard and operability study (HAZOP) review and other specific requirements for each applicable company.
- vi. Initiative execution plan.
- vii. Decision making and path forward plan.
- v. Method of verifying results

Table 4 List of typical energy saving opportunities [26]

No	Subject of opportunity	Proposed solutions
1	Condensate and steam loss due to malfunction steam traps and pipe leaks	Improve steam traps reliability, revisit design, and replace with more efficient units and increase inspection frequency.
2	High heater flue gas excess oxygen levels	Reduce excess oxygen level to the optimum point and review excess oxygen control scheme.
3	Burner combustion issues	Check burner condition frequently and make adjustment as needed.
4	Steam header pressure control	Reduce steam pressure to the optimum limits acceptable to

No	Subject of opportunity	Proposed solutions
		process. Plant test may be required.
5	Cooling water system – high water circulation and fans control	Reduce number of pumps in operation and introduce fans operating strategy. Plant test is required.
6	High plant water usage	Reduce overall plant water usage, cooling water improvement, piping reliability and water saving awareness events.
7	Poor motor efficiency	Revise maintenance procedure in replacing and procure motors.
8	High steam deaerator vents	Reduce deaerator working pressure to minimize steam used for scrubbing. Plant test is required.

Ultimately, the energy improvement guidelines manual can provide brief description of typical energy improvement initiatives as per the following subjects [26]:

- Introduction of scope and coverage of the improvement guidelines. It shall include expectations for energy coordinators, members of its energy team as well as other energy critical positions.
- Description of specific procedure based on company' know-how and external best practices, lessons learned and well-known literatures, but not limited to the following scope:
 - Energy programs provide mechanism for continuous improvement in energy performance e.g., planning, training, communication, accountability, monitoring, reporting, feedback and recognition.
 - Performance monitoring approach to track progress of energy optimization program.
 - Measuring and metering are critical to ensure successful energy performance monitoring efforts.
 - Heat exchanger improvement program.
 - Furnaces/Fired boiler improvement program.
 - Air preheaters' improvement program.
 - Waste heat recovery units improvement program.
 - Steam systems improvement program.
 - Electrical systems improvement program.
 - Flare systems improvement program.
 - Vacuum systems improvement program.
 - Rotating equipment improvement program.

- Miscellaneous heating/cooling systems and insulation.
- Effluent treatment plant.

3.2.7 Describe Performance Monitoring Program

The first task for continual improvement in energy performance is to define EnPIs. A right selection of EnPIs will enhance tracking of the overall implementation progress against defined EnMS expectations and other desired performance targets [27]. Moreover, dedicated actions can be taken to correct them as defined duration. EnPIs will ensure common objectives of EnMS (e.g., increase reputation, improve energy intensity, reduce cost and GHG emissions) are met [28].

The ultimate approach is to apply lagging and leading EnPIs. The lagging EnPIs are based on actual operational data that reflect the as-is situation of energy performance, and are commonly applied by oil companies [4]. A basic measure of lagging EnPI is also known as Energy Intensity (EI) or Energy Utilization Index (EUI) in industry and building respectively. EI is a measure of the energy required in generating a unit of products [29]. Meanwhile, EUI is a measured value of the amount of energy annually used for cooling or heating a building or facility per area of conditioned space [16].

Meanwhile, overall progress in driving for continuous improvement in the energy performance can be tracked through the leading EnPI [30]. It appears that the leading EnPI is a preferred tracking tool to monitor the progress of continuous improvement in overall energy performance, tracking performance scorecard, and reporting results of EnMS implementation [32]. Leading EnPI can also be applied to monitor the progress against the implementation objectives of EnMS in which companies are deployed [33].

As to summarize, the proposed leading EnPI indicators can be applied to assist concerned companies in tracking their leading performance, as per the following [30]:

- Implementation status of energy improvement initiatives.
- Energy performance trends such as energy efficiency by product, process unit and major equipment
- Energy objectives and targets the status of achievement.
- Effectiveness of operational and maintenance activities to enhance energy efficiency.
- Level of awareness among the companies' management and employees.
- Level of competency of energy related personnel.
- Internal EnMS assessment performance.
- Overall implementation of EnMS.

3.3 Case Study for Deploying EnMS

In a case study [15], one of largest oil companies in Middle East, namely SC has successfully

implemented the EnMS. SC is a huge corporation involves six main disciplines. SC disciplines are segregated according to specific tasks and location as per Table 5.

Table 5 Main disciplines' description

Disciplines	Description
1	Main function is to treat and process the raw gases to meet the power plants and downstream requirements. This division consists of six gas treatment facilities
2 and 3	Main function of these two divisions is to provide oil, gas and water separation from raw crude and gas wells. These two divisions are separated by demography. Both of these divisions consist of five production facilities
4	This is a downstream division that consists of six refinery and condensate splitters facilities
5	This division is dedicated to provide transportation of treated crude and gas from oil and gas storage facilities to users and customers. This division consists of six facilities
6	Marines, transportation and maintenance

SC has initiated the EnMS at corporate level since year 2005, even before the establishment of internationally recognized ISO 50001 for EnMS standard in mid of 2011 [18]. In 2012, over 50 of SC applicable organizations were requested to embrace each element of the established EnMS guidelines. The major goals for the request include becoming more energy efficient, energy responsible, and to be able to demonstrate this responsibility to stakeholders, the government, and the public. The main reference for SC's EnMS is the one published by ISO Standards (ISO 50001: 2011) [18].

During the initial stage of EnMS implementations, delays can occur due to a lack of commitment or even rejection from respective parties. Some company organizations may not understand how to apply EnMS. These delays can be compounded by a lack of support from top management, limited resources, and geo-political structure.

Mitigation of these issues in realizing the full benefits of implementing EnMS was investigated. After conducting a number of surveys, reviews, and brainstorming sessions, it was concluded with the following implementation recovery tactics:

- Embedded EnMS under OEM umbrella.
- Confirmed applicability of the EnMS to impel energy saving.
- Introduced a comprehensive framework template to ease deployment of EnMS for new identified organizations.
- Concluded performance monitoring program. Both lagging and leading EnMS

- have to be included in the monitoring program.
- Published energy improvement guidelines.

The applicability of SC organizations to EnMS was determined in Table 6. As of 2017, there were more than 50 organizations that had successfully confirmed their applicability, based on this checklist. It provided a solid justification for these organizations to deploy the EnMS prior to earning cost savings. In addition, it could sustain their financial performance by reducing operating cost, and minimizing expenses associated with environmental-related activities. Ultimately, these organizations started to link EnMS to certain business goals, in particular "efficiency" and "environment."

Further enhancement took place in 2013, as SC introduced the OEM to strengthen its business portfolio, and the EnMS was concluded as one of the SC' critical programs. Deployment of EnMS as part of OEM is an effective strategy to promote and mandate full EnMS implementation company-wide.

Part of the implementation methodology is to customize EnMS by incorporating selected expectations from OEM. In addition, adoption of EnMS into OEM will enhance management commitment and provide clear links to SC relevant business goals.

As part of EnMS deployment initiatives, the framework template was introduced to the concerned organizations of SC in late 2015. SC has fully relied on this template as a main reference to deploy the EnMS since it was considered new to the company. The framework template is an important quick reference of EnMS to ease deployment and later to push for full implementation of EnMS by applicable organizations. The framework template includes all relevant steps, sub-steps, activities and guided approaches for a successful implementation of the EnMS. The comprehensive EnMS framework template will allow any concerned organization to quickly establish and therefore integrate EnMS into their management practices, including fine-tuning production processes and improving the energy efficiency of their systems.

Table 6 Threshold limit for implementation of EnMS

No	Questionnaires	Yes / No	Remark
1	Does your organization consume electricity or fuel or any other form of energy above 21,000 mmBTU/year ^{Note-1} ?		
2	Does your organization involve in energy (power ^{Note-2}) generation for internal or external use?		
3	Does your organization involve in the production of energy resources ^{Note-3} ?		
4	Does your organization require to establish EnMS by local authority ^{Note-4} ?		

Definitions;

Note 1: Approximate 6 GWhr/year

Note 2: Electricity

Note 3: Oil and gas

Note 4: Statutory requirement

The most convincing factor of successful EnMS implementation in the eyes of management is the cost savings gained. In this purpose, the introduced energy improvement guidelines are to describe a methodology of quick energy assessment approaches. Therefore, energy improvement can be conducted faster and effectively. Quick energy assessment methodology is a step-by-step manner that includes simple models for data representation and checklists for identifying and evaluating energy saving initiatives. The guidelines are intended to be a main reference to energy coordinators, energy

engineers, specialists or other concerned energy practitioners responsible for efficient operation of their organizations.

In tracking the overall organization energy performance, lagging EnPI concept of energy consumed in gigajoule (GJ) over the final product in metric ton is used as a basis for EnPI calculation. Due to confidentiality, these tracking trends will not be revealed. As an example, EnPI for Downstream facility of Purified Terephthalic Acid (PTA) is shown in Figure 3. The target line is marked on the chart to easily indicate its energy performance.

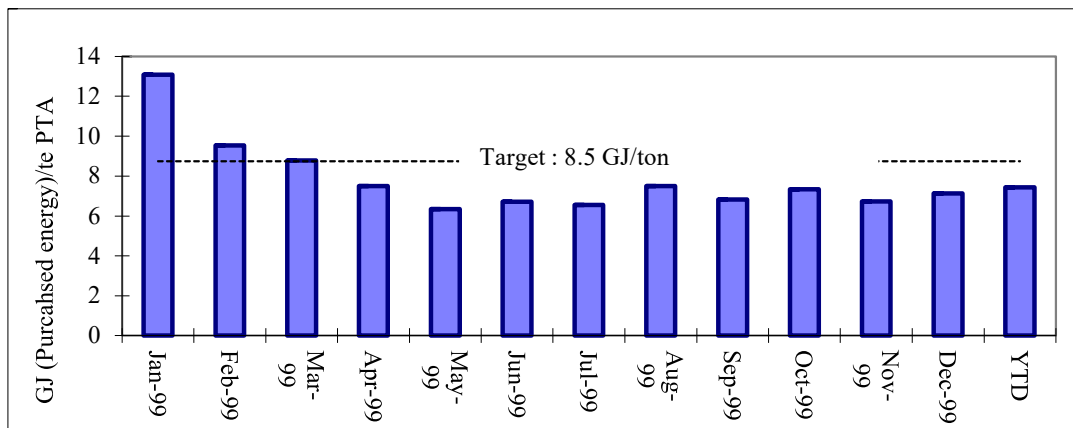


Figure 3 EnPI for one PTA manufacturing facility [31]

A leading EnPI has been successfully implemented to track SC organizations progress towards excellence in energy performance. At defined interval, each of the concerned organization conducts a comprehensive self-assessment, based on customized questionnaires, to gauge the progress of its EnMS implementation against EnMS critical steps, e.g., Plan is to define energy plans, Implementation is to conduct improvements, Check is to track energy plans implementation, and EnPIs, Act is to conduct management reviews. The customized EnPI was based on an allocated weight for each of the major EnMS stages as per the Deming quality cycle of PDCA, where a certain weight to reflect the current needs of each organization was given. The maximum weight of 100% will be allocated to an organization that fully meets all agreed expectations. The allocation for PDCA in this case study was an equal weight of 25% [30].

In conclusion, embedded deployment tactics have drastically improved the implementation pace of EnMS. As indicated in Figure 4, within less than four years since it was initiated, the progress of company-wide EnMS implementations has boosted up to 91% towards meeting the minimum requirement of ISO 50001. It was based on the leading EnPI measures, as discussed in the previous paragraph. Many of the SC' organizations have scored full marks on their EnMS self-assessment. The systematic approach from well proven methodology has resulted in a significant energy savings and a tremendous reduction of GHG emissions.

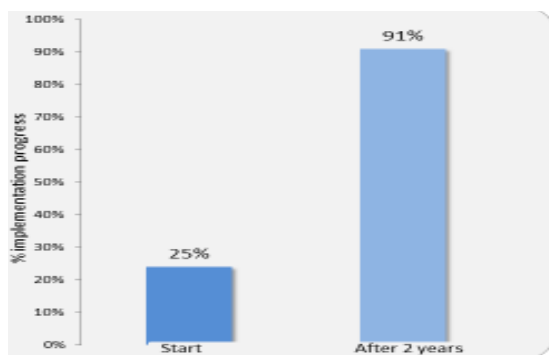


Figure 4 Company EnMS implementation progress

4.0 CONCLUSION

It is a need for systematic tactics prior to realize a sustainable EnMS implementation in concerned oil companies. Main workable measures can be attained by full implementation of EnMS. It includes reduction in OpEx from energy improvement, minimization of environment impacts through well-structured energy utilization resources management, and enhancement of the company image in the eyes of stakeholders by engaging international recognized EnMS.

The paper listed seven tactics that can be considered to ease EnMS deployment and implementation by concerned oil companies. Such tactics e.g., engage higher management commitment, subscribe to reputable and latest standards, ensure the EnMS impels for energy savings, embed EnMS into existing and matured management programs, present a comprehensive framework template, prepare an energy improvement guideline, and describe the performance monitoring campaign.

These are proven tactics, has and been successful applied by many organizations in one leading oil company. It is evident from the case study that the proposed tactics such as imbedded EnMS as one of the OEM critical processes, applied comprehensive framework template as a deployment/ implementation starter kit, and tracking energy improvement are managed to engage dedicated commitments from all level of employees. The number of benefits and the opportunities for improvement will be captured during the actual deployment of EnMS. One of the major benefits is to ease the adaptation of the tactics, and ultimately drive for steady incremental improvements of energy performance. These tactics are easily implemented, without the need for neither a major allocation of resources nor a lengthy deployment time frame.

Acknowledgement

The authors would like to express their sincere gratitude to one anonymous national oil company

for providing access to the venue and facilities during the case study.

References

- [1] Hassen, K. G. 2011. Households' Energy Use – Which is the More Important: Efficient. *World Renewable Energy Congress 2011- Sweden, 8-13 May 2011, Sweden*.
- [2] Worell, et al. 2006. Energy Efficiency Improvement in the Petroleum Refining Industry. Advisory Committee on Energy Efficiency (ACEE) Summer Study Energy on Efficiency in Industry. International Electrotechnical Commission (IEC), Geneva, Switzerland.
- [3] Johnson, N. 2013. Race to Finish– Lubricants Producers' Partner with Automotive Manufacturers to Gain a Competitive Edge in Technology-driven Marketplace. *Hart Energy Fuel*. December 2013: 33.
- [4] IPIECA. (2013a). Guidelines for Implementing ISO 50001 Energy Management System in Oil and Gas Industry. The Global Oil and Gas Association for Environment and Social Issues. Climate Change. International Association of Oil and Gas Producers, London, UK.
- [5] ISO 50001. 2018. Energy Management Systems – Requirements with Guidance for Use. International Standards Organization. Switzerland.
- [6] DNV.GL 2015. Saving Energy Today for Brighter Tomorrow. View Point Report. May 2015. Norway.
- [7] Equinor. 2016. Equinor Warns that the Energy Transition is "Too Slow". *Near Surface Geoscience*. First Break. 36(3): 31.
- [8] Dipaola, A. 2017. Saudis Kick Off \$50 Billion Renewable Energy Plan to Cut Oil Use. *Bloomberg*. (20 Feb 2017).
- [9] Luca, C. 2018. Regain Trust by Aligning with Society's Need. *Journal of Petroleum Technology*. 70(6): 14.
- [10] IPIECA. 2013b. Saving Energy in the Oil and Gas Industry. The Global Oil and Gas Association for Environment and Social Issues. *Climate Change*. International Association of Oil and Gas Producers, London, UK
- [11] Kaplan, R. and Norton, D. 2001. Scorecard Companies Thrive in the New Business Environment. The Strategy-Focused Organization. *How Balance*. 1st Ed. USA. Harvard Business School Press.
- [12] Arab Forum. 2013. Environment and Development Executive Report Summary Recommendations. Arab Environment & Sustainable Energy Prospect, Challenges, Opportunities. Beirut, Lebanon. 1 and 9.
- [13] Hashim, et al. 2018a. Advancing Energy Performance in Oil and Gas Industry through Systematic Implementation of Energy Efficiency Programs by applying an Operational Excellence Model. *Journal of Energy and Safety Technology*. 1(2): 51- 59.
- [14] Galisky, et al. 2005. Energy Improvement in the Petroleum Refining Industry. 2005 Summer Study for Energy Efficiency in Industry. Associate Energy Engineers. USA.
- [15] Altwayrishi, B. 2016. Site Energy Management Systems (EnMS) Development and Implementation in Saudi Aramco. *Proceedings of the 10th Middle East Refining and Petrochemicals Conference*. September 26-29, 2016. Bahrain. 17.
- [16] Turner, C. W. 2001. *Energy Management Handbook*. 4th Ed. USA. The Fairmont Press.
- [17] UNIDO. 2010. Global Industrial Energy Efficiency Benchmarking. An Energy Policy Tool Working Paper, Nov2010. United Nations Industrial Development Organization, Vienna, Austria. Xi-3.
- [18] ISO 50001. 2011. Energy Management Systems – Requirements with Guidance for Use. International Standards Organization. Switzerland.
- [19] Worland, J. 2015. What to Know About the Historic 'Paris Agreement' on Climate Change. *Time* (2015, Dec 12).
- [20] Pyzdek, T. and Keller, P. 2013. The Handbook for Quality Management. *Complete Guide to Operational Excellence*. 2nd Ed. USA. McGraw Hill.
- [21] Australia Government. 2013. Energy Savings Measurement Guide. How to Estimate, Measure, Evaluate and Track Energy Efficiency Opportunities. Australia' Department of Resources, Energy and Tourism Version 2. Australia.
- [22] National Environment Agency. 2013. Singapore's Mandatory Energy Management Requirement. Energy Conservation Act (ECA). Singapore.
- [23] Japanese Government. 2013. Cabinet Decision on the Bill to Partially Amend the Act on the Rational Use of Energy (Energy Conservation Act). Japanese Minister of Economy, Trade and Industry Press Release.
- [24] EMEER. 2008. Efficient Management of Electrical Energy Regulations 2008. Electrical Supply Act (P.U. (A) 444).
- [25] Mullins, L. J. 2005. *Management and Organizational Behavior*. 7th Ed. UK. Prentice Hall.
- [26] Hashim et al. (2018b). Identify Energy Saving Opportunities from Operational "Self-Help" and "Quick Fix" Optimization Approaches. *Journal of Energy and Safety Technology*. 1(2): 41-49.
- [27] Lindberg, et al. 2015. Key Performance Indicators Improve Industrial Performance. *The 7th International Conference on Applied Energy – ICA2015 Proceeding*. *Energy Procedia*. Elsevier.
- [28] Nuaim, A. S. 2019. One Year of Sustainability is Not Enough'. *Journal of Petroleum Technology*. 2019: 10.
- [29] Solomon. (2013a). Fuels and Refinery Performance Analysis. Energy Intensity Index Analysis Methodology. Salomon Associates. 1.
- [30] Hashim et al. 2019. Leading Energy Performance Indicator. *Academy of Science Malaysia Journal*. December 2019.
- [31] Hashim, M. K. 2004. Water Management Study for BP Chemicals (M) Sdn Bhd. Master of Science. Technology University of Malaysia, Skudai.
- [32] Marcus, A. 2011. ICT and Eco-sustainability Working Group for McKinsey and Company. World Economic Forum. Davos, Switzerland. 29.
- [33] Estes, J. M. 2009. *Smart Green. How to Implement Sustainable Business Practices in any Industry – and Make Money*. 1st Ed. USA. J. Wiley & Sons, Inc.