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Research Article

Energy management systems in light of ISO standards

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ABSTRACT

Generation of energy in form of electric power is susceptible of vanishing threat due to high dependency on hydrocarbon fuel (e.g. oil). Energy management system (EMS) standards (e.g. ISO 50001) are developed for supporting the efficiency of concurrent generation means. In this paper, analytical study is performed for evaluating worthiness of EMS in various organizations including power production industry. Data of ISO enlighten EMS in various global organizations are obtained from clean energy ministerial (CEM). Results found that only 2.69 % of total global power production industries are using the EMS standards. The major number of EMS costumers are found to be end users including the manufacturers and retailers.

Keywords: EMS, ISO, CEM, VAR, efficiency, generation, balancing, demands

INTRODUCTION

Energy is generated by means of power systems which involves two essential domains: conventional fossil fuel based power plants (e.g. steam turbines, gas turbines, nuclear reactors, etc.) and green energy harvesting power plants (e.g. wind turbines and photovoltaics). Power system is susceptible of various performance degradations which eventually increase the total cost by raising up more path losses [1]. Loses can take place at any sector of power system ore likely at generation, distribution and load. Generation stations/power plants are encountered of losses due to emission and equipment faults [2]. Gas emissions in gas power plant is a symptom of error/fault at the turbine compressor; it influences the gas power which reduce the mechanical torque that rotates the turbine blades [3]. From the other hand, most of energy losses is occurring at distribution system and transmission lines [4]. Faults in distribution systems are among major loses influencing the power system. Since the inductive loads increases the reactive power (VAR) which increases the power loses, the load nature is also impacting the performance of power system [5]. Power grid involves connecting set of generation stations (plants) with loads in particular topology ensures optimum power flow. The grid topology is disturbing due to events alike fault or fail in particular busbar. Power grid need to be updated in accordance with power system fluctuation such as changing the load nature or during the equipments failure. Considering that power generation is limited by several constraints such as fuel availability and cost related matters, supplementary systems are required for facilitating the power generation and distribution. Energy management system (EMS) has come into picture after the energy demand increased and generation of energy is restricted. Paris calamite agreement has restricted the level of emissions from industries alike power plant; which influenced the amount of generated power from such plants [6]. From the other hand, dependency if fossil burning in energy generation has its limitations too as fossil is expected to exhaust within next 60 years [7]. Knowing that energy demand is a function of human population and since population keeps on expansion, the demand is highly increased in current years as compared to last decade. Energy resource optimization is the key solution for balancing the load and generation in energy sectors. Robust EMS is in charge of maintaining energy generation and energy demand in equilibrium. EMS involves service alike cost minimization and optimum resource allocation.

In this paper, we reviewed the quality constraints and problems faced in power production and distribution industries and identified the popularity of LMS standards in those fields.

ISO 50001

In order to maintain efficient performance of the power system, several regulations need to be enforced. International standards origination (ISO) has taken the responsibility for drafting the standards regulating the operations of various system and technologies including power generation plants. Furthermore, it saves natural resources and protect the mother earth by limiting the poisonous emissions of the fossil fuel based industries. ISO 50001 standard (which will be termed hereafter as “the standard”); has formed as energy management system for enhancing the power consumption efficiency at organizational level [iso] (including generation stations and the end users). The standard represented by set/bunch of regulations and roles, can be implemented by any

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organization i.e. residential compounds, hospitality buildings, power plants, etc. according to [8], largest hospitality company; the Hilton, has minimized their power cost as well as carbon emissions by 20.6 % and 30% respectively after implementing the standard. Another example can be reviewed about the national Ireland police force who reduced energy consumption and saved 11307142 USD after implementing the standard [9]. However, organizations following the standard must have reviewed by ISO auditors in order to verify the same and accordingly organization is granting ISO certification of "the standard" adaptation.

QUALITY CONSTRAINTS

Power can be generated with respect to load requirements; considering that power demand is continuously increasing due to population expansion or any other circumstances, the generation stations could maintain standby mode for fulfilling the demand. Future prediction of load/demand is not a tough task [10]; it can be evaluated using traditional analytical and statistical methods [11]. The practical situation of power system is farther than prediction of future, it is actually suffering from several performance degradations linked to the production and distribution systems. Most of the reported losses in power system are occurring in distribution network where power is carried through transmission lines towards end users. The aforementioned assumption of using analytical and statistical methods for determining future load status cannot stand with uncertainty of load fluctuations. From the other hand, load may suddenly increase over particular nodes in the distribution network and may sharply drop over other nodes resulting what so-called loading imbalance. Load congestion over particular nodes in the system triggers bigger problems such as transformer short circuit or dropping at busbar voltage profile [12]. This can be occurred during transmission line fault where load of the faulty sector is feed from other feeders. Hence, feeders may themselves experiencing a high load which poses loading imbalance issue. Such events are highly probable during seasonal loads e.g. (air conditioners are active during summer more than winter). The imbalance loading problem can be tackled using advance monitoring systems that capable of detecting the fault rapidly. Intelligent monitoring systems are presented in [13] where proactive monitoring is performed which predicts the event of errors before it's actually occurred. Load fluctuation due other aspects such as demand increasing over particular node/busbar in the network is also addressed using optimization algorithms such as artificial bee colony (ABC) [14], genetic algorithm (GA) [15], particle swarm optimization (PSO) [16], etc. Such algorithms are searching the optimum feeders and diverting the loads amongst them for balancing the network. Instantaneous error addressing procedure is required for maintaining high quality of power transmission. Such procedures are folded under EMS which helps power companies as well as the end users/consumers in both quality and economic aspects.

INDUSTRIAL ENERGY MANAGEMENT

EMS is highly need in intensive power consumers industries such as cement and petrochemical factories. Energy management in such industries has largely improved during the last 30 years as effects of EMSs incorporation. This indicates that potential amount of energy can be still utilized. The general formulation of EMS definition can be stated as optimizing of energy efficiency in the organization including industries and service appliances. Finding of energy efficiency gap is vital for successful EMS. The difference between the optimum efficiency (during the design process) and real-life efficiency (monitored during the practical situation) is termed as a gap of the efficiency [17]. The value efficiency gap can be used as measure for future target of energy enhancement achievable through EMS. Management of energy as stated by [18] is adaptation of all procedures during the planning phases and all routines during the operation phases which participates energy efficiency improvement. Such planning strategies and operations routines are cited from experiments and empirical models which were in use during the previous attempts for efficiency improvement. In order to compile those strategies, five systematic stages are proposed by [19] namely planning strategies, operations strategies, controlling strategies, management (human resources) strategies and cultural strategies. Compiling of those stages may help in bringing the MSE into practice. Thus, EMS five strategical stages mentioned above are specified by special bodies namely committees that taking different posts (in private or governmental sectors and formed officially under the so call standards. The instructions/roles of energy management are varying in accordance to the provisions of governments. Generally, international standardizations are enforcing maximum energy efficiency and safety were formulated by organizations such as international standard organization (ISO). European parliament and industrial emission directive council have formulated a document called as 2008/1/EC that enforcing particular roles for efficient energy management in the industries [20]. Power industries have witnessed large developments in terms of capacity and size. The control systems have drastically developed as new technologies came into light e.g. (artificial intelligence and machine learning). International standard organization have come with respective norms in order to regulate the overwhelming development of technology. ISO have drafted 50001 firstly in 1995; hereafter, several developments are relied on the mentioned standard called as ISO 50001: 2008 [9] and ISO 50001: 2011. Emerging of new technologies and tools in power systems had motivated the periodical editions of the standards.

STANDARDS CORRELATIONS

It was discussed in preceding sections of this paper that standards involve efficient regulations and procedures formed by specialized organizations/bodies for energy enhancement interest (it can be also formed for other technologies apart from energy sector e.g. communications and spectrum allocation ISO/IEC 15961-2:2019). It is however, formulated by originations such as ISO, international communication union (ITU), etc. Governmental agents may also formulate local/country-wise norms/standards

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of EMSs. For adopting any standard in real-life, correlation process is mandatory. At [21] quantitative methodology is prosed in order to evaluate correlation of ISO 50001: 2011 with the situation of practical power generation plants. The study has been established by formation number of questionnaires according to the hypothesis and subsequently testing those hypotheses according to the results obtained from questionaries' analysis. [21] proposed modifications on some clauses of the existing standard as well as adding of other clauses to the said standard for increasing power efficiency. Basically, proposing of any modifications in existing standards is required feedbacks and opinions of specialist committee who may accept or reject the proposed idea. Hence after, if committee approved the proposed ideas, pilot study could be initiated in order to understand the applicability of those modifications on real-life projects. Proposed modification might be assessed under several constraints alike cost, time, cultural aspects, man power, local (geographical) authorities' regulations, etc.

CASE STUDY

ISO has wide varieties of standards that regulating the energy use for improving the efficiency. In other word, EMS available standards are aimed to fill the gap between designated/theoretical and practical efficiency. They do so by governing the ways of energy generation, power system control and monitoring, manpower and safety and energy efficient consumption. Taking example of energy rationing at consuming stations; energy saving light bulbs includes light emitting diodes (LED) based lighting; have been widely populated according to ISO 50001. Same as energy saving lights, all the electrical home appliances are today manufactured in such way to save energy. Furthermore, today; machineries are integrated with smart control systems (using of electronic chips) for energy harvesting. In order to recognize the impact of robust EMS standards on the energy efficiency, this paper is demonstrating various applications, fields and sites which had adopted the ISO 50001 standards. United nations for industrial development organization (UNIDO) have approved and ISO 50001 and promoted using of this standard after witnessing the enormous success of the organizations which implemented that standard [22]. Firstly, ISO standards that developed up to date are demonstrated in Table 1.

Table 1: ISO EMS related standards summaries

ISO Standard	Description
50001:2011	EMS (the requirements and how to use) first edition
50001:2018	EMS (the requirements and how to use) second edition
50002	States about auditing of energy and released on 2014.
50004	Released on 2020 and involved the guidelines of improving the existed standard 50001.
50005	Involved phase-wise implementation of existing standard 50001.
50006	Released on 2014 and stated about energy performance monitoring using performance indicators.
50015	Released in 2014 and stated about energy performance validation and measurements.
52120	Stating about building EMSs.

According ISO official web portal, energy management system has a core standard which termed as 50001, all the relevant standards that mentioned in Table 1 as well as on the ISO web portal are commentaries are established for supporting the core one. Depending on the data obtained from [23], clean energy ministerial (CEM) is found for promoting the clean energy through conduction of high-level international award represents the leading organizations in energy management proficiency. CEM forum is commenced on 2016 and involved 28 members by date when this paper was written. At 2018, 50 organizations from global have involved with CEM when excellence award in energy management was granted for three members: The Russian, PJSC Magnitogorsk Iron & Steel Works (MMK) [24], the Ireland, A Garda Síochána (AGS) [25] and the Indonesian PT. Pembangkitan Jawa-Bali Gresik(PT PJB) [26]. However, CEM is working for promoting the benefits of investing in energy efficiency technologies. It keeps analyzing and validating of ISO 50001 LMS standards by collecting annul energy costs reports from its members. It also focusses on determination of yearly carbon emission reductions. As per the current report of CEM, total cost reduction of 383 million dollars and 4.3 metric tons of CO2 has been reduced by CEM members after accurately implementing of ISO 50001 (e.g. the standard). The profiles of top CEM awarded members can be summarized as following:

1. AGS at Ireland: this origination is representing the national police force in Ireland, it is considered as first police in world which is certified with ISO 50001. AGS has applied 50001 norms on the vehicles fleeting over two of largest Ireland cities. By whole, AGS could harvest a sum of 11.3 million dollar and eliminate 70,340 metric tons of vehicles Carbonic emissions for eight years.

2. MMK at Russia is biggest steel manufacturing company on Russia, it has adopted the norms of 50001 and subsequently harvested of 20.5 million dollars (for one year) and total of 698,186 metric tons of CO2 elimination for three years.

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3. PT PJB at Indonesia is a steam power plant that supplies east Java by electricity; it has implemented the 50001 norms for three years and could successfully achieved the government budget goal of harvesting a sum of 9.69 million dollars and eliminating of 2.72 metric tons of CO2.

At this point of the study, some global projects that recognized by CEM as active partners of green energy harvesting are listed in Table 2.

Table 2: CEM data illustrating the applications (samples) using EMS standards

SN.	Organization	Type	CEM reward	Country of origin
1	ABB S.A.	Manufacturer	Energy Management Insight Award	Argentina
2	Abu Dhabi City Municipality	Human colony	Energy Management Insight Award	UAE
3	Aguas Andinas	Water service	Energy Management Insight Award	Chile
4	Allied Irish Bank	Finical service	Energy Management Insight Award	Ireland
5	Banco de Crédito e Inversiones	Finical service	Energy Management Insight Award	Chile
6	Beijing Capital International Airport Co., Ltd.	Transportation	Energy Management Insight Award	China
7	Dubai Municipality	Service premises	Energy Management Insight Award	UAE
8	El Araby Company for Trading and Manufacturing	Manufacturer	Energy Management Insight Award	Egypt
9	Google	IT services	Energy Management Insight Award	As many as Belgium, Ireland, Singapore, Taiwan, USA, Canada
10	Grasim Industries Limited	Textile industry	Energy Management Insight Award	India
11	JK Cement Ltd.	Manufacturer	Energy Management Insight Award	India
12	L&T MHPS Turbine Generators Pvt. Ltd	Manufacturer	Energy Management Insight Award	India
13	LG Electronics Inc., LG Digital Park	Manufacturer	Energy Management Insight Award	Korea
14	Zhilkomservice	Builder	Energy Management Insight Award	Russia
15	Viña Cono Sur	Food industry	Energy Management Insight Award	Chile
16	Vardar Dolomit Dooel	Manufacturer	Energy Management Insight Award	Macedonia
17	Sungshin Cement Co., Ltd.	Manufacturer	Energy Management Insight Award	Korea
18	SIN PAR S.A.	IT services	Energy Management Insight Award	Argentina
19	Roads and Transport Authority Dubai (RTA)	Service premises	Energy Management Insight Award	UAE
20	Raymond Limited	Textile industry	Energy Management Insight Award	India
21	Puerto Ventanas S.A.	Manufacturer	Energy Management Insight Award	Chile
22	PT. Pembangkitan Jawa-Bali Paiton	Power plant	Energy Management Insight Award	Indonesia
23	PT. Cheil Jedang Indonesia	Social Activities	Energy Management Insight Award	Indonesia
24	MMK	Manufacturer	Award of Excellence in Energy Management	Russia
25	PT PJB	Power plant	Award of Excellence in Energy Management	Indonesia
26	AGS	Transportation (police vehicles)	Award of Excellence in Energy Management	Ireland

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CONCLUSION

After analyzing of data obtained from CEM portal involves the world wide ISO 50001 certified industries and CEM awarded companies. We referred CEM portal as it considers majority of ISO 50001 implementors in global scale. However, this portal may not include entire data of whole ISO 50001 based organizations in the world, but it provides sufficient insight of world leading industries that are actually used the standard and granted the advantages of the same. There must be standalone organizations that are not CEM partners but still deployed the standard. However, from virtual inspection of the aforementioned information of this paper, once can understand that total originations/samples collected from CEM are 26, out of it, only two are into power plants and rest are varying under different applications. The histograms plotted in Figure 1 and Figure 2 are made according to the obtained data (Table 2).

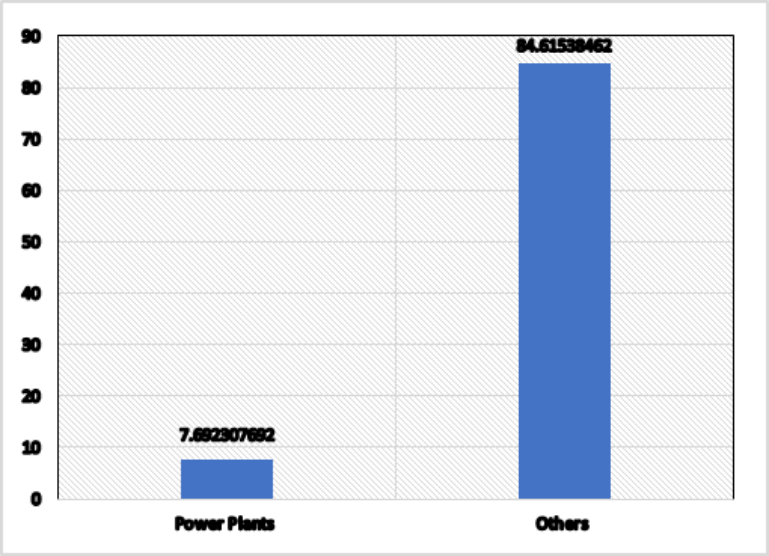

Figure 1: Percentage of EMS ISO 50001 deployment in power plants as compared to other fields

It was realized that only 7.69 percent of the power plants are deploying the standard of EMS whereas 84.615 percent of other applications are deploying the same. The breaks of deployment percentage of the other applications can be demonstrated in Figure 2.

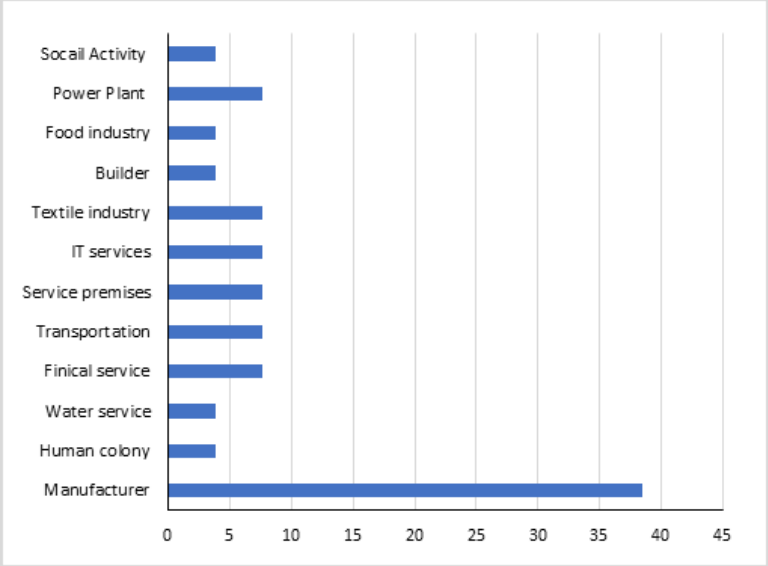

Figure 2: Demonstration of deployment rates of all applications enlisted at Table 2.

According to the obtained results, it can be said that most of those which are using EMS standard (i.e. ISO 50001) are considered as power consumers from power analysis point of view. The retails have found best way for cost cutting is implementation of the standard at their own organizations. Less efforts were performed in adoption of the standard over power plants. Thus intensive

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study to analyze the level of energy management in power plants including generation and distribution stations is highly recommended in order to get insight with the power generation efficiency and for planning the methodology for tackling them

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