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Identify Energy Savings Opportunities from Operational "Self-Help "and "Quick Fix" Optimization Approaches

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Abstract

The objective of this paper is to describe the importance of formation of a pragmatic Energy Optimization Program (EOP) at the concerned oil and gas facilities. Substantial amount of energy savings can be realized by focusing on initiatives that require no investment or so called "self-help" that can easily be implemented without further a due. A "quick fix" initiative involves a nominal investment; it can also be easily executed without the need for detailed project justification. Given the increasing expectations to oil and gas organizations to maintain a competitive edge in the modern global economy have caused the instability of crude oil as the world's major commercial energy source for the next coming years and greater commitment to reduce greenhouse gas (GHG) emission. Regardless of during high or low crude oil price, energy is certainly a critical business continuity driver for both users and producers. Having significantly greater EOP to explore energy savings opportunities require many efforts including new efficient equipment, new technology, new processes and approaches which should be given a priority. Ideally, EOP focused team shall effectively participate in early design stage of project, so that all significant energy efficiency concepts will be considered in the design. In reality, many energy efficiency efforts may be missed out as a result of loose energy efficiency definition, less competency of design engineers, hectic project schedule and/or resource constraint.

Keywords: Energy performance; energy optimization program; energy self-help and quick fix

1.0 INTRODUCTION

It is increasingly more challenging for oil and gas organizations to maintain a competitive edge in the modern global economy. Despite of instability in the world's major commercial energy source as the price of crude oil reached record peak of USD147.27 per barrel in July 2008 and went down quite significantly in 2016. It is expected to remain low for the next coming years. Most of oil and gas organizations are burden with high expectations on environmental requirement to reduce GHG emissions, increase profitability from its operations and social contribution. Many countries including major oil producers such as Saudi Arabia, Kuwait, Bahrain, Oman, Venezuela, Iran and Russia are suffering to manage budget deficit due to high subsidies on energy during high crude oil price [1]. Similarly, low crude oil price also causes negative impact as most of those countries are highly depending on oil revenue.

Instability in energy price is certainly a critical business continuity driver for both energy consuming or producing organizations [2]. Focusing only on prices is shortsighted. Regardless of during cost of energy sources remain high or low, the need to explore energy savings opportunities including new efficient equipment, new technology, new processes and approaches shall continue. In the age of globalization, optimum plant performance including energy productivity and energy efficiency are decisive success factors and this transformation is a need [3]. Oil and gas organizations continually strive to increase efficiency and reduce expenses [4]. In fact, it was indicated that only few of them have been investing significantly over the past few years on energy efficiency and renewable energy [5]. In practical, the following activities shall be done prior to project completion;

- Energy supply technology selection shall be optimized before the end of front end design (FED), by applying a real cost of energy to the design optimization process.
- All major and medium size projects shall undertake and adopt energy value improving practices (VIP) during the project development.
- Major and medium size projects shall incorporate online systems that monitor all sources of energy and GHG emissions, and major energy flows to process units or large items of equipment within the facility.

In many cases, experts indicate that energy contributes small percentage of operating costs. Therefore, it may receive very little attention from top management [6]. Subsequently, EOP has always been forgotten during project development as well as limited resources allocation in energy efficiency research and development. It is jeopardizing the organization energy performance as it will widen its gap as compare to best in class. By implementing EOP in which the main target is to focus on self-help and quick fix initiatives, this can partially reduce the gaps. This is basically the quickest way to be implemented, as no capital investment is required.

The objective of this paper is to describe in step by step the EOP as one of the effective continual improvement tools. Therefore, each concerned organization shall allocate all required resources to deploy it successfully. During execution stage, opportunities for improvement begin with ideas that can be generated from the analysis of energy use and consumption, the determination of energy big picture or from a variety of other sources such as site visit, data analysis, learn from other success story, benchmarking, gaps analysis as well as suggestion campaign. This stage is the most effective way to identify opportunities in improving energy performance and the development of a prioritized list of these improvement opportunities at any concerned organization. Ranging in cost and complexity from walkthroughs to detailed assessments, the collection and analysis of data forms the foundation for prioritizing opportunities for improvement.

The task shall be part of a continuous improvement process, but may also involve periodic analysis using proven techniques. Involving a range of people in this process such as operational and maintenance staff can help to reveal a full range of ideas. These ideas become opportunities through examination and refinement, using data analysis to determine potential of energy performance improvement and feasibility [7]. All opportunity shall be registered in initiatives list and furnished with detailed description; indicative energy savings potentials, implementation cost and complexity of implementation [6]. Each of initiative shall be lumped into five categories; rejected, pending verification, operational self-help or initiative with no implementation cost required, quick fix or initiative with nominal implementation cost and capital project for initiative that requires substantial amount implementation cost. A typical magnitude of energy savings for the last three categories is listed in Table 1 [8]. Self-help and quick fix related initiatives can be executed accordingly after completing necessary implementation reviews.

Table 1. Typical energy savings [8]

Energy Saving Approach	Potential Energy Savings
Operational improvement or "Self-Help" by considering low hanging fruits energy saving initiatives	< 15%.
Energy low cost "Quick Fix" initiatives	< 35%.
Higher cost initiatives (dedicated energy project)	< 50%.

2.0 METHODOLOGY

Industries best-practices, case studies and some other supported documents were referred in defining the most effective steps while pursuing the EOP [9]. In the Figure 1 provides brief methodology of this whole study as presented in this paper. Establishment of EOP with focusing on self-help and quick fix initiatives gathering and implementation at any concerned organization and then strengthening it to pave the way towards improving company profitability. A brief description of the preferred EOP will be walked through based on actual plant experiences or by lessons learned from reputable literatures.

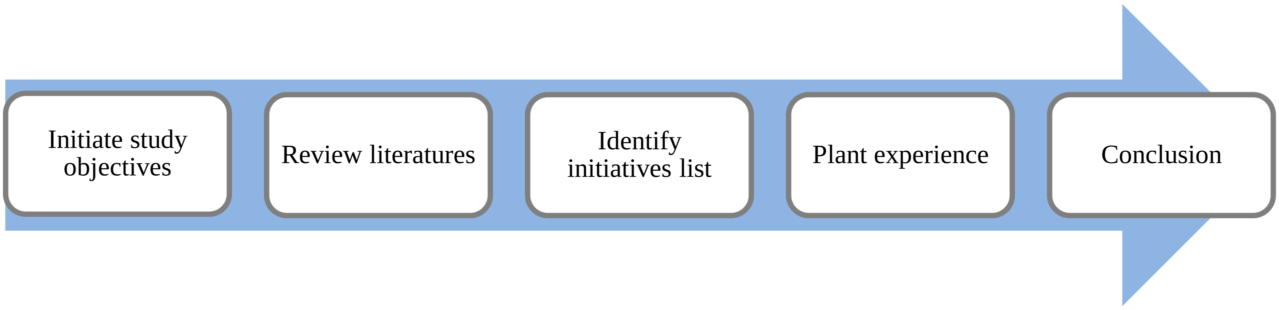

Figure 1. Detailed steps of methodology taken in this study.

3.0 RESULTS AND DISCUSSION

3.1 Energy Optimization Program (EOP) Steps

Five main steps of EOP have been identified starting from obtaining management commitment, form an EOP team, define optimization plans, execute optimization actions and evaluate achievement which is mirroring Deming quality circle of Plan, Do, Check and Adjust [10][11]. As illustrated in Figure 2, each of steps will be supported by several sub-steps to provide more coverage of required activities toward strengthening intent of the program. Starting with to gain management commitment which consists of several activities such as allocation of resources, definition of its objectives and targets, performance tracking as well as close review of outcomes for further improve the step.

The second step is to form energy team which involves the appointment of competent members from multi disciplines but not limited to engineering, operation as well as maintenance representative. Dedicated team led by competent energy engineer should be fully empowered to gather their commitment to meet the desired objectives and targets. Subsequently the optimization plans are defined. In this step, the team shall identify the energy optimization plan, a comprehensive checklist to simplify process to gather energy savings initiative as well as to establish systematic evaluation method.

In the execute step, optimization task is taking place to capture any applicable energy savings. It follows by assessing and prioritizing applicable self-help and quick fix initiatives. Therefore, implementation of any accepted initiative shall be planned in due course. In the last step of evaluate achievement, each of implemented initiative shall be closely monitored and evaluated to confirm its effectiveness. Lessons learned shall be compiled and reported to management for further review. In realizing an optimum benefit from EOP, several approaches shall be considered such as; treat energy efficiency as a significant aspect and develop a continuous improvement plan, work toward energy excellence through implementation of best practices, eliminate continuous or routine venting of steam and compress air, flaring of hydrocarbon, reduce heat demand by improving the transfer of energy between relevant process streams within and between relevant units, develop and maintain an auditable model that relates energy consumption to projected levels of business activity and install as well as maintain energy-metering systems.

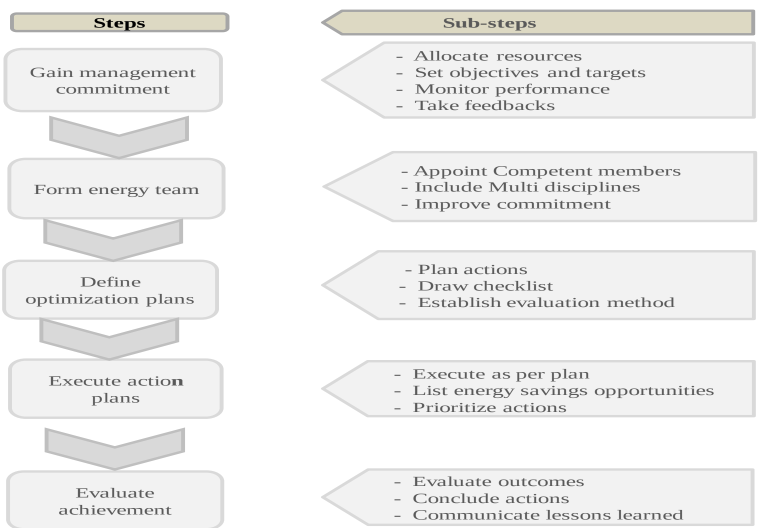

Figure 2. Energy Optimization Steps

3.2 Execution of the Energy Optimization Program (EOP)

The most important step of EOP as indicated by several reseachers is to gather top management commitment toward improving its energy performance [12]. The committed management will allocate adequate resources such as formation of focus group (energy team), funds to manage the team and to execute identified energy saving initiatives. In addition, the management shall provide all necessary supports to define a realistic energy performance, objectives and targets, and embed them into the organization activities. The program shall be prepared to any triggering event that can be caused by changes in the competitive marketplaces or changes in the management structure of an organization, changes associated with internal performance, operations, technology, economic environment as well as political and legal factors.

Strong management supports by empowering an energy team is essential to ease execution of energy optimization activities. Competency of the energy team members is also one of important successful factor. Harnessing valuable tacit knowledge is very critical task to boost competitive edge within the organizations [13]. Members of the energy team shall have a strong technical knowledge on the facility that he or she is going to assess besides being well verse in energy optimization techniques. Lead by a competence energy coordinator who plays a pivotal role in ensuring a proactive stance on good energy practices and in developing a comprehensive EOP. The coordinator alongside with other energy team members shall not only be a technical expert, but also an enthusiastic salesperson to generate interest and commitment to the energy program from the management to the other team members as well as unit operators and maintenance personnel. The coordinator's job is more than just evaluating potential energy projects; equal time shall be devoted to employee involvement efforts aimed at operating existing facilities as efficiently as possible. A key goal is to establish appropriate responsibilities at each level of the organization. There is no simple recipe for securing the commitment of the workforce. Doing so requires a creative approach that meets the needs of the organization as well as those of the employees [14].

Prior to execute the assessment, the energy team shall establish the relevant checklist to ensure all required tasks are covered and to establish a list of key elements of the assessment [15]. The list includes required expected information, data collection processes, analysis, opportunities identification and evaluation, decision making process as well as communication. Conducting a systematic energy optimization assessment can identify deficiency of energy system performance and other following information as listed [16];

- Define the types and cost of energy use.
- Identify how energy is being used or wasted.
- Investigate "energy big picture" and therefore identify significant energy users (SEUs).
- Identify and analyze alternatives such as improved operational technique and / or new equipment that can significantly minimize energy cost.
- Perform an economic analysis on these alternatives and determine those that are cost-effective for business or industry involved.
- Understand current obstacles and constraints for both process units and utility.
- Determine future energy assessment approaches and frequency.

Main preparation prior to execute an energy optimization is to establish selection criteria prior to list energy initiatives. This is a generic list that has potential to optimize any related process that differentiate from other sectors due to spectrum of products, feed-stocks and imposed criteria in decision making. Typical criteria are as follows:

- Operational improvement with no or at minimum investment cost to implement the identified energy savings initiatives but can accouter high risks of execution.
- Operational improvement with no cost or at minimum investment cost to implement the identified energy savings initiatives without any risk of execution.
- High investment cost and low success rate of implementing the identified energy savings initiatives; in fact this uncertainty makes most organizations to continuously delaying these initiatives.
- High investment cost and requires an extended time to plan for implementation due to cost constraints, technical doubt and lack of operational experiences.

The first and second bullet points from the previous list are representing self-help and quick fix initiatives. List of common areas of opportunities to further improve energy performance are as follows;

- Steam loss due to steam traps and pipe leaks [4].
- High furnace flue gas excess oxygen levels [8] [17].

- Burner combustion issues [18].
- Steam header pressure control [4].
- Cooling water systems – high water circulation and fan control [19].
- High plant water usage [20].
- Poor motor efficiency [21].
- High steam deaerator vents [4].
- Flare mitigation program [22].

During execution stage, all energy savings ideas will be generated from various sources such as site visit, data analysis, learn from other success story, benchmarking, gaps analysis as well as suggestion campaign. The list is also included with detailed description; indicative energy savings potentials, implementation cost and complexity of implementation. In addition, savings potential against its effectiveness helps to stimulate in-house energy saving measures. Initiatives given is based on either through actual implementation experiences, literature and common best practices captured from various sources as listed below;

- Energy savings potential (Indicative):
  - High: potential savings is greater than 10% from reference basis.
  - Medium: potential savings between 5% - 10% from reference basis.
  - Low: potential savings below 5% from reference basis.
- Implementation cost is based on literature (Indicative);
  - High: expected cost is above USD 1 million (presumed included under capital project).
  - Medium: expected cost is less than USD 1 million (considered under simple project or quick fix initiative).
  - Low: no or very minimal implementation cost.
- Implementation complexity (indicative);
  - High: the identified initiative requires a special focus under capital project, extended shut down window and associate with many risk factors.
  - Medium: the identified initiative requires moderate focus, short facility shutdown window and associate low risk factor.
  - Low: no facility shut down required and no or minimum associate risks.

3.3 Self-help and quick fix tips

It is a fact that operation and maintenance play a critical role in energy optimization. Properly maintained equipment and processes are necessary to keep the facility at the optimum capability. A primary concern for oil and gas facilities after health, safety and environmental issues, is to manage its production plan. Energy often comes a poor second. Changes in one process or piece of hardware can cascade hard to foresee consequences, some may improve site wide energy use but others may have a negative impact on site wide energy use or robustness of operations.

Good operating philosophies are, for example, to run motor at optimum condition, operate within process limits, fix all process and utilities leaks, eliminate steam vent and other activities that can improve facility' energy performance. Operators can be made responsible for energy targets they can influence. Any conflicts with margin value can be dealt with the daily variability and daily disturbance that every facility encounters. Similarly, according to researcher that maintenance measures are also essential, particularly on each identified energy significant users including monitoring equipment performance, initiating preventive maintenance program and fixing any equipment deficiency within acceptable duration [23]. As an example, effort of optimizing an open recirculation cooling water system was a great achievement in reducing energy cost after implementing several initiatives such as;

- Pump load management by operating with less number of pumps.
- Retrofit initiative by replacing cooling tower fan with lighter blades.
- Apply suitable cooling water treatment program to minimize deposits and anti-scaling enhancement prior to operate at reduced cooling water flow, high cooling water as well as low tower blow down.

- Operation effort to optimize required number of cooling fans based on cooling duty requirement.
- Use high efficiency motor.

Another important recommended initiative to save energy is by minimizing pressure drop. It can be achieved by maintaining clean pipelines through removal of internal scaling; apply right valves with less pressure drop and select low pipe roughness. In addition, reducing crude oil viscosity with dilution agent is one of the initiatives to be highly considered [24]. Nearly 80% of that energy consumed for high service pumping costs is to overcome the static head and friction losses of utilities distribution systems [25]. There is an opportunity to employ various energy saving strategies that can result in a 20 to 50 percent reduction in energy consumption and likewise, operating costs.

Energy savings initiatives listed in Table 2 are widely accepted. However, its implementation measures are preliminary and further confirmations are required to be quantified. In fact, each of identified initiatives shall be evaluated promptly through the following subject items but not limited to;

i. Technical evaluation.

ii. Operational evaluation.

iii. Simple Risk Analysis i.e. strength, weakness, opportunity and threat.

iv. Incentives: economic and GHG reduction.

v. Process Safety Management (PSM) review such as Management of change, hazard and operability study (HAZOP) review and other specific requirements each applicable organization.

vi. Initiative execution plan.

vii. Decision making and path forward plan.

After evaluating each of energy saving idea in accordance to the above subject items, the final energy saving initiatives shall be concluded to include all following details but not limited to [26];

i. Responsibility appointment.

ii. Estimated time of completion.

iii. Impact to energy performance.

iv. Performance verification.

v. Method of verifying results.

Table 2. Typical Energy Savings Initiative list

No	Energy Savings Initiatives	Measures		
	Category – Operation and maintenance Initiatives	Potential savings	Cost to implement	Complexity of initiatives
1	Improve insulation for piping, furnaces, fired heaters, boilers and other related equipment	M	M	L
2	Clean and maintain boiler tubes from deposits and scale for better operations	L	M	M
3	Conduct preventive maintenance of energy system components such as heat exchangers cleaning and rotating equipment typical servicing	M	M	M
4	Operate cooling towers and cooling systems at optimum condition	M	L	L
5	Fix compressed air and steam piping leaks	L	L	L
6	Optimize air compressor and pump operation i.e. operate at best efficiency point, shut down compressor at low feed rate, low vibration	L	L	L
7	Eliminate steam vents	L	L	L
8	Clean and maintain pipelines and valves to minimize pressure drops	L	M	M
Category: Monitoring Management				
1	Flare mitigation program	H	M	M
2	Heat Exchangers fouling monitoring program	M	L	L
3	Steam traps monitoring program	M	L	L
4	Implement load management program for pumps, compressors, boilers, steam turbines and gas turbines	M	L	L
Category: Boiler, Steam System and Fired heater				
1	Optimize combustion burner flame control	L	L	L
2	Optimize excess oxygen	L	L	L
3	Minimize boiler tower blow-down to increase boilers cycles of concentration through good water treatment	L	L	L
4	Adjust boiler steam pressure and temperature to the extent that matches process needs	L	L	L
5	Minimize steam let downs	L	L	L
6	Optimize stack temperature	L	L	L
7	Optimize your waste heat boilers	M	L	L
9	Maximize hot condensate recovery	L	L	L
10	Lower down operating pressures of steam deaerator	L	L	L
11	Optimize steam use in reboiler	L	L	L
12	Minimize live steam utilization	L	L	L
13	Optimize boiler operating condition by conducting regular analysis on steam and condensate	L	L	L
Other Energy Initiatives				
1	Reduce natural gas consumption by understanding fuel gas sinks or constraints	L	M	M
3	Minimize water consumption by increasing cooling towers cycles of concentration through good water treatment, maximize use of recycle water or Minimize fresh water used in desalter and other scrubbing applications	L	L	L
4	Minimize generation of wastewater	L	L	L
5	Eliminate hydrocarbon leaks	L	M	L
6	Optimize pressure of instrument air system	L	L	L
Category – Retrofits				
1	Optimize Combine Heat and Power (CHP) system	H	H	H
2	Include heater to preheat combustion air	L	H	H
3	Use Variable Speed Drive (VSD) on BFW pumps. larger pumps and compressors	M	H	H
4	Include economizers to recover energy from Furnaces/Boiler' flue gas	M	H	H
5	Use auxiliary turbines to minimize steam let downs	L	H	H

	Energy Savings Initiatives	Measures		
6	Utilize boiler blow-down for heat integration	L	H	H
7	Evaluate turbo-expander to generate power in the high pressure/Low pressure control valves	L	H	H
8	Re-use the flue gases in process heating	L	H	H
9	Cool down the inlet gas/air temperature to compressors	L	H	H
10	Replace turbine drives with electric motors if more economical since they are more efficient	L	H	H
11	Re-use the flue gases in process heating	L	H	H
12	Keep Hydrogen gas separate from fuel gas system	L	H	H
13	Minimize or eliminate live steam consumption in strippers by replacing it with re-boilers	M	H	H
14	Recover valuable gases from your fuel gases	M	H	H
15	Use high efficient motor	L	M	M

Note: H – High, M – Medium and L- low

In realizing an optimum benefit form EOP activities, several approaches are required to gain additional focuses by respective organizations. Table 3 has listed several areas of concerns for specific EOP steps.

Table 3. Area of concerns

Step	Action
Gain management commitment	Treat energy efficiency as a significant aspect and develop a continuous improvement plan
Define optimization plans	Work toward energy excellence through implementation of good energy practices
Execute action plans	Eliminate continuous or routine venting of steam and compressed air or flaring of hydrocarbon due to supply and demand imbalances across the facility (with the exception of venting related to emergency, safety, and abnormal operational conditions).
Execute action plans	Assess all process units for opportunities to reduce heat demand by improving the transfer of energy between relevant process streams within and between relevant units.
Evaluate achievement	Develop and maintain an auditable model that relates energy consumption to projected levels of business activity.
Evaluate achievement	Install and maintain energy-metering systems.

4.0 CONCLUSION

This paper has concluded that a structured EOP has been successfully developed as a starting point to enhance energy performance at the concerned oil and gas organizations of this study, which also deem fit to be applied in any other interested organizations. The proposed EOP has been established based on the industry best practices as some of the listed initiatives were based on real applications. There are five main deployment steps and sixteen sub-steps that shall be taken prior to strengthen the EOP. The first approach of EOP is to identify and follows by assessing and prioritizing all self-help and quick fix initiatives. Therefore, implementation of any accepted initiatives shall be planned in due course. Each of implemented initiative shall be closely monitored and evaluated to confirm its effectiveness. Lessons learned shall be compiled and reported to management for further review.

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