The Optimization of Energy Consumption by The Introduction of Iso 50001: A Case of An Algerian Company

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Abstract
World energy consumption is rapidly increasing. Oil remains the number one energy source, accounting for 33.1% of global energy consumption, but this is the smallest share of oil in a very long time. In addition to its economic cost to organizations, energy also has an environmental and societal cost due to the depletion of resources and certain problems, such as climate change, to which it contributes. It takes a long time to develop and deploy technologies to harness new and renewable energy sources. The Algerian company SONATRACH, one of the largest companies in the world, has started to implement the Energy Management System (EnMS) in its units. The question is: Has the implementation of the energy management system been successfully implemented? To better answer this question, we will use an evaluation tool specifically designed to assess the implementation of this system called ENERGIE-CHECK. For the second phase of this work, we will try to determine if this system will achieve the goals and objectives of the energy policy set by the company's general management.

Keywords: Environment, energy consumption, economy, energy management, ENERGIE-CHECK tool

Introduction

With the socio-economic development, global energy consumption has increased and is projected to continue to grow in the future. Energy is omnipresence in all types of goods and is needed to produce any service (Fadzilah et al. 2014). About 85% of total energy consumption comes from coal, oil, and natural gas, which raises concerns about greenhouse gas emissions and fossil fuel consumption (Bago et al., 2023).

Taking action to manage our energy consumption better not only helps the planet, it saves money for organizations and society as a whole. Therefore, when energy benefits are combined with additional benefits such as operations and maintenance savings, rental premiums, increased property values, positive impact on stock prices, and access to additional capital for publicly traded companies, organizations can make stronger business cases (Liu and Sheaffer, 2018).

The ISO 50001, Energy Management Systems - Requirements with guidance for use (ISO 50001) is an international standard developed by the International Organization for Standardization (ISO) at the request of the United Nations Industrial Development Organization (UNIDO). This standard provides organizations with requirements for Energy Management Systems (EMS). Generally, the release of ISO50001 has received favorable support from the industries. A total of 461 certificates of ISO50001 Energy Management System (EnMS) were released to 32 countries within six months of launching in the year 2011 (ISO survey, 2012).

In Algeria, the eleventh largest country in the world with over 44 million people (ONS, 2019), Hydrocarbons have long been the backbone of the Algerian economy: oil and gas accounted for two-thirds of the State revenues and about 30% of its Gross Domestic Product (MeetMed, 2020). Compared to other developing countries with a similar development level, Algeria's consumption is high (1.4 toe per capita), partly because of consumption and losses in the energy sector (oil and gas production and LNG plants, mainly). According to the (Enerdata, 2021), electricity consumption per capita reaches 1 600 kWh. Therefore, a number of companies have introduced ISO 50001.

Nevertheless, organizations and companies encounter barriers and challenges when implementing the ISO 50001 energy management system, including the integration of energy management and technology, energy performance indicator definitions, the technological bottleneck of energy efficiency improvement, and third-party certification (Wong, 2011). The demand items in ISO 50001 include energy technology items that necessitate, for example, the involvement of consultants with experience in related technology fields to measure and monitor various detection devices for public facilities and production equipment (Valencia-Ochoa et al., 2020).

A content analysis of 72 case studies of successful ISO 50001 implementation underlines that organizations typically do not

prioritize improving overall system efficiency via implementing an energy management system, in that three frequent barriers were energy management being neither integrated nor rewarded within organizational culture, difficulties in educating personnel at various levels within the organization, and sustaining commitment from top management ().

Our work presents a case of an Algerian company that implemented the Energy Management System (EnMS) standard via the use of the PDCA approach. The question is: Has the implementation of the energy management system been successfully implemented? Our study is to assess the implementation of the ISO 50001 in this manufactory by using the ENERGIE-CHECK tool.

Literature Review

Thus, to achieve efficient use of energy, companies must make changes in their organizational structure in the way they carry out their planning and in the decision-making process [8]–[10]. The International Organization for Standardization (ISO) officially announced the ISO 50001 management system on 15 June 2011 after numerous meetings and discussions (ISO, 2011). The goals of energy management standards can provide enterprises with an organized platform for integrated energy management performance. These goals include adjusting production processes and increasing the energy efficiency of the system (Fossa, 2011). ISO 50001:2018, *Energy management systems (*EnMS*)*, is a strategic tool that helps organizations put in place an energy management system and use their energy more efficiently and effectively. From large retailers to smaller manufacturers and small businesses, the standard offers organizations the opportunity to become more resilient against energy costs and availability. For the proper implementation of this standard, it is necessary to research new methods that allow industries to reduce their production costs without compromising the quality or quantity of such products (Valencia-Ochoa et al., 2020).

Objectives can include both overall improvements to an EnMS and specific, measurable energy performance improvement targets (BSI, 2018). The value of an ISO 50001 EnMS and the foundational "Plan-Do-Check-Act" management framework is recognized by the industry, government, and utility programs (Batmale et al., 2013). One way to conceive of an EnMS is to have an implementing organization manage energy as a business practice, just as it manages other important aspects of its operation (Fuchs et al., 2023).

Although the ISO 50001 energy management system architecture is similar to the ISO 9001 quality management system and the ISO 14001 environmental management system announced by the ISO, it includes unique energy management demands and special technical definitions, such as those found in its provisions and demands regarding energy performance indicators and significant energy use (McKane.et al., 2009, Macdonald and Skaggs, 2012).

Many developed and developing countries currently impose obligatory regulations for their energy-intensive industries to practice implementing energy management systems (Hepbasli, 2003).

Methodology

This study used a qualitative approach with a single case study as a research strategy. The method used in this study is the Energie-check tool. In the form of a checklist, this tool allows the energy manager to carry out a "self-assessment" of the energy management approach in place in his company (ATEE, 2022). The assessment is proposed according to 5 axes:"

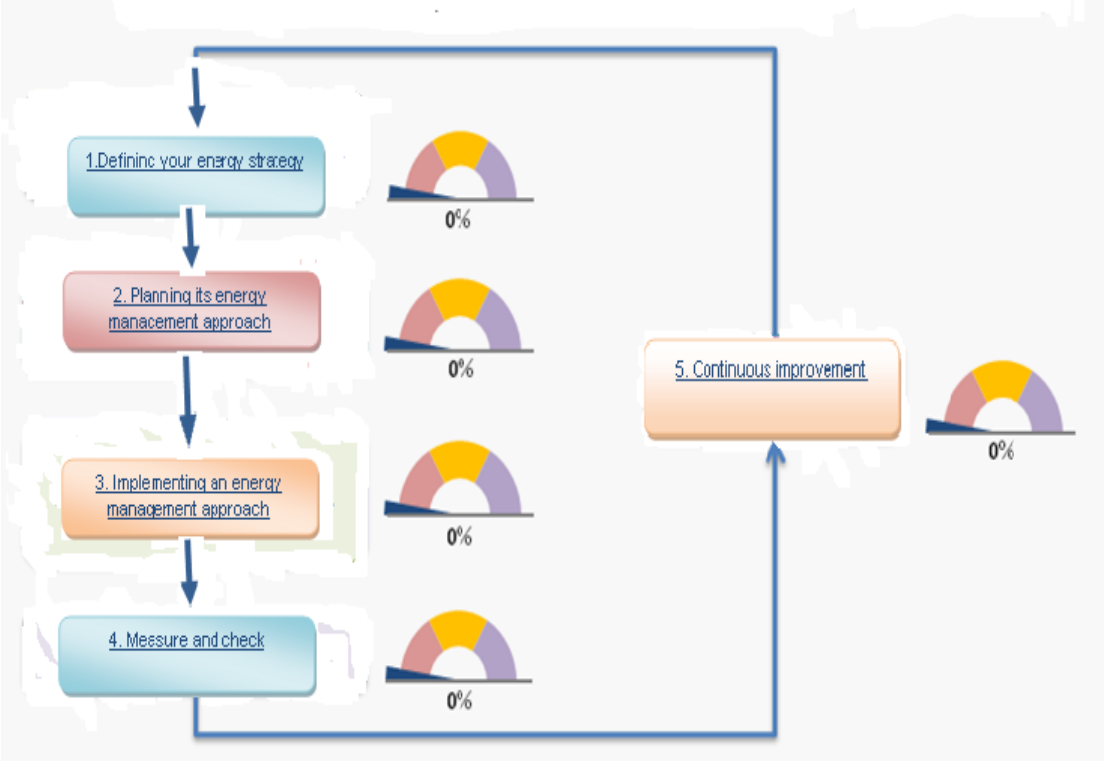

Figure 1: The 5 steps of an energy management approach

The main investment items for each axis are as follows:

1. Defining the energy strategy (Energy policy, Energy Organization),
2. Planning its energy management approach (Compliance with regulations, Knowing and analyzing its energy consumption, Defining an action plan),
3. Implementing an energy management approach (Competency and awareness, Communication, Operational procedure, Purchasing design and investment),
4. Measure and check (Measurement, monitoring and analysis of consumption, Verify the achievement of objectives),
5. Continuous improvement.

The "Checklist" tab provides a list of forty or so questions to which the energy manager must answer "Completely" / "Partially" / "Not at all" / "Not applicable" using a drop-down menu.
The tool follows the logic of the ISO 50001 "Energy Management System" and its PDCA (Plan-Do-Check-Act) methodology. The result of the assessment allows the company to identify its areas for improvement in energy management.

Result and Discussion

This section elaborates the main results of the observation that were conducted at the selected factory. It starts with explaining the background of company and followed by the implementation of the EnMS using PDCA cycle and reviewing the energy performance result after the implementation of the system.

Background of the Company

This Algerian Liquefied Petroleum Gas (LPG) manufacturer was established since 2013. It is an associated gas liquids extraction unit designed to receive upgradable associated gas from the crude processing unit and to return depleted gas and ship the LPG extracted from the feed gas to a new pump station. An associated gas processing unit for the production of LPG and condensate consists of the following systems and utilities:

- Gas supply
- Charge gas compression
- Feed gas dehydration
- Liquid processing trains
- Liquid product storage and shipping.

Utilities

- Fuel gas system
- Hot oil system
- Torch system
- Chemical injection system
- Instrument air compressors / Air service
- Nitrogen compressor
- Closed drains
- Open drains
- Oily water treatment
- Diesel unit
- Raw and drinking water.

Evolution of the consumption of fuel gas

In this section, we illustrate the evolution of the annual energy consumption before and after the application of ISO 50001, in order to see the performance of the implementation of the energy management system (Figure 2). The distribution of energy consumption at the company is 98% fuel gas and 2% electricity.

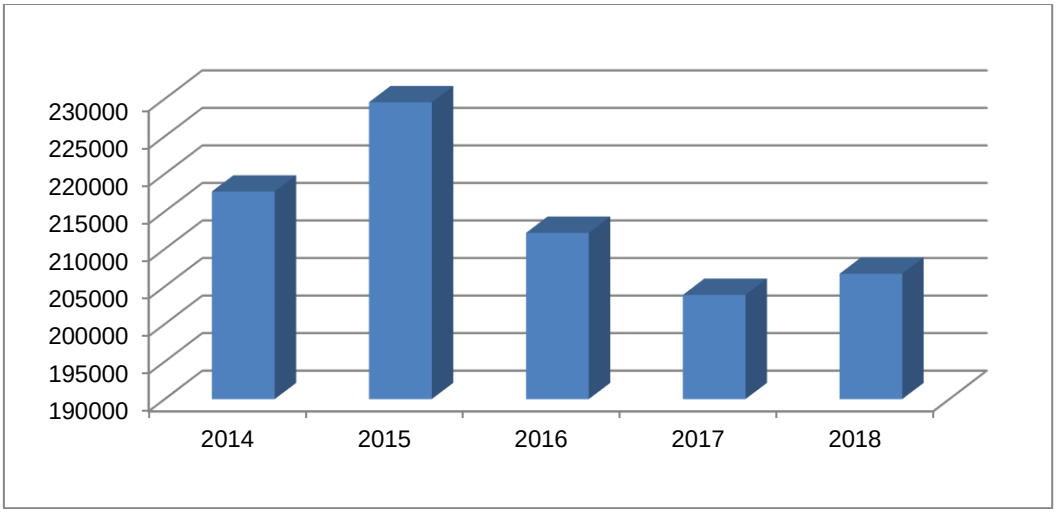

Figure 2: Annual fuel gas consumption from 2014 to 2018 consumption ($Sm^{3:}$ Siemens cubic meter)

An important amount of the consumption of fuel gas for the years 2014 and 2015, this can be due to:
- Low priority on energy management and energy elements are not integrated into operation activities such as production, maintenance and others.
- A number of breakdowns that affected several pieces of equipment (pumps, automatic valves.).
- A number of untimely train stops.
- Lack of an energy management system.

The decrease in energy consumption from 2016 is due to the start of the planning for an energy management system (ISO 50001), which was prepared in 2016 and installed in 2017.

Energy optimization after the implementation of energy management systems

For this evaluation we will use the Energy-Check tool which is based on an on-site survey and an interview with the head of the energy management team, where he answered the various questions of the ENERGIE-CHECK. The answers for the different axes are as follows:

- **Energy policy**: all questions about energy policy have answers, i.e., that the company has an energy policy validated by management with quantified energy performance objectives putting the necessary resources to

achieve them and promoting the collaboration of all the actors involved by making available to them all resources, equipment and services to achieve the objectives set.

- **Energy Organization**: 4 out of 5 questions concerning the energy organization have quiet answers, i.e., the company is appointed a well-defined steering committee with a distribution of responsibilities and roles and provides all necessary resources to achieve the set objectives. However, the result is partially for "reports to the management about the energy performance of the company?" because the communication with the management is done from time to time.
- **Compliance with regulations**: all questions concerning compliance with regulations and standards have been answered, i.e., the company ensures compliance with the requirements of the ISO 50001 standard.
- **Knowing and analyzing its energy consumption**: all the questions concerning the analysis of energy consumption in the Z-CINA unit have been fully answered, i.e., the company has determined the sources of energy that can be used and has identified the "significant energy uses" (installations, equipment, processes, systems that consume the most energy) and also installed equipment to count the energy consumed monthly and annually.
- **Defining an action plan**: Questions regarding the definition of an action plan are fully answered, i.e., that the company has set objectives and targets (deadlines, assignment of responsibilities, means at their disposal, method of verifying results) for continuous improvement.
- **Competency and awareness**: the two questions related to competence are fully answered, i.e., the company has organized designated training courses for the whole energy team to improve their energy skills and knowledge, but for the question of awareness of the employees and subcontractors, the answer is "partially" because there are employees and subcontractors with temporary roles and limited responsibilities, the company does not need to introduce them in awareness programs
- **Communication**: for this axis we have an answer of completely for the information of the collaborators on the progress and initiatives related to the energy performance of the company i.e. the company will share with the employees all the information related to the energy performance of the unit to make them more enthusiastic but author have an answer of not applicable for this question "Is the energy performance the object of an external communication?" because this system has been applied for only two units therefore the external communication is not compulsory.
- **Operational procedure**: the questions concerning the operational procedure have been answered completely, i.e., all work instructions in the unit (building management, operation of processes/equipment), including the reduction of energy waste and all departments.
- **Purchasing design and investment**: we have 4 questions:
  - The first question is: "Do the purchasing procedures of my company include energy performance criteria?" and the answer is no because these procedures are decided by another department (purchasing department).
  - The second question is: "Is the evaluation of energy performance integrated into the design phase?" the answer to this question is yes, i.e., in each new internal project the company takes into account energy planning.
  - The third question: "Are the investment requests evaluated with respect to energy performance (over the life cycle)?" and the answer is no. If the company takes into account this principle, it can lose many investments and lose many customers because this system is not applied in most companies.
  - The fourth question: "Do the investment requests take into account the support devices for energy efficiency' and the answer is no because these procedures are decided by another direction (purchasing direction).
- **Measurement, monitoring, and analysis of consumption**: the questions concerning the measurement and analysis of consumption have been fully answered, i.e., the company sets up meters adapted to the size and complexity of the unit's equipment in order to monitor energy consumption and also to define the "significant energy uses" of the unit and also to propose corrective actions.
- **Verify the achievement of objectives**: the questions concerning the verification of the achievement of the objectives have been answered in full, i.e., the company periodically verifies the achievement of the set objectives and implements corrective actions.
- **Continuous improvement**: for this axis, we have two questions. The first one is: "Does the energy team periodically check the good functioning of the energy management approach in place in the company? The first question is: "Does the energy team periodically verify the proper functioning of the energy management system in place in the company?" the answer is yes, i.e., there are periodic inspections carried out by the energy team to verify and control the operating status of the system. The second question is: "Are improvements made to the energy management approach?" and his answer is not at all, i.e., the company does not have suggestions for improvement for all the axes because there are axes that are well adjusted like the energy policy, performance indicators, and action plan objectives.

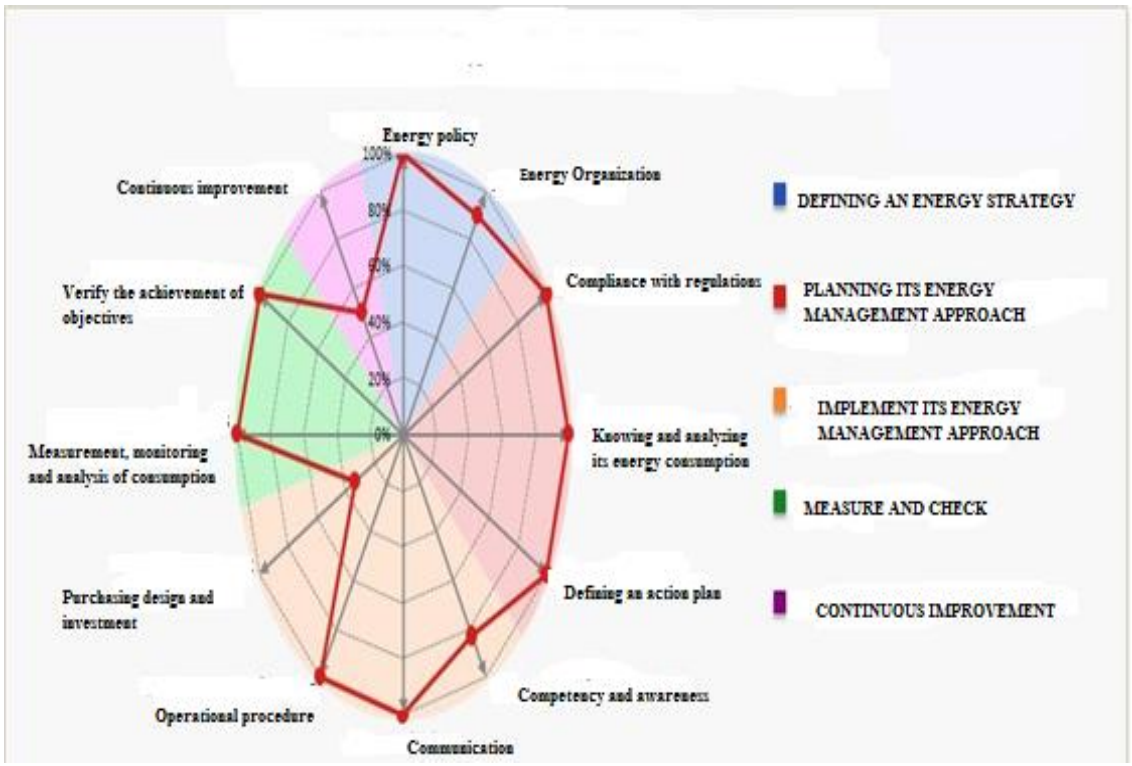

Figure 3: *Assessment of the implementation of the energy management system (According to the 12 axes)*

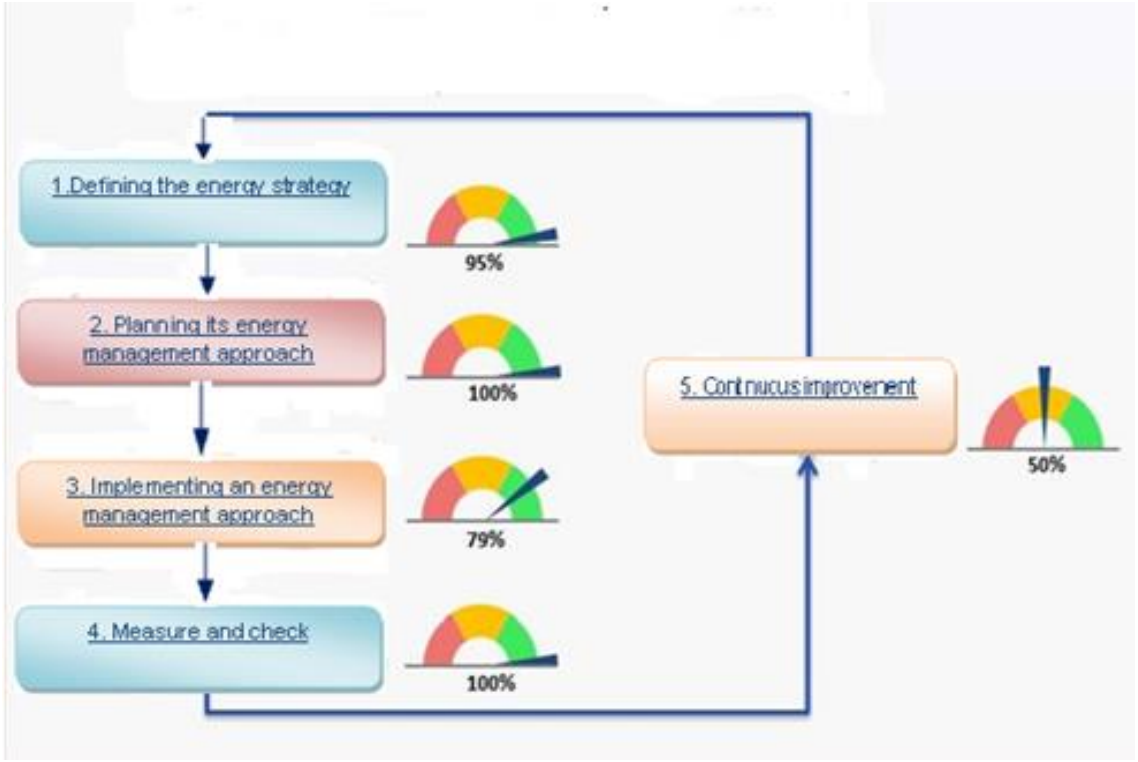

Figure 4: *Assessment according to the 5 steps of an energy management approach*

Figures 3 and 4 show the assessment of the implementation of the energy management system at the company according to the PDCA approach. It can be observed that the assessment of the implementation of the energy anagement system at the company according to the PDCA approach is satisfactory. For the 2 items (Planning its energy management approach, measure and check) are 100%. Almost 10 axes respond favourably to 90% of the requirements that are achieved to know operational procedures, communication, define an action

plan, know and analyze its energy consumption, measures, monitoring and analysis of consumption. However, we also note that the results are unsatisfactory for the two axes "purchasing, design and investment" and "continuous improvement" (35% and 50%, respectively). The dissatisfaction with the two axes, "purchasing, design and investment" and "continuous improvement," can be attributed to the following causes:

- The amount of cost required to implement this system.
- The finance department also wants to meet the requirements of other sectors
- The project budget is limited
- The installation of the system is ongoing,
- The time to obtain the certificate is too long (4 years of preparation for the ISO 50001 certificate).

The objective outlined concerning energy optimization can be achieved by adopting the following practices, which can affect the two axes of the CHECK-ENERGIE tool, namely "purchasing, design and investment" and "continuous improvement":

- Compensation of the flares by retention tanks outside the unit to avoid the waste of fuel gas in case of untimely stops.
- Exploitation of the hot gas emissions from the turbine exhaust in the gas heating system instead of the furnaces, thus saving gas.
- Calibration of measuring devices to avoid false detections that lead to untimely shutdowns.
- Monitoring and evaluation of preventive maintenance actions during shutdowns.
- The use of two gas pumps in redundancy instead of one to ensure the normal operation of trains in case of breakdowns in these pumps.
- Adjustment of the operating parameters of six furnaces to reduce the consumption of low-pressure gas oil.
- Carry out corrective and preventive actions following the results of internal checks and controls.
- Planning preventive actions to avoid train stoppages.
- Allocate a larger budget for continuous improvement.

Conclusions

The implementation of the energy management system has revealed that a large part of the energy consumed is unnecessary, which leads to a significant economic loss for the company, and this loss is reflected in particular in the great quantity of gas directed towards the flares and also in the cases of untimely stops of trains.

After implementing the energy management system, it was noticed that there has been a remarkable optimization in energy consumption since the first year, despite some problems encountered in the unit, for example. These untimely shutdowns are the biggest phenomenon of energy waste in oil companies. Finally, and after this analysis, it is concluded that the management system has a great virtue in reducing energy waste and helping to optimize the consumption of these energies and can largely help SONATRACH to make a great image in the world market to allow it to become also more and more competitive, and of course to improve their reputation.

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