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The Reduction Management Pattern of Greenhouse Gases in Shahid Tondgooyan Raw Petroleum Refinery Company

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ABSTRACT

Nowadays, the damages caused by climate changes via spreading greenhouse gases especially CO_2 due to the industrial development of the countries are obviously observable. Using the low-carbon economy approach on the path to the development is a necessity for corporations and industrial businesses. By low-carbon economy, we mean an economical business in which the least amount of CO_2 is produced. Therefore, itis important to pay more attentions to concepts such as stability and low-carbon economy or even making patterns regarding this subject. The question here, is how to apply the management method and choose the optimal method, along with knowing the effective factors of reducing greenhouse gases. In this study, we have studied the spreading of the greenhouse gases in petroleum industries which are one of the most important industries consuming fossil fuels. The main goal of this study is analyzing the management factors effective in reduction of the greenhouse gases bases on the low-carbon economy in Shahid Tondgooyan raw petroleum refinery company. To achieve this, the effective factors of reducing the greenhouse gases were identified, evaluated and prioritized and in the end, a management pattern was presented based on the low-carbon economy.

Keywords Reduction management, Greenhouse gases, Shahid Tondgooyan, Raw petroleum refinery company.

INTRODUCTION

In the last century, the health of human beings has been affected by the industrial developments. Among some problems which jeopardize human health, we must point to environmental pollution (Javaherian 2018). Cities are growing at an alarming rate, which leads to some environmental and social issues (Barati Goudarzi and Gharai 2016). One of the biggest environmental challenges is the economic damages caused by climate changes. Such as, spread of greenhouse gases, icebergs melting, losing agriculture products, unbalanced distribution of rain, increase in floods and famines (Akdogan et al. 2019, Asemani et al. 2019). Nowadays, the damages caused by climate changes via spread of the greenhouse gases is mostly related to the CO_2 produced during industrial development.

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One way to prevent these damages, is controlling the earth temperature. In other words reduce the greenhouse gases effect, so rainforests can be preserved. Habitat destruction and global warming are some of the effects caused by deforestation. Destruction of forests can also result in soil erosion (Abdi et al. 2017). Without trees, the soil is washed away, which can lead to vegetation growth problems (Hayati et al. 2018 a,b). To achieve this goal, the amount of greenhouse gases in the atmosphere must be controlled and reduced below 550 ppm. To reduce the amount of CO_2, nowadays low-carbon fuels are used instead of high-carbon fuels which seems logical because of the available natural gas resources.A considerable reduction is possible by using new technology and natural gas simultaneously. Consequently it serves negatively as it causes many new technologies like air conditioning which make this issue worse as Pazhohesh and Zhang (2015 and 2019 a, b), Karbassi, Ministry Publication (1394) have conducted many research on air conditioning in houses and the effect of this. But this is only applicable in places with low-carbon fuel resources like natural gas. A great reduction is not that far from the reality by using non-carbon energy resources or using renewable fuels instead of fossil fuels (Badri-Koohi et al. 2019, Badri-Koohi and Tavakkoli -Moghaddam 2012). Depending on the geographical region, there various resources of renewable energies, which include wind, sun, biomass, hydrogen, geothermal and tide energies.

The low carbon economy is one of the new methods designed for this purpose. Therefore, itis needed for the corporations and industrial businesses to stride their development path with low-crbon economy approach. By low-carbon economy, we mean an economical business in which the least amount of CO_2 is produced. In low-carbon economy, we should use solutions which produce the product with most efficiency and least spread of greenhouse gases. The experts of stable business management believe that other usual methods are not the answer, because passive perspective based on watching the legal limitations will cost a lot for a business (Errico et al. 2009, Zareanshahraki et al. 2020, Hadidi et al. 2016, ECF 2010). On the other hand, most companies act based on unstable business patterns (Oil refinery 2011, Concawe 2015, Aermod), therefore, itis important to add stability and low-carbon economy concepts to the business patterns or make new ones. Moving towards stable business and low-carbon economy requires some activities which prevent the spread of CO_2 by using the fossil fuels appropriately.

Theory basics

Global warming is depending on the activities of residential and industrial centers, petroleum and gas refineries and heat powerhouses and the related affairs such as countries transportation systems (directly and indirectly) (Amir-Arian 1395, Seyyed Ali 1393). Although some of the CO_2 production from human activities are inevitable,but some negative effects could be avoided and there is the possibility to reduce them to the least amount. To reach this goal, management patterns are used to reduce greenhouse gases. Carbon management means measuring and managing the six greenhouse gases including CO_2 which are covered by the Quto protocol. Regarding this, industrial companies and science centers are trying to present management patterns to control, report and reduce greenhouse gases some of them are presented below: Cambridge University management pattern, Carbon footprint in Mumbai petroleum industry refineries, Nottingham University by presenting a management pattern to manage and reduce GHG from 2010 to 2020, Iran green management association has presented an environment compatible pattern and followed the footprints of carbon, which is the revision of the Mohammad-Hasan and Majid (1393), Ahmadi (1390) patterns and is combined of environment compatible design pattern and the evaluation of LCA cycles : The pattern of carbon management for 2010-2020 in English universities.

Petroleum refineries are complex units which could have very unique and special processes depending on the raw material (raw petroleum) and the products. Environmental performance may vary from one refinery to another. Producing different fuels is the main duty of refineries and will determine its general structure and the type of the operation. Refineries set

Table 1. Method of GHG measurement.

Raw	Assessment method/Measurement	Accuracy/Cost
1	Use of standard emission standard factors	Low accuracy/Low cost
2	Use of model	
3	Use of intermittent method	
4	Direct measurements	
5	Continuous direct measurement	High accuracy/High cost

some methods for themselves based on their rules to report the amount of GHG. The atmosphere spread group suggest a method for measuring GHG which should be done with enough precision. Another limitation is the economical aspect. For some units, high precision like Tier 5 is not economical and must use other methods (Table 1) below.

In order to decide whether to apply the above methods or not is depend on the below factors: The amount of emission from the source and its negative consequences on the environment, Increase of accuracy and availability of data.

MATERIALS AND METHODS

This study is of illative descriptive type and is based on the results of data analyses which have been carried out in Tehran Shahid Tondgooyan oil industry refinery and to achieve the research goals, logic and inductive methods are used. This refinery is located in Shahr Rey, Bagher Abad and 25 kms from Tehran.

To answer the research questions, the below tools and materials were used: Information and direct or indirect statistic related to the research subject from scientific books and articles. Using the components and sub-components checklist identified in study researches in different areas of GHG reduction in oil refinery industries (Seyyed-Hassan 1391). Remote questionnaire by Delphi method to ask the opinions of the experts to evaluate the components and sub-components based on the numbered checklist as the research statements. The goal of this method is for the experts of a certain area to come to an agreement about a subject. In person interviews were done with environment protection organization experts, HSE main office of the petroleum organizations (HSE Panel 2006), HSE management of the refinery and distribution of petroleum products, HSE office of Shahid Tondgooyan Tehran and operative units,technical services, tanks, refinery engineering, general engineering, maintenance and other related experts and the results were recorded using notes in the first place and then distributing research questionnaires in the second place and the limitations of GHG reduction were studied. Equipment and standards, including Multiple criteria decision making (MCDM) and Multiple attribute decision making (MADM). The multiple attribute models are used to choose the best option and since we want to determine the best way of GHG reduction based on economy, we use MADM model. Using Excel, SPSS, ASP softwares to analyze the data (Mansour and Alireza-Sharifi 1390). Using the presented management pattern in this study along with its evaluation method, to assess the GHG reduction level in the refiner.

To determine the narrative validity of the statements in this study we have used Cronbach's alpha method and to check the context validity we have used experts' opinions which are theoretical method and based on the experiences of the experts. To achieve this, after calculating the capacity of the data, the statement's narrative validity was studied based on a survey about components and sub-components in the form of a questionnaire via cumulative analysis of the experts.

In the analysis phase, the data and the identified factors were analyzed qualitatively and quantitatively. To determine the importance and preference level of the criteria and identified options, the decision making support system (MCDSS) was used to determine the importance and effect level of teach known criteria and then, in the terms of global warming concepts and principals and then the MCDM and AHP methods were used to describe the effect of options in reducing

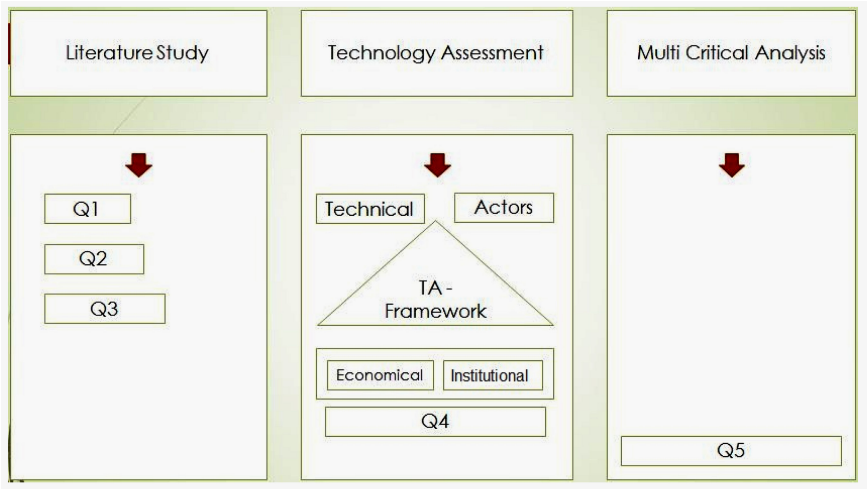

Fig. 1. Study design, based on research resources.

greenhouse gases and technology assessment (TA), is a scientific, general and analyzer tool which seeks people and authorities suggestions and collaborations for social, scientific and technological consequences. Van-Est and Boom (2012), Grunwaid (2009) the questions and the goals of the study are analyzed.

Multiple methods were used to achieve study's main goal, "identifying spread resources of the GHG and choosing and prioritizing the best method with most GHG reduction level". To reach the study's goal, questions number 1 to 3 were answered by studying the library and documents of oil refinery industries and the 4th question was answered by technology assessment tool and the 5th question was answered using multi criteria analysis.

TA is used to identify the criteria and sub-criteria for choosing the best GHG reduction level in oil refinery industries (EPA 2010, Refinery industry 2017). The process of using TA in the study: The use method of TA is shown in Fig. 1. Regarding the description of TA tool, the main criteria is chosen and used regarding the DM apects and multi-criteria analysis method.

After choosing effective options and prioritizing them by presenting the Figs. 2 and 3, the management chosed the options again by giving a score to each criteria and sub-criteria considering the equipment.

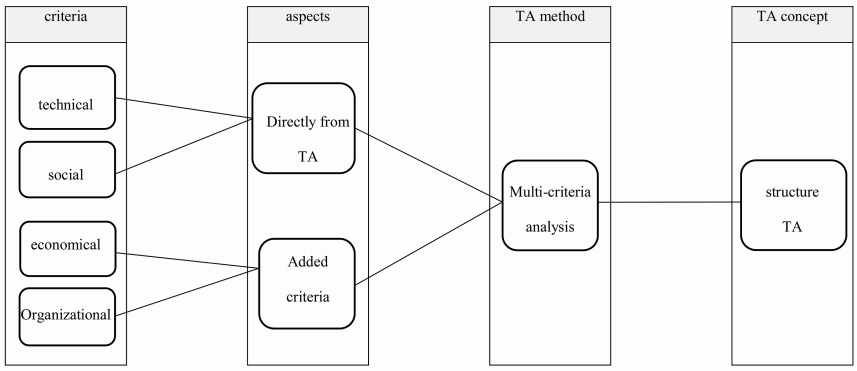

Fig. 2. The process of using TA in the study.

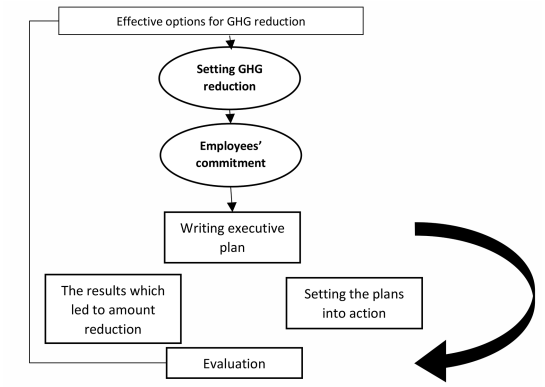

Fig. 3. Management pattern of GHG reduction based on low-carbon and stable economy in oil refinery industry.

RESULTS AND DISCUSSION

Considering the extraction of the results from previous researches inside and outside of the country, the effective factors were chosen as below and were confirmed by related experts. (EC 2013, ECN 2015).

The main options evaluation criteria including 4 criteria : Economical, social, technical engineering, organizational.

The sub-criteria set includes : Reduction capacity, implementation equipment, technology's availability, project cost, economical cutback, demand flexibility, systems gathering, effects on the region's environment, effects on the environment, general acceptance, based on the current regulations, necessity of change in the organization, based on the policy.

Options (reduction technologies) including 8 options: Optimizing the steam operation and grill efficiency, managing the gases entering the Feller, using replacement fuels with low-carbon, increasing the effect of the converter network, isolating tanks, pipes and equipment trading heat, reserving CO_2, CCU and CCS, optimizing the efficiency of distillation tower, changing the initial ingredients (raw petroleum) into lighter substances.

Based on the results of the narrative and stability and some questionnaires to gather the needed data, the Cronbach's alpha value was equal to 91 which is more than the minimum 70% acceptable value. Therefore, the stability of the research statements was confirmed too. Also, the minimum amount of acceptable needed questionnaire was calculated using Morgan table which is based on the Cochran formula. The results showed that, the least number of needed questionnaires for the data to be sufficient is 19. Therefore, 25 questionnaires were distributed amongst the experts which 20 of them were completed and gathered. Also, we used the TA method to determine 4 main criteria and 13 sub-criteria for evaluating the options which is shown in Table 2.

Table 2. The list of criteria and sub-criteria of option evaluation.

Criteria 1: Technical (T)	
Code	Technical and engineering sub-criteria
SCT_1	GHG the reduction capacity
SCT_2	Implementation equipment
SCT_3	Technology's availability
Criteria 2 : Economical (E)	
Code	Economical sub-criteria
SCE_1	The project cost
SCE_2	Economical cutback
SCE_3	Demand flexibility
SCE_4	System gathering
Criteria 3 : Social (S)	
Code	Social sub-criteria
SCS_1	Effects on the region's environment
SCS_2	Effects on the environment
SCS_3	General acceptance
Criteria 4 : Organizational (I)	
Code	Organizational sub-criteria
SCI_1	Based on the current regulations
SCI_2	The necessity of change in the organization
SCI_3	Based on the policy organizational

After getting the weight of criteria and sub-criteria, based on the separate judgement of 4 groups, based on the attached tables, we create the comparative matrix of option based on each criteria and sub-criteria and get the weight of each option based on its criteria and sub-criteria. In the end, to choose the technology with most reduction level, we multiply the weight of options by criteria, based on this formula:

$$\sum_{i=1}^{n} A_i * C_i = \text{Final weight}$$

Table 3. Pair comparison matrix between main criteria based on environment experts.

	CT	CE	CS	CI
CT		3.0	2.0	2.0
CE			3.0	6.0
CS				3.0
CI	Incon: 0.02			

Table 4. Pair comparison matrix between the main criteria based on the HSE experts of oil ministry.

	CT	CE	CS	CI
CT		5.0	3.0	2.0
CE			2.0	7.0
CS				5.0
CI	Incon: 0.01			

Table 5. Pair comparison matrix between the main criteria based on the HSE distribution and refinement management.

	CT	CE	CS	CI
CT		5.0	5.0	3.0
CE			2.0	2.0
CS				2.0
CI	Incon: 0.02			

Table 6. Pair comparison matrix between main criteria based on Tehran refinery HSE.

	CT	CE	CS	CI
CT		5.0	3.0	3.0
CE			2.0	9.0
CS				5.0
CI	Incon: 0.02			

The pair result of criteria and sub-criteria regarding choosing the most effective options for GHG reduction

To get the weight and the effect of the main criteria (economic, social, technical), first we compared these 4 criteria as pairs. First we make the decision making matrix for the main criteria and then based on the judgement of four expert groups (environment organization, oil ministry, refinement and distribution of petroleum products management and Tehran refinery office) the weights of the main criteria was determined as Tables 3–6 regarding the main goal "choosing the best method of GHG reduction".

Also, the decision making matrix is created to prioritize and setting the weight of criteria and sub-criteria compared to the main criteria and then prioritize them based on the opinions of four DM and the weight of every criteria is calculated.

CONCLUSION

Generally, refineries could be improved in two major parts, maximizing the energy and carbon efficiency compared to the chosen and executed new technologies. While evaluating a vast range of chosen options, after doing research and study, 8 options which were the most effective in GHG reduction were chosen and prioritized using the TA technology and AHP based on the opinions of four expert groups (environment organization, oil ministry, refinement and distribution of petroleum products management and Tehran refinery office) as shown in Table 7. Based on this table, the options and their weights are as below: Based on the scores from Tables 3—7 by experts, the best

Table 7. The rankings of GHG reduction options based on the opinions of 4 organizations experts.

Rank	Score	Code	Options
1	28687	A_6	Reserving CO_2
2	25689	A_7	Optimizing the efficiency of distillation tower
3	19924	A_3	Using fossil fuels with low-carbon
4	16511	A_4	Increasing the effect of converter network
5	14509	A_2	Managing the entered gases to feller
6	14095	A_5	Isolating tanks, pipes and the equipment exchanging heat
7	9486	A_1	Optimizing steam operation and grill efficiency
8	8648	A_8	Changing the initial ingredients (raw petroleum) towards lighter things

options for reducing GHG gases in Tehran refinery.

Regarding the table, 3 most effective options which will lead to the most GHG reduction level were chosen as below: Option 6 (A6) score : 28678, Option 7 (A7) score : 25689, Option 3 (A3) score : 19924.

Using the gathered results, we can conclude that first of all, the effect level of each criteria despite the dependency of different criteria is not the same. Second, we can't define an inner or outer relationship between sub-criteria and their dependency to different criteria. In other words, the effect level of criteria and their sub-criteria has independent inner and outer relationship and therefore, a structural releationship between them can't be determined.

The current study aims for GHG reduction in refinery industries and the correct execution of national and international regulations regarding the global warming. Considering the done evaluations of the studied industry, the below suggestions are made for people who are interested in this area : Codifying and maintaining the needed standards while buying machineries, equipment and tools and upgrading the technology level such that they have the least carbon spread. Requiring to maintain environmental standards such as IS014000. Setting the regulations and criteria to reduce the energy consumption. The effects of GHG reduction methods are confirmed by the experts. Therefore, it's recommended to execute these options for future researches. To complete the study, using other methods such as TOPSIS, Ideal planning linear and fuzzy logical planning is recommended as replacements for weighting and prioritizing criteria, sub-criteria and reduction options.

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