# The ways of energy cost reduction in steel industry

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## Abstract

*These days, limited energy resources, and also the cost of investment in new and renewable energy is very costly and uneconomical. In the industrial sector, especially energy-intensive industries such as steel, finding appropriate solutions to update the technology, production and reduce energy consumption in this sector is very important. The main aim of this study is the identification and ranking the methods to reduce the cost of energy consumption in the steel industry with the MCDM approach, that Mobarakeh Steel Company is the largest firm economic basis in our country. The population of this research, experts in Mobarakeh Steel Industries of Esfahan city, which are composed of 10 experts. In this study, three questionnaires for screening of selected indicators, prioritize important measure known and set relationship among parameters using fuzzy Dematel approach and determine the extent of the relationships between variables using network analysis process (ANP), is used. The outputs of this research show that the steelmaking and casting, steelmaking, blast furnace, accumulation and withdrawal, carriage, coking, iron making, rolling, agglomeration and converter have the most energyconsumption*

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## Introduction

The trends of economic revolution in recent centuries has been associated with the use of energy but the energy crisis in recent decades that was associated with a economics recession in many countries led that energy find a special place in economy literature. Limited energy resources in the world, as well as high investment costs in new energies and renewable energy that production energy be very costly and also, the negative view of human societies in the industrialized countries that composed of most of world energy consumption, sometimes to prevent the closure of nuclear power plants or build new plants has led to these countries invested heavily to reduce the energy consumption per unit of production. Since the steel industry, especially steel is produced of the arc (80% of the steel produced by this method is produced Mobarakeh Steel Company, Khuzestan and Khorasan Steel is made of steel.) Has very high energy consumption, as well as the use of natural gas as a raw material for the recovery of iron ore used in this way is very much.

In-depth study on how energy consumption, ways to reduce it and reach the desired point, which is to compete in the global market, is of particular importance. Now, in Iran, various ways are used to reduce energy consumption in the household sector, because, unlike the industrialized countries that have a large proportion of energy consumption in the manufacturing sector (about 60%), in Iran, Most of the energy consumption in either natural gas or electricity in the household sector, which forced the two walls of windows in new buildings, is a clear example of it. In the industrial sector, especially energy-intensive industries such as steel industry to find solutions appropriate to update the technology, production and energy efficiency in this segment of the industry is very important.

Since energy management systems insist on optimizing consumption and energy returns in the process steel, steel industry controls amount energy consumption in different parts of continuous production. Given that the share of energy costs in Mobarakeh Steel Company reach to 18 per cent after targeted subsidies, It is necessary to policymakers and managers with respect to the advantages available in the production of oil, gas and coal reserves, particularly iron ore and according to the existing technology in steel industry and selection new technology and replace old equipment, while modifying the consumption patterns, increase energy efficiency and with the production of cheap steel, the progress and prosperity of the country to expedite .

In this study, we sought to find the answer to the question of research. What are the ways to reduce the cost of consumption energy in the steel industry, and what is their priority?

## Literature review

Nowadays, economic growth is significantly related to energy consumption, so that energy is as one of the main factors of the dynamics of this growth. Any productive activity, including industry, agriculture and services requires the use of one or more energy carrier and the more these activities, it is natural that the energy consumption increases. With rising energy prices and environmental problems, problem of productivity intensification and prevent environmental pollution problems, gave a new dimension to the above criteria; this means that if

energy consumption in various countries is considered as a measure of progress, has two features:

First, energy consumption in various sectors such as industrial, agricultural, service and welfare has the reasonable the composition and second, the maximum efficiency of the energy consumed is generated.

In our country, studies show that the lack of proper management of energy and also appropriate industrial and technological structures, Depending on of production processes, the energy consumption intensity several times the world's energy intensity in other developed countries. Given the extraordinary importance of energy and the role of management in the efficient use of energy resources and to minimize energy losses, there is a the overall approach to the organization and to reduce energy consumption in the steel industry are:

A. Industrial energy management objectives include:
1. Reduce the cost of energy production by controlling energy consumption and purchase of energy at competitive prices.
2. Reducing energy intensity and improve the productivity and energy efficiency
3. Improve economic efficiency unit
4. Prevent environmental degradation

Studies show that there is the significant potential for energy savings in industrial sector.

B. Energy management programs, including:
1. analysis and energy audit and energy audit
2. control the balance of energy efficiency and energy efficiency in buildings, in each unit and every one of the equipment

3. engineering analysis and feasibility studies for investment projects based on financial goals
4. training and awareness of employees

To implement energy management programs, check the function of the unit and its structure is essential. If energy management program not has been implemented, it is necessary to implement all the above steps. Otherwise, each step of the program can be done separately.

C. Matrix of Energy Management

Planning is the key element in energy management. The planning is more important stage of decision that the idea of energy saving due to the limitations of the organization turn to executive projects and makes all efforts to save energy according to the other organizational activities are seen as a set of integrated and linked together. One way to determine the current status of each organization in terms of energy, determining the status of an organization in matrix of energy management (the efficiency and energy organization, 2011).

D. Making Policy on Energy Management

Many organizations and units that consume energy, even those that are good in terms of technological productivity, May be are unaware the official policymaking of energy. Although, these types of organizations and industries might be have less public perception to energy consumption, But the effort to do these things formally denied and reporting the performance of these responsibilities not registered in a place. In fact, the official policymaking of an organization, on the one hand, create collective sense of corporate responsibility to energy savings,

and the other, it guides energy management activities in the pre-planned routes and monitor these activities. (The efficiency and energy organization, 2011)

H. Organizing energy management unit

Energy management is an activity that covers all parts of an organization or an industrial unit.

In fact, the energy management programs should be pursued in accordance with the following units:

➢ Technical unit
➢ Human resources department / office
➢ Financial unit
➢ Executive management Unit / Manager
➢ External consultants

Obviously, for the success of energy management programs, especially when these programs have a lot of size and scope should have access to appropriate official organizations or industrial organization by organizing and coordinating between different parts and top management (energy and efficiency organization, 2011).

Due to the abundant usage of energy in different parts of the country, several studies in the field of energy consumption have been conducted. Extensive studies have been conducted with implementing of the targeted subsidies policy in this area.

Nakhaee, Naderi and iran nezad (2012) studied the amount of energy by analysis energy production and consumption in the mining industry, iron and steel on a global scale. Mohseni, Kamarposhty and Ali Nejad (2009), stated one of the most important programs to reduce energy consumption with the aim of changing the attitudes and behavior of energy consumers are made aware of it.

Mirjalili, Hesami far, Sharif Yazdi (2011), in this paper, after describing the history of production and trend of energy saving in steel industry in the world, Using the global statistics of steelmaking processes are compared in terms of energy consumption and is shown If there is the possibility of supplying scrap, EAF process in terms of energy consumption, especially in comparison with the BOF process is economical.

Research was conducted in (2014) by Jigar VA.Shah. In this study, eight samples of influencing energy consumption considered are: Policies and programs, energy management systems, transparency and disclosure, placing a price on carbon, supply chain, finance, and innovation, set criteria.

Erika A.Bergstrom (2010) stated that increase in energy prices, depletion of natural resources, widespread environmental degradation, increasing demand for the production of steel are described problems in the steel industry. This study includes an assessment of the impact of energy costs on improving the process of research and the production and finding energy resources.

Patrick, Magnus, Mats, Dan (2005) state that energy costs in industrial plants can be reduced in three ways. Actions to reduce energy consumption, load management and change of energy carrier are the three methods for this study.

In the energy industry, you can take an important step toward efficiency and effective use of natural resources with creates a single energy management unit. This is certainly due to the strategic position in terms of dependence on other countries will help internal energy supply. According to that review, it is possible that

due to electrical energy and natural resources consumption in Mobarakeh Steel industry than the global norm, this factory has a high potential for energy savings that can prevent energy waste by managing energy consumption to a large extent.

## Research methodology

Since researchers sought to use the results of study in the short term and in the action field (the company), this study in terms of objection is applied (sarookhani, 2008) and in term of path is correlation survey that try to investigate the relationship between independent variables and the dependent variable through a process comprising the steps of deciding about the issue or question or hypothesis, choice of study population and sample, collection methods and analyze data.
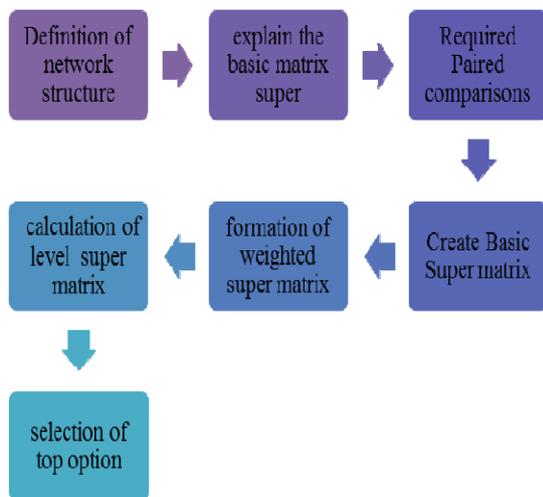


**Figure 1. Research methodology**

For this study, first, according to the study of literature, research history, methods extraction, and indicators to reduce energy consumption and screening on these indicators with use of expert idea, important criteria for prioritizing ways to reduce energy consumption in the steel industry have been identified and then

using a pair questionnaire and use of fuzzy Dematel approach to identify relationships between measures and then using a analytical network process (ANP), the priorities of each ways to reduce consumption are examined. Research methodology is shown in Figure 1.

Validity or reliability is one of the technical characteristics of measuring instruments (sarmad et al, 2007) and and refers to the extent that the results obtained of the measurement tool are same in different times and the same conditions (Mir, 2010). In fact, the reliability shows that how measurement tools give us same results in same conditions (sarmad et al, 2006). Therefore, reliability deals with stable, accuracy and the ability to predict the results of measurements tool (venous et al, 2004). There are several ways to measure the reliability that one of them is the Cronbach's alpha (Allen & Yen, 1979). In this study, as in many other studies to assess the reliability of measuring instruments was used Cronbach's alpha. In The first questionnaire due using Likert scale, we use Cronbach's alpha for reliability. Then, according to the criteria obtained for the first research model according to the results of first questionnaire has been approved by experts, the validity of the relevant pair questionnaire is valid and to check the reliability of the pair questionnaire should be obtained and review incompatibility rate by using the Expert Choice software.The present study investigates and prioritizes ways to reduce the cost of energy consumption in steel industries of Isfahan Mobarakeh Steel Company with MCDM approach. In other words, our society is managers and experts in Mobarakeh Steel industries. According to the experts of this

study are directors of Mobarakeh Steel Industries, which has at least a bachelor's degree and has been working for over five years, the number of 10 experts was selected for this job.

## Data analysis

In Table 1, the sample distribution by age, gender, employment status, education, and experience has shown:

**Table 1. The sample distribution**

| percent | frequency | age |
|---------|-----------|-----|
| 12.43 | 1 | X<30 |
| 27.61 | 3 | 30<x<40 |
| 59.96 | 6 | x>40 |
| | | Sex |
| 72.3 | 7 | Male |
| 27.27 | 3 | female |
| | | Education |
| 10 | 1 | Diploma |
| 10 | 1 | Above diploma |
| 40 | 4 | BA |
| 30 | 3 | MA |
| 10 | 1 | PhD |
| | | Job experience |
| 24.41 | 2 | X<5 |
| 20.34 | 2 | 5<x<9 |
| 36.36 | 4 | 10<x<14 |
| 10.46 | 1 | 15<x<25 |
| 8.43 | 1 | X>25 |
| | | Employment status |
| 73.4 | 7 | Official |
| 26.6 | 3 | Treaty |

In The first part, the experts opinions were examines (first questionnaire) to separate the important from non-important

criteria (screening). Those which the geometric mean have more than 3, chosen as an important criterion. For this purpose, we the use GEOMEAN function in Excel software.

Each of the criteria, according to the expert's opinions for determining the best way to reduce energy consumption in each of the options suggested for coking, agglomeration, rolling, blast furnace, steel converter, accumulation and withdrawal, iron making, steelmaking and casting and carriage. In other words, each option will evaluate the above criteria 8. But because of the nature of the network in the study should identify relationship between the criteria. For this purpose, Dematel the method was used. Due to the long process of calculation, we denied from them and only provide the final model and prioritize the criteria.

In other words, the criteria 1 affect on criteria's of the second and fourth to eighth. The second criteria affect only firs criteria. The criteria 3 affect on criteria's of first, the second and fourth to eighth. The forth criteria affect only firs criteria and the criteria 5 affect on criteria's of first and the second. The criteria 6 affect on criteria's of first and the second and finally criteria 7 affect only firs criteria.

**Table 2.Screening important criteria using the Geomean**

| Row | Evolution criteria | Geometric mean | Result |
|---|---|---|---|
| 1 | economic and technical feasibility | 4.128918 | Confirmed |
| 2 | The amount of time it takes to implement | 4.102356 | Confirmed |
| 3 | Infrastructure preparations by company | 2.258694 | Not confirmed |
| 4 | alignment of project goals with the company macro strategy | 2.491462 | Not confirmed |
| 5 | The use of project the results In similar future projects | 1.966307 | No confirmed |
| 6 | facilitate production processes | 2.594558 | Not confirmed |
| 7 | to attract money from the overhead organization | 1.943283 | Not confirmed |
| 8 | reduction of environmental pollution | 2.143547 | Not confirmed |
| 9 | Amount of price growth in energy factories | 4.011829 | Confirmed |
| 10 | laws and government policies | 1.782602 | Not confirmed |
| 11 | saving in water consumption | 4.128918 | Confirmed |
| 12 | Saving in natural gas consumption | 3.948701 | Confirmed |
| 13 | amount of savings in consumption of petroleum products | 4.011829 | Confirmed |
| 14 | amount of savings in power consumption | 3.622202 | Confirmed |
| 15 | Amount of saving in The solid fuel consumption | 3.441817 | Confirmed |
| 16 | Amount of the use of renewable energy | 1.943283 | Not confirmed |
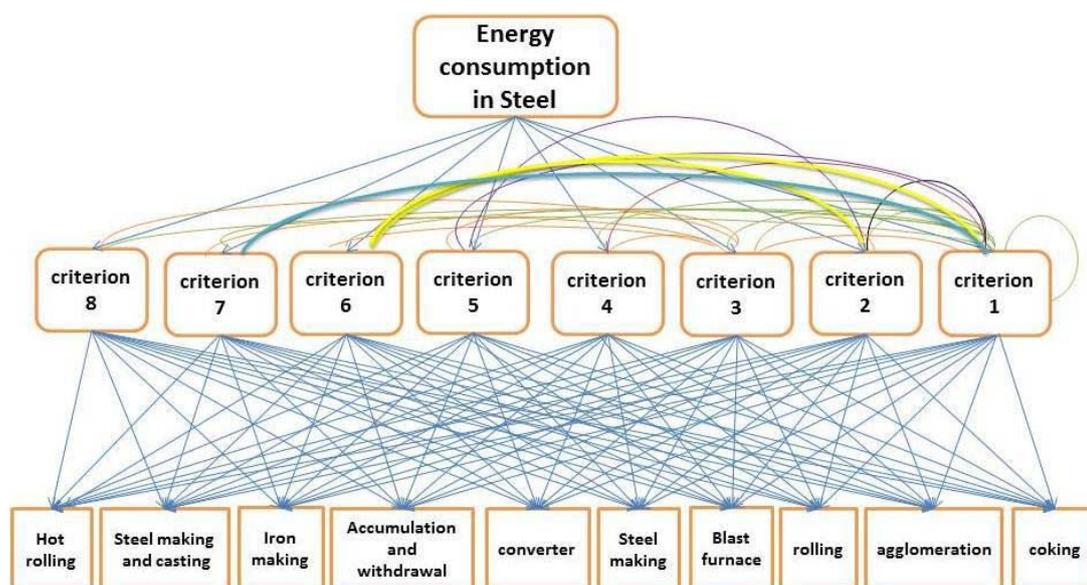


**Figure 2. Final model**

**Discussion and conclusion**

The main purpose of study is to examine ways to reduce the cost of energy consumption in the steel industry and setting priorities to implement Mobarakeh Steel Company. In this regard, various criteria that have been used in other steel industry was obtained by the study of literature .in next phase, by Dematel methods and network analysis process, these criteria compares and priority options were identified.

The purpose of the first sub-study was to determine the criteria used to rank methods of reducing the cost of energy consumption in the steel industry, which 16 criteria was obtained by studying the history of literature, and 8 criteria was chosen by a questionnaire. These criteria include: (1) reduction in natural gas consumption, (2) reductions in water consumption, (3) reduction in the consumption of petroleum products, (4) reduction in fuel consumption of solid, (5) reduction in power consumption, (6). The amount of time it takes to run (7) amount of the price growth of energy factors and (8) technical and economic feasibility of the project.

The purpose of the second sub-study was to determine the relationship between the various criteria by using fuzzy Dematel method, Research results show that economic and technical feasibility criteria and the rate of price growth of energy factors has most relevant with the other criteria.

The third goal is to determine the weight of each criteria that results of criteria comparison is the following:

**Table 3. Weight and rank criteria**

| criteria | weight | rank |
|---|---|---|
| reduction in the consumption of petroleum products | 0.331 | 1 |
| reduction in natural gas consumption | 0.231 | 2 |
| reductions in water consumption | 0.157 | 3 |
| reduction in power consumption | 0.106 | 4 |
| amount of the price growth of energy factors | 0.071 | 5 |
| technical and economic feasibility of the project | 0.048 | 6 |
| The amount of time it takes to run | 0.033 | 7 |
| reduction in solid fuel consumption | 0.024 | 8 |

The forth and main purpose of this study is priority cost reduction methods The result of this comparison is as follows:

**Table 4. Weight and rank options**

| criteria | weight | rank |
|---|---|---|
| steelmaking and casting | 0.138 | 1 |
| steelmaking | 0.103 | 2 |
| blast furnace | 0.079 | 3 |
| accumulation and withdrawal | 0.052 | 4 |
| carriage | 0.035 | 5 |
| coking | 0.026 | 6 |
| iron making | 0.022 | 7 |
| rolling | 0.018 | 8 |
| agglomeration | 0.017 | 9 |
| converter | 0.009 | 10 |

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