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Reducing Greenhouse Gases, Electricity Production and Creating Cooling Power by Sour Gas flares in Oil Region

Sirous Dehdar[1*], Ali Hajati Shimini[2], Sahar Ahmadifar[3], Behroz Farahbakhsh[4]
[1] Regional Electricity Company, Tehran; [2]Science and Research Branch, Islamic Azad University, Isfahan, Iran; [3]Payame-Noor Univeristy, Shahin Shahr, Iran; [4]Khozestan Regional Electricity Company
*Email: sirous110@gmail.com

Abstract

This study has dealt with evaluation of existing power generation and the amount of power for conditioning by gas produced with oil burnt in flares around Ahvaz. There are rapid methods for generating power and coolness. Economic savings resulting from the project and the benefits to the environment of the region receive attention. Ahvaz 1 has four big flares and it produces about 65 megawatts electricity. It is inspired by solar tower power plant. It produces coolness using the heat coming from the optimized combustion of flares by absorption chillers that is at least over 400 tones of cooling that can be given to all the flares in the region. After being implemented, it can be exported as engineering services to oil countries in the region. In the vicinity of this project, glass-roofed parks, exhibition, recreational and cultural centers and tourism centers can be built.

Keywords: Sour gas and cooling, flare, electricity, environment, distributed generation

Introduction

On November 3, 2013, It rained in Fall in Ahvaz. Within ten days, 12000 people went to hospitals and 3000 people were developed dyspnea or shortness of breath. Years after years, sour gases are burned in flares with oil due to lack of need to them or impossibility of being saved without extracting their oil liquids and sweet gas and they create air pollution in industrial cities including Ahvaz. It is for several years that National Oil Company has implemented the project collecting and using these gases but it it is proceeding slowly. It needs much time to be implemented completely because of the sanctions. Ten percent of these gases still remain after implementing the collecting project. According to Moharam Nezhad and Dabagh Zadeh (2005), due to the large volume of these gases, rapid solutions for using the sour gases are opposed and evaluated. Iran is a country that has a large volume of flaring gases. Using the results and suggestions of this research, after being implemented, can be exported to other oil countries as engineering services. The patent of this project has been done and it has been referred to Industrial and Scientific Research Organization as a kind of innovation in technology. The base of the suggestion is inspired by solar tower power plant that is briefly explained. Such projects have simple construction and internal technology is used. Homan Farzad , in his book, proposes solar tower power plants for the plains of Iran (Farzad, 2000). Regarding that they are completely constructed inside the country, tower power plants can be built using gas and solar energy. First, electricity or power production by solar tower power plant is briefly explained then it is explained how to use sour gas and produce coolness.

Finally, economic issues are discussed. Indeed, this paper examines simultaneous generation of power and cooling by using sour gases and it is considered (CCHP) or Combined Cooling Heating Production.

Solar Tower Power Plant

Solar energy passes through glass surfaces and creates greenhouse effect and the warm air is directed toward a very long stack (200 m). Then the air is severely directed toward the outside of the stack due to differences in air density. The produced flow creates a large volume of air. It generates power like wind turbines if turbine and generator are installed on it.

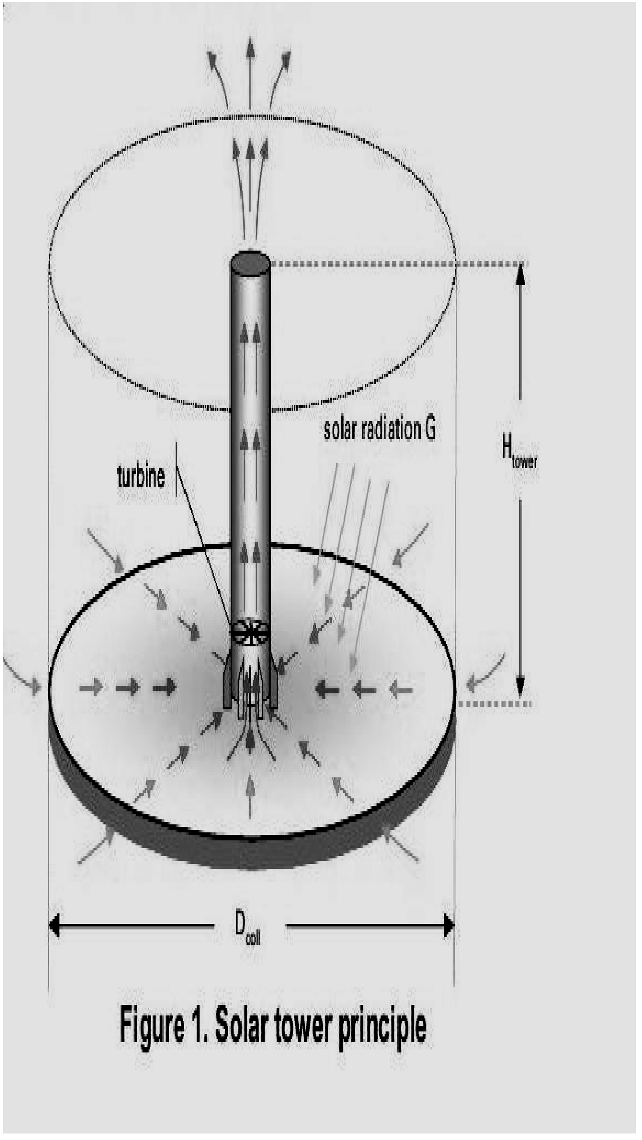

Figure 1. Principles of Solar Tower Power Plant

In figure 2, Manzanares solar tower power plant in Spain is shown. During the hottest hours, wind speed reaches 70 kilometers per hour which is equivalent to 19.4 meters per second. The turbine is in the middle of the stack and it starts to turn over with the generated wind.

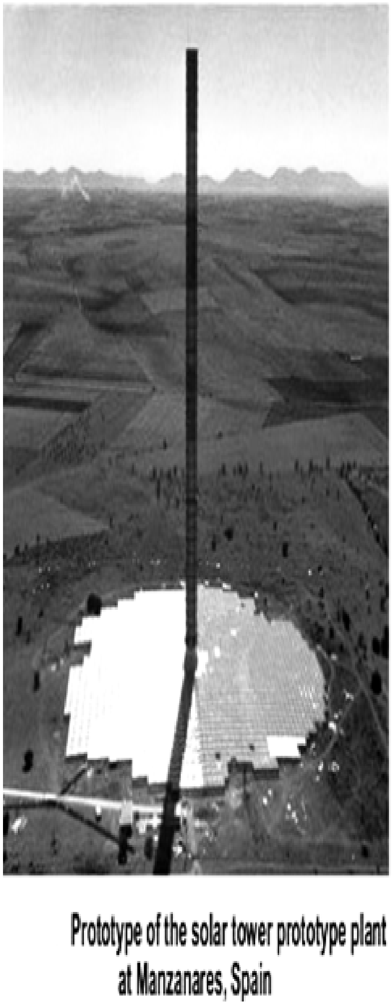

Figure2. Spain Solar Tower Power Plant with 50 Kilowatts power.

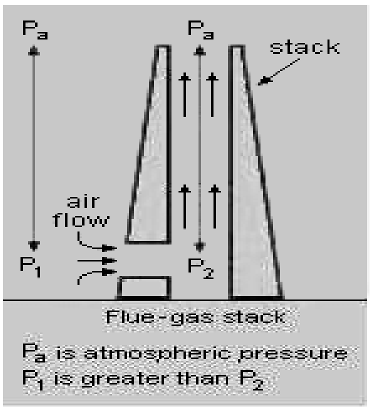

Figure 3. Stacking effect generates power in solar stack and sour gas power tower. Turbine is seen in a place named "air flow" in sour gas project.

The generated pressure difference creates stacking effect. wind generator and turbine are installed at the mouth of the combustion furnace.

The burning of the gases with oil in open air and above a flare that has a height between 5 and 50 meters depending on the type of gas and its compositions, happens when it is subjected to different elements especially wind. The gas with oil often contains hydrogen, light hydrocarbons, carbon dioxide and nitrogen.

On one hand, the burning of the gas with oil makes people concerned and on the other hand it can be one of the priorities of every government and economy center of of oil country. These activities contradict article 50 of the constitution and article 1, 8, 9 and 10 of the environment laws.

In general, flares are designed to burn elusive organic compounds at the high temperature above the flare.

These gases divide into sour and sweet gases based on the percentage of sulfur they contain. In flares, sour gases that are extremely dangerous to environment, all sulfurous compositions, theoretically, convert into Sulfur dioxide but incomplete combustion can produce the following substances: Carbone monoxide, (unburned) Hydrocarbons, and other elusive Organic compositions like petrol, Toluene and Zeilin, Polycyclic Aromatic Hydrocarbon, Carbonyl sulfide.

Open flares of the oil wells around Ahvaz are active in a condition that over one million people live in the productive plain of Khozestan with hot and dry climate. In addition, these flares are located near Karoon River that is a main water supply and it has a special ecosystem.

According to the conducted samplings, the most pollutants resulting from the burning of sour gases of Bangestan layer in Ahvaz are: Carbone dioxide, Carbon monoxide. In addition to creating the above-mentioned compositions, flares spread Dioxins (different kinds of hydrocarbons, heterocyclic) that play an important role in developing cardiac and respiratory disease and cancer.

A research carried out in USA calculated per capita for respiratory patients between 1681 and 10812 US $. Flares are known as the main reason for chronic disease especially respiratory onces. The high statistics of respiratory or cardiac patients in the regions close to the flares in comparison to other urban areas in Ahvaz denotes this. The cost of treating the respiratory patients living near the flares is twice higher than cost of treating people living in other places. The effect of temperature inversion layer is one of the cases in the boundary of the pollutants of this flare.

The lack of attention to the environment at the time of designing and building well flares in Ahvaz resulting from field study as well as the lack of attention to the location of the flares are the main problems with the flares. These flares have caused economic, environmental and hygienic problems for the people living in the neighborhood so that, based on the statistics obtained from the respiratory patients living in 47 residential areas in Ahvaz, the average number of the patients was 4.2. So, in proportion to other residential areas, the ratio for the patients living near the flares is 2.8.

If the cost of treating every patient is 300000 Rails, The average cost for 20 days is 16200000 Rials for treating the patients living in areas near the oil and gas wells. Therefor, the cost of treating a patient annually is 29575000 Rials that with the inflation, it will be more than this figure. So, health per capita of these patients will be about 2.8 percent in comparison to other areas of Ahvaz.The increase in cost is associated with the pollution deriving from the flares.

The generated pressure difference and the stacking effect in the stack becomes stacking effect. In this paper, thermal furnace and stack produce stacking effect. A turbine and a wind generator are installed at the mouth of the combustion furnace. Even, neighboring countries like Turkey and United Arab Emirate. United Arab Emirate Project generate 100 megawatts power and Namibia Project is expected to generate over 500 megawatts power by solar energy.

Coolness Production by Sour Gas

Solar tower power plant to be used in Iran's plains is shown in table 1 and different countries are examining or manufacturing that. Sour gas combustion produces a lot of heat. If radiation flares are installed in heat furnace, we can at least absorb twenty percent heat generated by combustion and transmit it into cooling. This cooling can be used in gas and oil unit production thereby we can save electricity. Even we can use some of the saved electricity for cooling cultural and tourism centers and art galleries near these installations. The amount of cooling produced depends on the type of thermal exchanger and the amount of sour gas given to us.

The Method of Using Sour Gas and Generating Power and Coolness

In this method, sour gas is burned in a furnace by optimized radiation flares and then it goes toward the stack and in the stack cooling is produced by the exchange between the heat and absorption chillers. The amount of gas produced in the four big flares around Ahvaz are shown in Table 1. Pay attention to schematic areas (Figure 5 and 6) of the project.

Table 1: The amount of gas burned with oil in Ahvaz Production Units

Row	Index	Amount (million cubic feet per day)
1	Ahvaz (1)	3/53
2	Ahvaz (2)	5/43
3	Ahvaz (3)	8/15
4	Ab Teymour	8/19
Total		4/132

The amount of loss due to non- use of these sour gases is shown in "table 2". The figures are related to 2005.

Table 2: Economic loss due to burning sour gases with oil and non-production of 4 kinds of chemicals.

Row	Product Name	Daily Production	The Value of the Product In Dollar	Daily Loss of the Product in Dollar
1	L.N.G	24000 barrels	12	28800
2	Light Sweet Gas	170 Million Cubic Feet	500	85000
3	Sour Gas	2000 barrels	18	36000
4	Solid sulfur	200 tone	60	12000
Total				421000

A study is going to be carried out on Ahvaz flare 1 that has the most amount of combustion. The amount of sour gas burned is 208.333 cubic feet per hour which is equivalent to 36.805 cubic feet per minute and 62530 cubic meter per hour. This is a large volume. This energy is 65 megawatts per hour. Pessimistically, only 20 percent of this energy is absorbed by heat exchangers that are installed combustion furnace. Also, 1.5 percent of 65 megawatts is absorbed by the generator turbine. We can generate 400 tones of refrigeration and over 100 kilowatts per hour power by the the turbine shown in figure 4. All the air-conditioners of personnel building of the oil company have been turned off and ventilation is done by absorption chillers. The rest of the refrigeration can be used in the surrounding buildings for cultural and recreational purposes, parks and glass-covered green spaces. Indeed, a wealth that was previously burned can now be used. Financial and physical damages resulting from air pollution have been reduced due to optimizing radiation flares that have been installed in the combustion furnace. There is little smoke and electricity consumption has been minimized and the electricity generated by the optimized turbines and wind generators is used in residential and industrial sector of the company.

Manzars solar tower power plant in Spain produces about 50 kilowatts power per hour. It works with the temperature difference derived from solar energy and created as a result o of density difference and this difference is about 11 degrees of Cecilius that reaches over 200 degrees in thermal furnace with sour gas. It has been taken into consideration and it is important for preventing erosion and dew point. As it is clear from figure 4, the produced power depends on the stack height, amount of gas, temperature difference and furnace geometry.

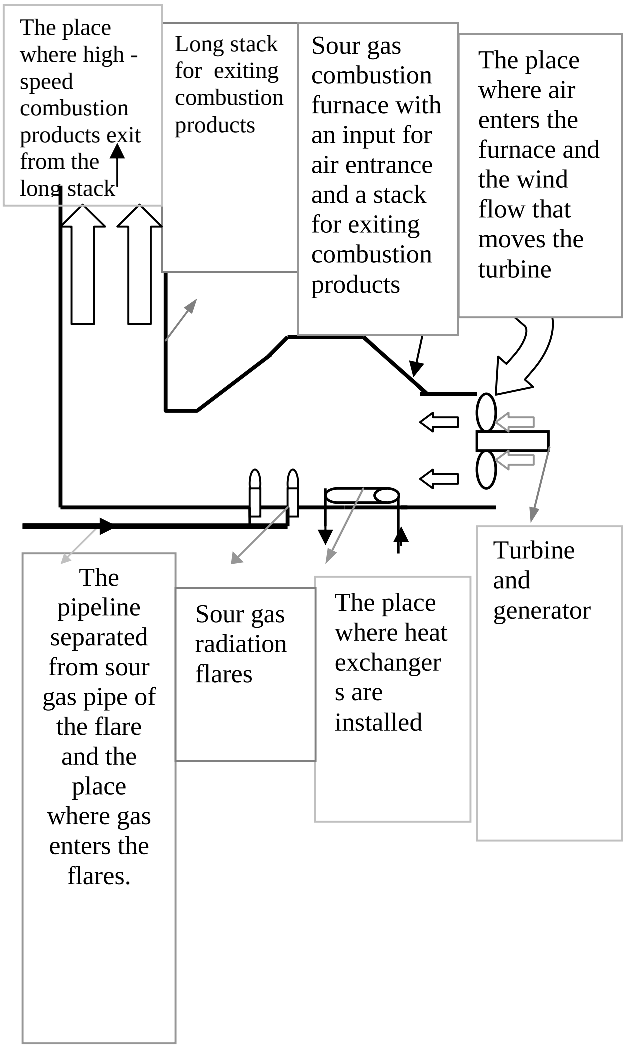

Figure 4: The schematic of the tower or long stack with sour gas fuel

Calculating the profit of generating electricity and electricity saving resulting from refrigeration production

The calculation was pessimistically done and the same amount of production in Spain project, 50 kilowatts per hour, has been considered. Perhaps in Iran, it is not possible to build a tower of 200 meters high like the one in Sipan. In return, we have higher temperature difference and higher density difference (due to the high temperature of sour gas combustion products and a tower with the height of 30 to 50 meters can be designed and built. If a good design is predicted, it is at least 200 kilowatts or 1 megawatt of the flare in Ahvaz 1 site. The flare of Ahvaz 1 burns a heat equal to 65 megawatts per hour and 1 megawatt per hour is only 1.5 percent of the power. It is clear that optimistically, much more power is generated.

This kind of generation is considered among the DG or distributed generation and Ministry of Power gives at least 1200 Rials for every kilowatt per hour to the producer. We can only generate 50 kilowatts electricity by the turbine and generator installed in the mouth of the flare of Ahvaz 1:

(1) $$N \times H \times C \times P = B1$$

N: The number of days of year with energy consumption for heat in winter

H: Hours of day and night

C= the amount of money paid by Ministry of Power for every kilowatt per hour

P= the power generated by sour gas tower

B1= the benefit derived from DG for the flare of Ahvaz 1

$$365 \times 24 \times 120 \times 50 = 52{,}560$$

$$B1 = 52560000 \quad RIALS$$

(2

With the installation of absorption chillers producing 400 tons of refrigeration, we can cause the shutdown of 266 air conditioners, 1800 BTU, per hour. And we have:

(3) $$N \times D \times C2 \times NC \times H = B2$$

N= the number of days of year with energy consumption for heat in winter.

D= Electricity consumption of every 1800 air conditioner per hour (about 2 kilowatts)

C2= the cost of per kilowatt hour that an air conditioner consumes (industrial electricity is 400 rials)

NC= the number of air conditioners shut down due to using absorption chillers.

H= the number of day and night hours

B2= the amount of saving obtained from using absorption chillers

(4) $$365 \times 2 \times 400 \times 266 \times 24 = 1864128000 \, RIALS$$

(5) RIALS B2=1,864,128,000

B1+B2=2,390,000,000 RIALS (6)

If subsidies are gradually removed from the industrial sector and the real price of per kilowatt electricity, about 1000 rials is calculated (4) and in stead of 400 rials, we must pay 1000 rials for a kilowatt per hour and then calculate (4) again, that is, in stead of C2, 1000 rials for every kilowatt per hour is considered:

B3= 4,660,320,000 RIALS (7)

B1+B3= 5,180,000,000 RIALS (8)

About half a billion dollars will be saved every year.

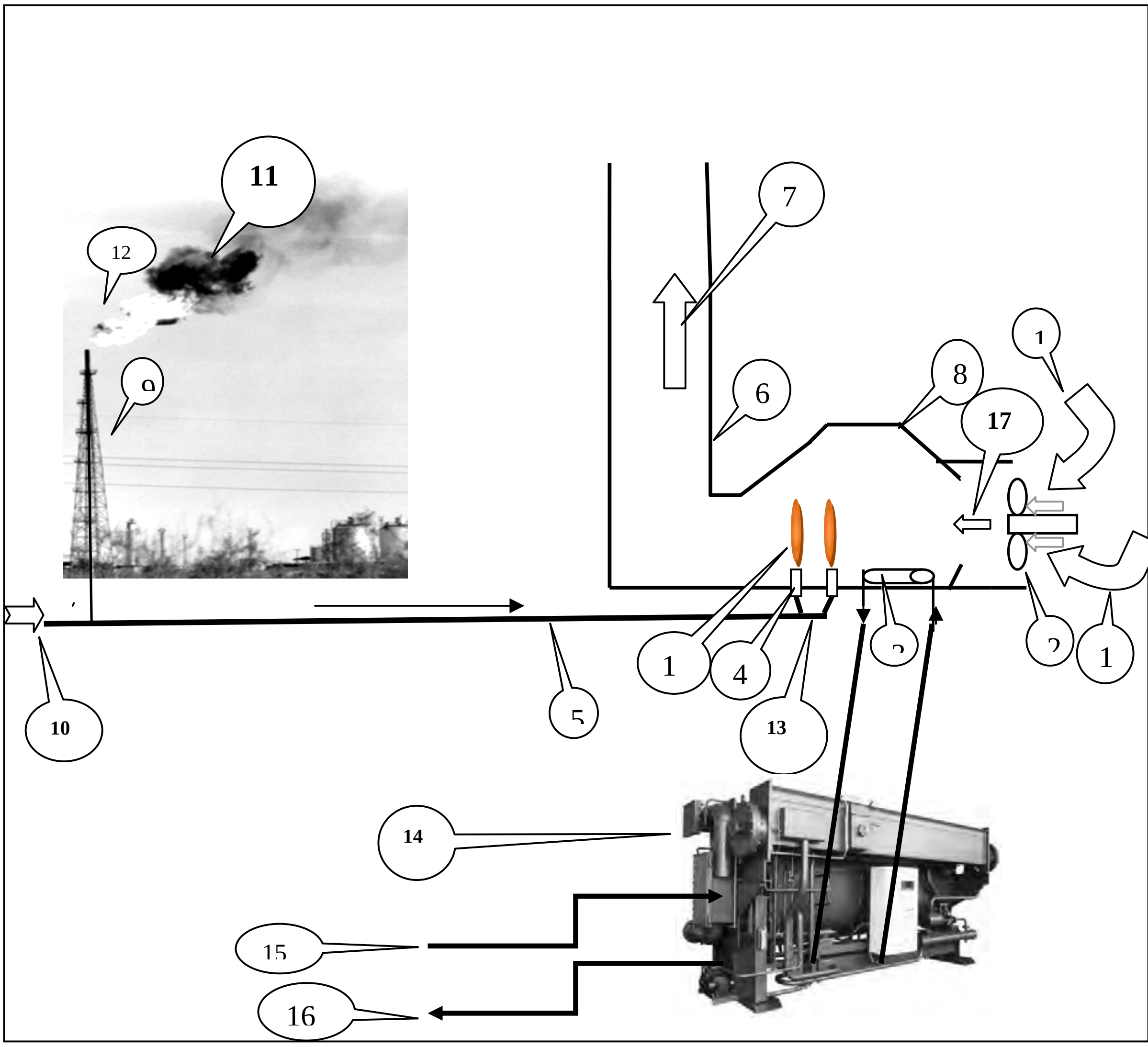

Figure 5. The location of the equipment and chiller

Table 3: Numbers related to figure 7

1	The place where air and strong wind enter the furnace and move the turbine
2	Turbine and generator
3	The place where heat absorptions and heat exchangers of absorption chillers are installed (in a platform of stone rubble native to Haftgol and Masjed Soleyman in Khuzestan). The stone platform has not been drawn in the figure. It has been shown in figure 6.
4	Sour gas radiation flares The schematic of the two flares has been shown in figure 2.
5	Sour gas pipeline separated from sour gas pipe of the flare and the place of gas inlet pipe to radiation flares
6	Long stack for exiting combustion products connected to combustion chamber.
7	The place where hot high -speed combustion products exit from the long stack
8	Combustion furnace or combustion chamber of sour gas with a place for entering air and a stack for exiting combustion products In the figure, a part of the furnace is shown

	without showing the stone platform and the pipe for absorbing the heat of absorption chillers. Only, the schematic of the absorption pipes has been shown. In figure 6, the stone platform and heat absorption pipes of absorption chillers.
9	Flare belongs to gas and oil companies
10	Sour gas toward the flares for burning
11	Smoke and pollution of combustion products resulting from the flare and its bad burning
12	The flame of the flare
13	The place where refrigerated fluid enters stone heat exchangers and heat acquisition and exit toward heat absorption chillers.
14	The heat absorption chiller that is installed near the furnace or combustion chamber.
15	The exit of cool water toward the fan coils of the industrial and office buildings or near recreational centers
16	Water entrance from fan coils to chillers for refrigeration
17	The place where the air needed for combustion enters from outside to the inside of the furnace This large volume of air helps the turbine to generate electricity.

Conclusion

If subsidies of industrial electricity is removed, around half a billion tomans capital is created by Ahvaz flare that currently, all its sour gas is burned. And the pollution is decreased in Ahvaz and this national capital is not wasted. As it was mentioned before, cultural and recreational centers, amphitheater, glass-covered green space and green house only use 20 percent of the energy produced. In calculations, only 20 percent of the energy has been used. If we are able to design exchangers that absorb more heat, this huge amount of capital can be used to serve the oil regions and their people. These services include: water treatment, heating the water of the near houses, cooling the near residential areas and so on. According to the second part of the article and treatment costs and a population of 1 million people, if every citizen is given less than 1500 tomans, the required capital for this project is provided.

There are four big flares around Ahvaz that have created pollution and a lot of problems for the people. There are also a lot of flares in distant areas in oil fields. Trying to use this God gift and short term solutions can be of great help. There are 45 flares in South Pars region. Such projects are helpful for autarky and prevent wasting national capital. Next, This knowledge can be transfered to other countries as engineering services. Ahvaz flares can generate a large volume of megawatts electricity. Also, there is high capacity for generation cooling or refrigeration in this hot region of the country. Even, we can transfer some of the sour gases to big power plants such as Varamin Power Plant to reduce the cost of electricity genereted by these power plants.

The cost of implementing such project is estimated to be one billion and four hundered million toman. Given that it annually makes half a billion income, after three years and a half or four years, all the money invested will return. The only costs are repair costs and maintenance of the chillers and wind turbines that can be given to private sector.

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