General Department of Economic and Financial Affairs of Khuzestan

Preparation and Compilation of Investment Opportunities in The Province

Investment opportunity studies report

«Graphite Electrode Production Plan»



v-2

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Khuzestan province is located in the southwest of Iran (in 47° 42 to 50° 39' east of the Greenwich meridian and 29° 58' to 32° 58' north of the equator). The area of Khuzestan province 63,238square kilometers. With a population of 4,994 is thousand people in 1400SH, it is the fifth most populous province in Iran (after Tehran, Khorasan Razavi, Isfahan and Fars provinces). Ahvaz is the capital of Khuzestan province and is located in the 880km of Tehran. This province is bordered by ILAM province from the northwest. Lorestan province from the north, CHAHARMAHAL and BAKHTIARI, KOHGILUYEH and BOYERAHMAD provinces from the northeast and east, the Persian Gulf (330km long) from the south and Irag (330km long) from the west. The location of Khuzestan is in the west of Zagros mountains. Due to the vastness of its plains, the border with Iraq and the Persian Gulf, and the distance from other provincial centers have placed this province in a strategic position.

1-2- County

According to the latest national divisions of 1401 of the Ministry of Interior, this province has 29 counties, 70 districts, 145 villages, 90 cities and 3 special governorates. The latest political divisions of the province are described in Figure (3).

Ahvaz is one of the cities of Khuzestan province, centered in Ahvaz city. Ahvaz has a population of 1,420 thousand people, 28% of the population of the province. This city has a common border with SHUSHTAR, BAVI and RAMSHIR cities from the east, HAMIDIEH and HOIZEH cities from the west, KARKHE city from the north and Khorramshahr, Karun and Bandar MAHSHAHR cities from the south. After passing through DEZFUL, it enters Ahvaz and connects to Karun River at BANDGIR, which after the confluence of two Dez rivers, Karun forms the great Karun River, and after passing Ahvaz, it enters Abadan and Khorramshahr. A total of 185 km from the Karun River, 61 km from the Karkheh River and 5 km from the Dez River are located in Ahvaz .

From the industrial point of view, Ahvaz is considered the vital artery of Khuzestan province where large factories of food, mineral, metal, and chemical industries have been established there. In the industry sector, there are five industrial towns (Ahvaz 1 to 5).

Critical industrial centers including National Iran Drilling Company, Steel Complex, National Steel Industrial Group, Pipeline Company, Oil and Gas Companies, Northeast Agriculture and Industries, DEHKHODA and sugarcane ancillary industries are located in Ahvaz. In addition, sandstone and wind (industrial) mines and rich oil and gas resources are being exploited in the area of Ahvaz and many utilization units and management facilities in the southern oil-bearing areas, including exploration, drilling and oil and gas production facilities are settled in Ahvaz. The prosperity of agriculture and



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industries in the region has led to the prosperity of commerce and all kinds of industrial products such as steel, iron sheets, pipes, profiles, industrial parts, artificial leather, pressure vessels and heat exchangers, all kinds of iron, oil and all kinds of petroleum products, sanitary products and detergents, food, agricultural products such as wheat, barley, tares, dates and fishery products are among the most important products exported from this region locally and internationally.



2) Project Status

The location of the proposed land is in Ahvaz Industrial Town no.5 with the following specifications and an area of about 33,000 square meters.

Acquiring industrial land in this place requires approval from ministry of industry, mining and trade, industrial estates company and environment protection agency.

One of the reasons for choosing this location is its proximity to important steel producing companies in the province. The distance of this town to Khuzestan Steel, AKSIN Steel and DAMAVAND ATIYE Steel companies is 10, 9.5 and 1 km, respectively. The distance between this industrial town and Ahvaz city is about 17 kilometers

2-1- Access to infrastructures

Currently water, gas and electricity infrastructures are available in this estate. It is also well-located in terms of access to transportation. The distance of the chosen place to the Ahvaz-Imam Khomeini Port freeway is 1.2 km and its distance to Imam Khomeini Port is 107 km. Ahvaz airport is also located 15.7 kilometers away from this place. Based on this, raw materials will be supplied from Imam Khomeini port.



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Figure (4): Project location map



Figure (5): Image of the project location

No.	Required Infrastructure	Distance From Project Status	Location Of Infrastructure Provision
1	Water	0.8	Ahvaz industrial Estate no 5
2	Electricity	0.8	Ahvaz industrial Estate no 5
3	Gas	0.8	Ahvaz industrial Estate no 5
4	Telecommunication	0.8	Ahvaz industrial Estate no 5
5	Main road	1.2	Ahvaz – Imam Khomeini port highway
6	Side road	0	Industrial Estate transportation
7	Airport	15.7	Ahvaz airport
8	Port	107	Imam Khomeini Port
9	Railway Station	18.7	Ahvaz Railway

Table (1): access to infrastructures







3) Technical specifications of the project

3-1- Product

Graphite electrode is a kind of consumable part¹ made of graphite² which can convert electrical energy into heat. Graphite electrode is a conductive piece that is able to pass electricity. This piece of conductor is used to pass electricity at a high scale. Graphite electrodes are required in electric arc furnaces to pass electric current. The electric arc furnace method is one of the conventional methods of steel production used in steel production units. There is no graphite electrode production in Iran³, so the country's demand is fulfilled with importation. In 1400, nearly 105 thousand tons of furnace electrodes imported from China, UAE, Germany, Turkey and other countries. It is worth noting that all types of steel production methods, such as blast furnace and pure furnace, are associated with environmental pollution. Steel production in electric arc furnaces is environmentally friendly due to the absence of pollution and is considered a clean fuel. Graphite electrodes play an important role as the primary part in the passage of electricity in these furnaces. They are also a consumable piece and need to be replaced. Therefore, graphite electrode supplying is one of the steels producing units' needs. Until now, due to existing restrictions, it has not been possible to produce it inside the country. Since only some countries have the technology of needle coke production, such as America, Germany, Japan, and China. These countries have strict rules for the transfer of this technology to others. The type of input that leads to the production of petroleum coke and is used in the production chain of graphite electrodes in the steel industry is the feed rich in aromatic hydrocarbons, which is the primary material for the production of sponge coke, vacuum tower residue and other heavy cuttings, which after thermal failure and time delay, turns into coke with fuel consumption. However, not every feed can be used to produce needle coke. Slurry Oil cuts, aromatic flows from oiling units and thermal fracture wire are usually used to produce needle coke. Currently, there is no unit for the production of needle coke in any of the refineries in Iran, even in the development and newly established units.

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Figure (8): General Plan of Graphite Electrode



Electric Arc Furnace

1. In steel production process, graphite electrodes are subject to oxidation, melting and sublimation and are consumed over time. Factors such as gravity, pressure, tensile force, breaking force, vibration, strength, electromagnetic force, thermal stress, thermal shock, etc. have an effect on this process.

2 . The chemical formula of graphite is carbon (C). Graphite is an allotrope of carbon, meaning it has the same chemical composition as carbon, but has different physical properties. Carbon is able to form three natural allotropes: amorphous carbon, graphite and diamond. When carbon atoms form a hexagonal crystal structure, graphite is formed. The hexagonal edges are joined together in layers, making graphite soft, malleable and ideal for use. However, each graphite layer is individually solid. A layer of graphite is known as graphene. Graphite is more than 300 times stronger than steel. The strength of graphene and its electrical and thermal conductivity properties make this material useful for industrial uses.

3. Currently, there is an official production unit called "Industry System" in the field of graphite electrode production. Surveys show; This company is not a manufacturer and does not have a production process and mostly provides graphite electrodes through importation and assembly. There are also 4 projects with operational progress (NOVIN ELEKTROD ARDAKAN, Carbon SANAT AMIRKABIR, SANAE FOULAD BALADVI, ATIYE Middle East Steel Company), which despite obtaining the license for more than three years, the actual progress is less than 50% and the possibility of utilization is low.



3-2- Project Requirement

3-2-1- Land And Required Infrastructure

To produce graphite electrodes, a land with an area of 33,000 square meters and construction infrastructure for production (Production building and other buildings) amounting to 9,600 square meters is required. The specifications of the land, main buildings and other required side buildings along with the amount of investment are described in the table below.

	Requirements		Inves	Investment Required		
No.		Description	Required Area m ²	Unit Price (Rial)	(Million Rials)	
Land purchase Khuzestan, Ahvaz city, Ahvaz Industrial 1 110 m * 300 m		Khuzestan, Ahvaz city, Ahvaz Industrial Estate No 5	33,000	6,700,000	221,100	
2 Site preparation and development According to relative calcula		According to relative calculations	23,100	2,216,450	51,200	
	Civil works, structures and buildings	Production building	6,000	55,000,000	330,000	
		Office and management building	1,000	80,000,000	80,000	
3		Labor and support building (restaurant, dressing room, prayer room, shower and restroom)	500	60,000,000	30,000	
		Water, electricity and gas facilities building	50	100,000,000	5,000	
		guard and janitor building	50	70,000,000	3,500	
		Other buildings (warehouse, etc.)	2,000	5,000,000	10,000	
		Fotal	-	-	730,800	

Table (2): Amount of investment in land, landscaping and building

3-2-2- Plant Machinery and Equipment

At present, the graphite electrode production technology is in the hands of several countries, and the possibility of producing needle coke and carrying out all its processes is not provided for other manufacturers in other countries. In addition, special devices and equipment are needed to produce graphite electrodes. These devices and equipment can be used in the production process of graphite electrodes. These devices are very special and have very high prices and high technology. These electrodes should be made of calcined petroleum coke according to international standards. In general, the production process of graphite electrodes is as follows:





Preparation of raw materials: The first step is to use raw materials to make graphite electrodes. It is natural that these materials must be of high quality. The main materials for the production of graphite electrodes are petroleum coke (Petroleum Coke - as binder) and needle coke (Needle Coke as aggregate). The production of these materials is limited to countries such as Germany, America, Japan and China. For this reason, only these countries have the ability to produce such an important part for use in electric arc furnaces.

Medium Crushing and Sieving: Needle coke is broken in a machine called Double Roll Crusher and then sieved by Multi-Layer Vibrating Screen. The breaking and sieving processes have special instructions.

Kneading: After batching, raw and auxiliary materials (quartz sand, metallurgical coke particles and coke powder) are mixed with a certain ratio of coal bitumen by heating and kneading to obtain one-hand plastic dough.

Pressed (Forming): After mixing and kneading, the produced dough is cooled and then pressed according to the specifications of the desired product using a T3500ton Vertical Ramming Horizontal Pressure Electrode Extrusion Machines.

Roasting: In Acheson Furnace, the raw embryo of the electrode is roasted to a certain temperature according to the technological needs. Then the final product is coated with a certain amount of coal, anthracene oil and synthetic resin to improve its mechanical properties. After soaking, the product should be roasted again.





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Graphitization: Secondary roasted products are placed in electric furnaces to be heated to 3000°C. As a result of such heat, the structure of carbon atoms becomes a special crystal form and carbon will turn into graphite.

Machining: In the final step, turning should be done on the electrodes. Turning will make the electrodes take a cylindrical shape and they can be produced in different diameters. Finally, a number of pins will be installed on the electrodes and it will be marketed after packaging.

According to the points mentioned about graphite electrode production, it is only possible to carry out the processes related to graphitization and turning in the country, and the production in the present plan is based on the purchase of roasted and enriched electrodes. According to the selected processes and technology, the required machines and equipment are as follows:

No	Equipment/Machinery	F	Total cost					
NO.	Equipment/Machinery	Amount	Unit Price	Currency	(Million Rials)			
1	Acheson Furnace	1	10,000,000	Euro	4,515,310			
2	Graphitization line	1	14,000,000	Euro	6,321,434			
3	CNC lathe machines	2	3,000,000	Euro	2,709,186			
4	5-ton overhead crane	1	25,000	(Million Rials)	25,000			
5	Arm crane	3	10,000	(Million Rials)	30,000			
6	Metal structure of product transfer lines	100	700	(Million Rials)	70,000			
	Total	-	-	-	13,670,930			

Table (3): Plant Machinery and Equipment

Production requirements: The production of graphite electrodes is mainly processed by high-speed machine tools. The stability of the machine tool should be good, the three-axis movement should be uniform and stable without vibration, and the spindle rotation accuracy should be as good as possible. Conventional machine tools can also complete electrode processing, but the tool planning process is different from that of graphite electrodes.

Graphite electrodes are carbon electrodes. Since graphite has good electrical conductivity, it can save a lot of time in electrical discharge machining, which is one of the reasons for using graphite as an electrode.

Graphite material is hard and brittle, and tool wear is more serious during CNC machining. In general, the use of cemented carbide or diamond coated tools is recommended. The dust generated by the graphite electrode during CNC processing is relatively large. This dust may cause pollution, and for this reason, the graphite lathe tool must have the relevant equipment and facilities to prevent the emission of graphite dust.



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ruble (1). Auxiliary and service plane Equipment							
	· · · · ·	Unit of	Type of	Require	d investment	Total cost	
No.	Equipment/Machinery	measurement	equipment	Amount	Unit Price (Million Rials)	(Million Rials)	
1	Distribution Of Electricity / Demand Price	Kw	Facility	700	6	4,200	
2	Several Electrical Cables	М	Facility	1,000	3	3,000	
3	Electrical Equipment of The Greenhouse Lighting System	Amount	Facility	100	40	4,000	
4	The Cost of Panel Boards and Related Electrical Equipment	Amount	Facility	6	320	1,920	
5	Water Branch	-	Facility	1	450	450	
6	Other Water Conveyance Equipment	Amount	Facility	1	2,000	2,000	
7	Firefighting, Safety and Health Equipment, etc.	Capsule	Facility	20	30	600	
8	Gas Piping	М	Facility	800	4	3,200	
9	Gas Branching	-	Facility	1	1,500	1,500	
10	Water Heater and Heater	Machine	Facility	5	350	1,750	
11	Ventilation Systems for Toilets and Bathrooms	Fan	Facility	10	35	350	
12	Air Conditioner	Set	Facility	10	850	8,500	
13	Evaporative Cooler	Set	Facility	10	250	2,500	
14	Gas Heater	Ton	Facility	10	100	1,000	
15	Industrial Heater	Machine	Facility	2	150	300	
16	2.5 Ton Pallet Jack with Scale	Machine	Vehicle	3	360	1,080	
17	3 Ton Forklift	Machine	Vehicle	1	25,000	25,000	
18	ZAMYAD Diesel Van	Machine	Vehicle	1	6,000	6,000	
19	SAMAND Soren Car	Machine	Vehicle	1	7,000	7,000	
20	Workshop and laboratory tools	Machine	Workshop and laboratory tools	1	10,000	10,000	
21	CCTV System	Set	Facility	1	2,500	2,500	
22	Office Stuff	Set	Office Equipment	18	1,800	32,400	
23	Restaurant Equipment	Set	Office Equipment	23	20	460	
24	Medical Equipment	Set	Office Equipment	1	800	800	
25	Other Facilities	-	Facility	1	1,490	1,490	
	Total – – 122.000						

Table (4): Auxiliary and service plant Equipment

3-2-3- Raw Materials and Intermediate Parts

In the present plan, the primary input material of the line is only baked and impregnated electrode, which will be imported from countries like China or Japan. These electrodes are entered in the graphitization section and then, according to their specifications and application, special machining operations are performed on them. The specifications of raw materials and packaging for the production of graphite electrodes are as described in the table below.

No	Title	Production quantity at maximum capacity	Unit	Average price (Rials)	Purchase unit	Consump tion per product unit	Amount of consumption in nominal capacity	The cost at the maximum nominal capacity (Million Rials)
1	Baked and impregnated electrode -450	8,000	ton	1,476,000,000	ton	1.10	8,800	11,125,724
2	Baked and impregnated electrode -500	12,000	ton	1,512,000,000	ton	1.12	13,440	17,598,872
3	Baked and impregnated electrode -600	12,000	Ton	1,692,000,000	Ton	1.14	13,620	19,679,527
4	Baked and impregnated electrode -700	8,000	ton	1,800,000,000	ton	1.15	9,200	14,539,298
5	pallet, packing belt,	40,000	ton	3,000,000	amount	0.313	12,500	37,500
Total		-	-	-	-	-	57,560	62,980,921

Table (5): Costs of Raw Material for Production

*The costs related to diamonds, drills, holders and fixtures, etc., are included in the maintenance costs of machines.



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3-2-4- Management and human resource

For Graphite electrode production, 46 human resources will be required in the production, management and support department as described in table (6).

		Number	
No Level of skill		of staff	Average basic salary
1	Senior	23	240,869,565
2	Mid-level	3	150,000,000
3	Junior	20	125,294,118
Numbe	er Of Direct Mid-Level Staff Required	3	Person
Num	ber Of Direct Junior Staff Required	20	Person
Num	ber Of Direct Senior Staff Required	23	Person
	Total	46	person

Table (6): Management and Human Resource

Number Of Direct Senior Staff Required	23
Total	46

4) Ownership and legal permissions

4-1- land ownership

The suitable location for this project is One of the industrial towns in Ahvaz (Ahvaz Industrial Town 5). The legal right for exploiting the land is 6,700,000 Rials. This estate is subject to the rules and regulations of Less developed industrial towns. Having legal permits which are mentioned in 3.4 section are required to obtain a land in this estate. If the construction phase in this estate gets rejected, it should be established in Imam Port Economic Special Zone.

4-2- Intellectual Property and Concessions

In order to produce graphite electrodes, high technical knowledge is needed. In the present project, technical knowledge in the field of graphite making and machining is considered. There is technical knowledge related to these processes in the country. In the machining department, there is a need for advanced CNC machines for large products. The production of graphite electrodes should be according to international standards (IEC60239-2005) and national standards (YB/T 4088 89-2000).

4-3- Legal permissions

In order to produce this product, we need legal permits such as (establishment permit and operating permit) from the Khuzestan Province Industry and Mining Organization, and environmental permit. It is worth noting; Graphitization processes are carried out using furnaces and at high temperatures. The fuel used in the furnace is natural gas and has no non-virtual pollution. Machining processes are carried out in the presence of machining fluids and this makes the relevant processes not create dust in the surrounding environment.



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5) market research and competition

5-1- Target market introduction

Nearly 25% of all steel in the world and 90% of the steel in Iran are produced by electric arc furnaces. The total production of steel in the world in 2021 was 1.95 billion tons and the total production of raw steel in Iran (in 1400 SH) was around 28 million tons. It is predicted that in the coming years, Iran's crude steel production will increase. According to the plans, the total production of crude steel in the country is expected to be more than 50 million tons (until 1405 SH). What is certain is that graphite electrodes are used in all electric arc furnaces. The amount of graphite electrode demand can be estimated according to the average consumption of graphite electrodes per unit of steel production. The consumption range of graphite electrode in electric arc furnaces is less than 1 kg (in the lowest amount) to 10 kg per ton of steel produced⁴. According to the Iran's importation statistics in the steel industry, the number for each ton of steel production was equal to 3.75 kg on average. According to the inquiry made by MOBARAKEH Steel Company of Isfahan, for each ton of steel, 2.1 kg of graphite electrode is required on average.





It is worth mentioning that the use of graphite electrode is not limited to the steel industry. It is used in industries such as Graphite electrode. Accordingly, the demand for graphite electrode in the steel industry, (exclusively for the steel industry) is equal to 60 thousand tons per year. According to the country's goals in the field of steel production, it is expected that the demand for graphite electrodes in the country's steel industries will reach more than 110 thousand tons per year.

Currently, there is no active graphite electrode manufacturer in the country. According to official statistics, only one company has been reported as an active unit for graphite electrode production which is responsible for design and assembly. Among the 15 units having graphite electrode production plans, only 4 plans (related to ARDAKAN New Electrode (Yazd - with a nominal capacity of 30 thousand tons and 46% actual progress), KARBAN SANAT AMIRKABIR (Arak, with a nominal capacity of 100 thousand tons with 28% of actual progress), BALADAVI Steel Industries (Kerman - nominal capacity of 1.4 thousand tons, 51% progress), Middle East Steel Company (Khuzestan - 30 thousand tons with less than 1%)) have progress which is less than 50%. Therefore, the country's demand is met only by importation so far. According to customs statistics, the country's total demand (import) is around 105 thousand tons per year. It is expected that the demand is going to increase due to the steel production rise. The country's total demand will reach more than 180 thousand tons per year in the next 5 years.

In the global market, graphite electrode production is monopolized by a few countries. Although it is expected that the price of graphite electrodes will decrease with the increase of competition between these manufacturers, in recent years, with the adoption of anti-dumping laws in the member countries of the World Trade Organization and with the increase in demand, the price of graphite electrodes has become

⁴ . The electrode is mainly used in the steel industry and both manufacturers and users make great efforts to improve its quality and reduce its consumption. After 40 years of scientific effort in this field, relative results have been achieved and it has gradually decreased due to the improvement of the quality of graphite electrode consumption in this industry.

Graphite Electrode Production Plan



higher. Of course, these sellers face a serious threat from Chinese manufacturers who can produce higher quality products at a more reasonable price.

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10 best producers of graphite electrodes in the world are:

Dan Carbon Company: Dan Carbon was established in 1994 in Dandong City, Liaoning Province, Northeast China. This company is one of the most important manufacturers that has produced graphite electrodes in China. Dan Carbon mainly manufactures special graphite electrodes for use in electric arc furnaces in steel smelting plants. Dan Carbon company also has the ability to produce professional graphite electrodes with diameters of 200 mm to 700 mm. This company is now one of the leading Chinese companies in the world market, which, based on its advanced equipment, has the ability to produce 100,000 tons of graphite electrodes per year.

GIL Graphite Company: Graphite India Limited (GIL) was established in 1967 in collaboration with Great Lakes Carbon Corp (GLCC) in America. The company has headquarters in Kolkata, West Bengal and India. GIL Graphite Company is engaged in the production of various graphite electrodes, various graphite products and waterproof graphite equipment and spare parts.

SGL Carbon Company: SGL Carbon, together with its subsidiaries, is active in the production of various carbon and graphite products. This company can annually produce carbon-based products that are used in a wide range of industries and industrial sectors.

Showa Denko Carbon Company: Showa Denko Carbon Company manufactures graphite electrodes for use in electric arc furnaces. The products of this company have specific industrial applications.

HEG Ltd: HEG Ltd is one of the leading graphite electrode manufacturers in the world, located in India. This company has one of the largest integrated graphite electrode factories in South Asia, which produces its products with the help of the latest technologies.

Tokai Carbon Company: With over a century of experience, Tokai Carbon is known as a manufacturer of carbon-based products that can produce the most essential parts.

Kaifeng Carbon Company: Kaifeng PINGMEI New Carbon Materials Technology Co., Ltd, or Kaifeng Carbon for short, is located in Henan province and can produce all kinds of graphite electrodes in diameters of 500, 550, 600 and 700 mm.

Nantong Yangzi Carbon: Nantong Yangzi Carbon Co., Ltd. is another top graphite electrode manufacturer in China, which is among the top 3 UHP electrode manufacturers.

Schutz Carbon Electrodes Co.: Schutz Carbon Electrodes Co. started its activities since 1987 as a manufacturer and exporter of electric arc carbons in India. This company has very professional equipment and machinery and can produce carbon-based products in bulk.



6) Physical progress of the project • No • • Yes

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This plan is a new project and has been defined to cover the needs of steel industry of Khuzestan province. The stages of its construction phase have not made physical progress.

7) Operational plan and implementation scheduling

The time between implementation and utilization is estimated to be 30 months. Project production phase is expected at 1405 SH. The project scheduling is described in Table (7).

Table (7): Project Scheduling 1401 1402 1403 1404 1405 year **Operations/Season** 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 Prior to investment studies Fundraising and starting Obtain legal permissions Providing engineering services Land purchase and preparation Ш Selecting contractor Equipping site Ш Construction and landscaping Ш 1000 1000 1000 1000 Order, purchase and transportation of machinery 000 000 000 000 Machinery installation Facilities Hiring and onboarding of staff Pilot utilization I Unexpected delays Ш production phase



8) Financial Plan

8-1- Cost Estimation

Generally, there are two ways to fundraise for this project, fixed capital and initial working capital. The required investment before utilization is provided through fixed capital. Initial working capital will be used during utilization. Fixed capital includes, purchasing land, construction and landscaping, machinery and equipment, facilities, office stuff and pre-production costs. These types of costs are incurred at the beginning and before operation and are consumed during the life of the project according to their service life. Working capital includes the capital required during the operation of the project. The working capital of a production unit is the set of facilities, inventories and work in progress, as well as the liquidity required for the exploitation of fixed capital in order to maintain the operation.

Determining the basic amount for inventories, work in progress and claims depends on the supply, production and sales capacity and business environment. In this section, the evaluation and estimation of the required investment (based on the price of the base year 1401 SH) is proposed.

No.	Subject	Amount (Million Rials)
1	Total Fixed Investment Costs	15,004,900
2	Total Net Working Capital Requirements	7,077,893
3	Total Production Costs (Annual)	65,275,277
4	Depreciation	1,472,317
5	Total Investment	22,082,793

Table (8): Cost Estimations

Table (9): Fixed Capital Estimations (Capital Costs)

No.		Cost (Million Rials)	
1	Ρι	irchasing land	221,100
2	Landscaping	and land improvement	51,200
3	Civil operations a	and construction of buildings	458,500
4	Production m	achinery and equipment	13,670,930
5	Ser	122,000	
6	Protection and	0	
7	O	0	
	Pre-Production Expenditure (As described in	Prior to investment studies	22,220
8		Project management	138,821
	Table (11)	Obtaining technology	29,559
9	Un	290,570	
	15,004,900		

The primary items included in working capital are:

- Raw materials (local and foreign): To prevent any interruptions in production process, production capacity, source and method of supplying materials, length of time during ordering and receiving materials, time of delivery and transportation, the amount of required raw materials, auxiliary materials and packaging are determined as one of the working capital items for one period. In this project, the material inventory coverage period is equal to 20.

- Finished product and work in progress: Considering the steps and methods of production, the required time for production and storage has been determined and the related costs are considered as working capital. In the current plan, the coverage period for the product under construction and the manufactured product is equal to 5 days each. With this in mind, the total stock in hand is equal to 30 days.

- Claims of expected funds from sold products that are collected in a short period of time. The duration for expected funds must be determined. According to the economic condition of Iran, cash is preferred.

- Revolving fund to finance the company's current expenses is considered as cash balance or revolving fund for a period of time in working capital based on production costs (without considering the cost of raw material production and depreciation). 30 days is considered in this plan.



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Table (10): Total Net Working Capital Requirements (Production Costs)

No.	Subject	Amount (Million Rials)
1	Raw Materials Inventory	4,648,750
2	Work In Progress	1,167,678
3	Finished Product	1,176,502
4	Accounts Receivable	0
5	Cash-In-Hand	84,964
6	(Commercial Accounts Payable)	0
	Total Net Working Capital Requirements	7,077,893

Table (11): Pre-Production Expenditure

No.		Subject	Description	Total (million Rials)
1	Incorporation		-	50
2		Obtaining Licenses / Production License	-	800
Studying, Consulting, Research and Development, Traveling, Visiting and Participating in Local Exhibitions, etc.		ring, Consulting, Research and Development, g, Visiting and Participating in Local Exhibitions, etc.	1.5 thousandth of the investment costs of the project	22,220
4	4 Property Insurance		2 thousandth of depreciable fixed assets	29,630
5	5 Survey Fee, Financing, Contract and So On		Survey fee 0.5 thousandth, other 2.5 thousandth	35,550
6		Cartography, Supervising	2 thousandth of contract expenses	28,360
		Staff Training	Equivalent to 3 days of Staff salary	1,199
7	Other's	Wages And Salaries During the Construction	Equivalent to the salary of 19 personnel in 30 months	69,011
		Other Expenses	%2.10	3,780
		Total		190,600

8-2- Sales Revenue

The income of the project in 1405 (at constant prices) is estimated to be equal to 56.7 thousand billion Rials. This amount will increase in the following years due to the increase in production capacity and will increase to a maximum of 81.1 thousand billion Rials.

No.	Subject	Q1	Q2	Q₃	Q4	Total 1 st Year	Total 2 nd Year	Total 3 rd Year	Total 4 Th Year	Total 5 th Year
1	Graphite electrode - diameter 450	2,590	2,590	2,590	2,590	10,360	11,840	13,320	14,800	14,800
2	Graphite electrode - diameter 500	3,990	3,990	3,990	3,990	15,960	18,240	20,520	22,800	22,800
3	Graphite electrode - diameter 600	4,452	4,452	4,452	4,452	17,808	20,352	22,896	25,440	25,440
4	Graphite electrode - diameter 700	3,164	3,164	3,164	3,164	12,656	14,464	16,272	18,080	18,080
	Total	14,196	14,196	14,196	14,196	56,784	64,896	73,008	81,120	81,120

Table (12): Project Revenue in The First 5 Years of Production Phase (Billion Rials)

8-3- Length of Production Phase

The duration of the construction of the plan is 30 months and it is considered to start from the second 6 months of 1402. Based on this, the operation of the project is expected from the beginning of 1405. The duration of the project is considered to be 5 years.

Table	(13):	Planning	Horizon
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Title	Month	-	year
Project identification	11	/	1401
Beginning of construction phase	7	/	1402
Beginning of production phase	1	/	1405
End of production phase	12	/	1409

Inį	g Horizon		
	Length of	Start of	Length of
	construction phase	phase	production phase
	(months)	(months)	(years)
	30	12	5



Graphite Electrode Production Plan



Khuzestan Province Investment Opportunity Study Report - 2023

8-5- Break-Even Analysis

From an economic point of view, break-even point analysis is an important technique that is used to study the relationship between costs, income and profit. The break-even point is the point at which total cost and total revenue are equal. In other words, it is used to analyze the effect of product volume change on the profit. The break-even point is calculated for 100% of practical capacity (year 1408SH onwards) below.

Proak oven cales value (Bials) -	T	otal Fixed (Costs		
Diedk-even sales value (Rials) =	1	Total Var	iable Costs		
	1	Sales	Value		The number of sales at the
break-even point $=\frac{F_C}{S-V_C}$					
FC = Total Costs VC= Average Varia	ble Costs	Q = Quar	tity of Sale	5 5	S = Unit Price
Break-even sales value 🛛 _		1,723,921		_	7 960 782 (Million Rials)
_	1	63	3,553,327	-	7,500,702 (Willion Mais)
	T	- 83	1,120,000		
	1,72	3,920,675,0	00		
even point =	5,070,000,00 0	0 - 3,9	972,082,95 2	*	1,570

Break-even ratio (%) = $\frac{7,960,782}{81,120,000}$ = 9.8%

Table (14): Project break-even point estimation (Million Rials)							
Titlo	Production	Production	Production	Production	Production	Production	Production
THE	1405	1406	1407	1408	1409	1410	1411
Sales revenue	56,784,00	64 896 000	73 008 000	81 120 000	81 120 000	107 760 000	107 760 000
Sules revenue	0	04,000,000	73,000,000	01,120,000	01,120,000	107,700,000	107,700,000
Verieble seets	44,517,72	50.000.000	F7 200 12C	C2 552 227	(2,552,227	04 400 700	04 400 700
Variable costs	8	50,862,929	57,208,126	63,553,327	63,553,327	84,400,798	84,400,798
Variable margin	12,266,27	14 022 071	15 700 974	17 566 672	17 566 672	22 250 202	22 250 202
variable margin	2	14,033,071	15,799,874	17,566,673	17,566,673	23,359,202	23,359,202
Variable margin	22	22	22	22	22	22	22
ratio (%)	22	22	22	22	22	22	22
Fixed costs	1,666,501	1,685,316	1,704,130	1,722,944	1,710,785	2,221,078	2,221,078
Break-even sales	7 714 600	7 702 750	7 974 427	7 956 270	7 000 122	10 246 212	10 246 212
value	7,714,099	1,195,150	7,074,437	7,930,270	7,900,122	10,240,212	10,240,212
Break-even ratio	13.6	12.0	10.8	9.8	9.7	9.5	9.5
(%)							-

According to COMFAR Results

Based on the calculations of COMFAR software, the break-even point including operating and nonoperating costs, is 7,956 billion Rials and it will be achieved in the 9.8% of the practical capacity.

In the mentioned formula, the break-even point is determined by the relationship between fixed costs and the difference between unit sales price and unit variable costs. Therefore, three practical results are obtained from it:

- The higher the fixed costs, the higher the break-even point.

- The greater the difference between unit sales price and variable operating costs, the lower the breakeven point. In this case, fixed costs are absorbed faster through the difference between unit sales price and unit variable costs.

- One of the break-even points is disproportionate. Since it makes the company vulnerable to changes in production (sales) levels.

Graphite Electrode Production Plan



8-6- Cost-Benefit Analysis

In project analysis, one of the most common methods is the **Benefit-Cost Ratio**. In this method, the ratio of the current value of possible benefits to the current value of costs is obtained. If this ratio is greater than one, the plan has economic justification for implementation. In terms of this index, the plan has favorable conditions.

Net Present Value is one of the other evaluation methods which is calculated according to the following relationship:

NPV= The Present Value of The Total Cost of The Period of Construction Phase and Production Phase - The Present Value of The Total Income of Construction Phase and Production Phase

NPV= The Present Value of The Fixed Assets Depreciation + Initial Investment - The Present Value of The Future Cash Flows

The **net current value** of the project at a discount rate of 30% is over 11,348 billion Rials, which shows that the project is economically feasible.

One of the other methods of evaluating investment plans **internal rate of return**. In fact, the internal rate of return is the interest rate or the discount rate in which the current value of all the plan benefits is equal to the current value of its expenses.

According to the calculations, the internal rate of return of the project is estimated at 49.6 % and compared to the Minimum Attractive Rate of Return, it is favorable.

Table (15): Project Return Index				
Index	Amount	Unit of measurement		
The Present Value of The Total Cost of The Period of Construction Phase and Production Phase	99,613,015	Million Rials		
The Present Value of The Total Income of Construction Phase and Production Phase	110,961,724	Million Rials		
NET PRESENT VALUE (NPV)	11,348,709	Million Rials		
Cost-benefit RATIO (B/C)	1.11	-		
INTERNAL RATE OF RETURN (IRR)	%49.6	Percent		
NPV RATIO (PI)	0.64	Rial per Rial of investment		
NORMAL PAYBACK	1.5	Year		

Profitability Index (PI) indicates how much economic profit will be obtained for each unit of money invested during the lifetime of the project

Project Investment payback is the period of time required to recover the project investment from net income, measured in years. In other words, it shows the length of time taken for the initial investment to be returned. This index shows the speed of investment return and the amount of project risk coverage. The ROR (simple) of the plan is estimated to be 1.5 years (equal to the year 1406) according to the calculations.



8-7- Sensitive Analysis

In the sensitivity analysis of the plans, the percentage of changes in the internal rate of return (IRR) is measured in relation to the change in some basic parameters and variables. In this plan, the analysis has been carried out by major variables such as sales, fixed and operating costs. Table (16) shows the results of the sensitivity analysis regarding the variables of sales income, fixed assets and operating costs.

8-7-1- Sales Revenue

Changes in sales revenue are mainly caused by alteration in two variables: planned sales amount and product sales price. The results of the sensitivity analysis regarding sales income show; 4% increase in sales revenue of the plan, the internal rate of return will increase from 49.6 % to 57%. On the contrary, in the case of a 4% decrease in sales revenue, the internal rate of return of the project will decrease to 42%.

Table (16): Sensitivity Analysis (Percentage of IRR changes caused by sales revenue, fixed assets and operating costs alteration)

Variation (%)	Sales revenue	Increase in fixed assets	Operating costs
-20%	-3%	58%	75%
-4%	42%	51%	55%
0%	49.6%	49.6%	49.6%
4%	57%	48%	43%
20%	81%	43%	12%

8-7-2- Fixed Assets

The change in the fixed assets is due to the fixed costs of the initial investment alterations. The results of the sensitivity analysis according to the fixed costs of the plan have been done and it shows that in case of an unexpected 20% increase in the fixed capital costs of the project, the internal rate of return will decrease from 49.6 % to 43%. Conversely, if there is a 20% reduction in the fixed capital costs, the internal rate of return will increase and reach 58%.

8-7-3- Operating Costs

The operating costs of the plan is one of the crucial items in terms of sensitivity analysis regarding its changes. Therefore, unexpected and possible changes should be investigated.

The change in project operating costs is mainly caused by changes in raw material, supply, human resource and finally changes in other overhead costs of projects. If these parameters change, it can be as a result of the change in the technical coefficients of product production or the change in their purchase price. The sensitivity analysis indicates that in case of a 4% increase in the operating costs, the efficiency rate of the plan will decrease to 43%. On the contrary, if the total operating costs of the project are reduced by 4%, the internal rate of return will increase to 55%. Finally, the results of the sensitivity analysis show that the current project has a very high sensitivity to changes in sales revenue (changes in sales amount or sales price) and more considerations should be taken in this regard.



As you can see, the slope of the IRR change curve is higher relative to the changes in sales revenue compared to other items while the slope of the IRR change curve is lower relative to the changes in fixed assets, which indicates the greater sensitivity of the plan's internal rate of return to sales revenue and its lower sensitivity relative to operating costs and fixed assets.



8-8- Conclusion

The implementation of the project is planned by taking a land with an area of 33 thousand square meters and carrying out construction with an infrastructure of 9600 square meters. The total investment in land and building is estimated at 730.8 billion Rials and the total investment in main and auxiliary equipment is estimated at 4,083.5 billion Rials. The total pre-operation costs are also estimated at 190 billion Rials. It is estimated. Including this, the total fixed capital required is 15 thousand billion Rials and the total working capital required by the plan is 7 thousand billion Rials. The total investment of the project is expected to come from the sources of the company's shareholders.

The project is expected to be sold in 1405 at fixed prices equal to 56,784 billion Rials. This figure will increase in the following years due to the increase in production capacity and will reach a maximum of 107,760billion Rials. The net profit of the plan will be positive in all years. The profit figure in 1405 is estimated to be 10,971 billion. The profit will increase in the following years and will reach a maximum of 17,545 billion Rials. The average annual profit of the mature plan is 14.701 billion Rials and the average profit margin is estimated at 18%.

The internal rate of return (IRR) of the plan is also estimated at 49.6% and the investment return period (PBP) is estimated at a maximum of 1.5 years. Also, the net present value of the project's cash flows (NPV) is positive and, taking into account the expected interest rate of 30%, is equal to 11,348.7 billion Rials.

The liquidity status of the plan and the payment of dividends to the shareholders from the company's funds are also suitable. Therefore, if the assumptions and predictions are fulfilled, the plan under consideration has favorable profitability and according to the financial results obtained, its implementation is recommended. The economic discussions of the plan are summarized as follows.

		,	
Nominal Capacity and Unit of Measurement	Product Name	Title Of the Project with ISIC Code	Title Of the Project
300	Graphite electrode	Graphite electrode (3190412407)	Graphite Electrode Production Plan
Required Human Resource (Person)	Equity Shares (Million Rials)	Total Fixed Capital (Million Rials)	Project Duration
46	7,077,893	15,004,900	30
B/C	Applicant Available Cash (Million Rials)	Net Present Value (NPV) (Million Rials)	IRR (%)
1.1	22,082,793	11,348,709	49.6%
ROI (%)	NPV Ratio / Profitability Index (Rial per Rial invested)	Dynamic Payback Period (Year)	Normal Payback Period (Year)
66	0.64	2.77	1.5
Average Assets Turnover Ratio	Average Net Profit Margin (%)	Average Annual Profit (Million Rials)	Maximum Annual Sales (Million Rials)
214.73	18.0%	14,701,857	107,760,000

Table (17): Summary of Economic Features

8-9- Estimation of currency rate fluctuation during the project implementation

The currency rate at the time of evaluation is included as described in Table (18). In the present plan, it is an important part of the cost of buying foreign equipment and requires foreign currency. Electrode purchase prices are also considered in terms of currency. But the product will be sold mainly in the domestic market. But domestic sales prices adjust very quickly with exchange rate fluctuations. Therefore, exchange rate fluctuations regarding the purchase of foreign equipment will be compensated to a large extent by the income from sales, and exchange rate fluctuations will have the least impact on the evaluation results.

Considering the currency of buying equipment and raw materials, both in the construction phase and in the implementation phase, the following are significant:

- As long as the financing of the project is through foreign currency sources, the number of financial resources required will not change much.

- If the financial resources of fixed and circulating capital are provided through internal sources, the increase in the exchange rate will directly increase the fixed and circulating investment costs and will make it difficult to provide financial resources for the implementation of the plan.

Table (18): Currencies exchange Rate					
Unit of Measurement Unit Price Currency					
Rials	413,204	USD			
Rials 451,531 EURO					
Exchange rate of Central Bank Exchange	e Trading System (ETS) dated 05/25/140	7			

Exchange rate of Central Bank, Exchange Trading System (ETS) dated 05/25/1402



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9) Investment Required, method of fundraising and guarantees 9-1- Foreign Currency Required

The fixed foreign investment is required for the purchase of foreign machinery which is estimated at a total of 30,000,000 euros. It is planned to be paid within two years (30 months according to the completion progress of the project). Other fixed capital costs are in Rials. The working capital required during operation to buy raw graphite electrode is also in foreign currency. The figure related to the purchase of the first year is expected to be 5.4 million euros. ((0) =

Table (19): Foreign (Fixed) Currency Required						
No.	Year	Required Investment				
1	Year 1 (1402)	6,000,000				
2	Year 2	12,000,000				
3	Year 3	12,000,000				
4	Year 4	0				
5	Year 5	0				

9-2- Model Of Partnership and Fundraising

Participation in the present project and its fundraising process is predicted to be in the form of establishing a company inside Iran. The total required investment is predicted through the investor's contribution. Financing through local banks has not been included in the fundraising process.

9-3- Payback Period

The payback period is the period of time when the initial investment of the plan is compensated from the annual cash funds. The payback period (normal) of the plan is estimated to be 1.5 years (equal to 1406) according to the calculations of CAMFAR.



Dynamic Payback Period of the plan is also estimated at 2.77 years.



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10) Incentives, features and benefits of the plan

Some of the financial supports for production companies are loans and bank facilities and tax exemptions which can facilitate the project implementation and provide the favorable condition for investment. In the following, some of these supports will be discussed.

One of the important bank facilities for production units is the long-time repayment period loans up to 70% of fixed capital by the Iran's state banks. This amount can be increased up to 90% for deprived areas if foreign machinery is used. The interest rate of long-term facilities in the industry sector is 23%, which in case of financial prudence, only a part of the interest can be repaid. The repayment period of long-term bank facilities is up to 8 years according to the production plan, the type of technology and the possibility of product exportation.

Another important bank facility is short-term bank loans (6 to 12 months) to use as working capital needed to carry out production processes, which will be provided up to 70% by bank communities. Obtaining short-term facilities to this extent depends on gaining the trust of the operating banks and having an acceptable financial history.

Tax exemption is another incentive for investors to establish factories. To name a few;

- Tax exemption for up to 10 years for implementation in deprived areas
- Tax exemption for up to 4 years for implementation in industrial towns

Investments in the project during implementation is of the investments in developed towns with industrial and mining activities. Since it is located within 30 kilometers of cities with more than 300,000 people, it doesn't have any tax exemption. But if it establishes in another industrial town within a range of more than 30 kilometers from cities with a population of more than 300 thousand people, it can get exempted from Article 132 of the Direct Taxes Law and up to 80% until four years after the date of operation from Article 105 (Direct Taxes Law)5.

So, the effective performance tax rate (annual profit) can be reduced to 4% in the first 4 years, and then it will be considered on the basis of 20%. Obviously; If the project location is in one of the deprived areas, it will be subject to 10 years of 100% exemption.

If the manufactured products (provided that it is in excess of the local market) can be exported to foreign markets, it can be exempted from Article 141 and 100% of the income from exports is exempt from taxes.

Obviously, If the legal personality of the partnership is defined as a public company accepted in the stock exchange market during its operation (in such a way that its shares can be traded with stock brokers), this type of company is subject to Article 143 of the Direct Taxes Law and up to 10% of the company's tax will be exempted.

5 - The exemptions of this article will not include the income of production and mining units located within a radius of 120 kilometers from the center of Tehran and 50 kilometers from the center of Isfahan, 30 kilometers from the centers of provinces and cities with more than 300 thousand people (according to the latest census).



(Attachment Number 2)

Summery Sheet

Project introduction

- 1. Project Title: Graphite Electrode Production Plan
- 2. Sector: Production sub-sector: Industry
- 3. Products/services: Graphite electrode
- 4. Location: Khuzestan, Ahvaz city, Ahvaz Industrial Estate No 5
- 5. Project description:

The implementation of the project is planned by taking a land with an area of 33 thousand square meters and carrying out construction with an infrastructure of 9600 square meters. The total investment in land and building is estimated at 730.8 billion Rials and the total investment in main and auxiliary equipment is estimated at 4,083.5billion Rials. The total pre-operation costs are also estimated at 190 billion Rials. It is estimated. Including this, the total fixed capital required is 15 thousand billion Rials and the total working capital required by the plan is 7 thousand billion Rials. The total investment of the project is expected to come from the sources of the company's shareholders.

The project is expected to be sold in 1405 at fixed prices equal to 56,784 billion Rials. This figure will increase in the following years due to the increase in production capacity and will reach a maximum of 107,760 billion Rials. The net profit of the plan will be positive in all years. The profit figure in 1405 is estimated to be 10,971 billion. The profit will increase in the following years and will reach a maximum of 17,545 billion Rials. The average annual profit of the mature plan is 14,701 billion Rials and the average profit margin is estimated at 18%.

The internal rate of return (IRR) of the plan is also estimated at 49.6% and the investment return period (PBP) is estimated at a maximum of 1.5 years. Also, the net present value of the project's cash flows (NPV) is positive and, taking into account the expected interest rate of 30%, is equal to 11,348.7 billion Rials.

6. Annual Capacity: 50,000 ton

Project Status

7. Local/internal raw material access: 0.06%

- 8. Sales: 81,120,000 (Million Rials)
 - Anticipated local market: 100%
- Anticipated export market: 0%
- 9. construction period: 30 months
- 10. project status:
- Feasibility study available?

Yes. The feasibility of the project has been evaluated from different aspects and the results of the feasibility study are favorable in terms of market, engineering, financial and economic indicators.

Required land provided?

Yes. Currently, there is industrial land in Ahvaz Industrial Town 5, and it has been selected based on geospatial criteria for the implementation of the project.

Legal permission (establishment license, foreign currency quota, environment) taken?

Yes. It is possible to obtain legal permits for this plan. In order to settle in the industrial town, the project must obtain legal permits from the organization of industry, mining, trade and environment of Ahvaz city.
Partnership agreement concluded with local/foreign investor?

So far, no partnership agreement has been prepared for the implementation of the project. This plan has the necessary features to attract shareholders' financial resources.

Agreement with local/foreign contractor(s) concluded?

So far, no agreement or contract has been concluded for the purpose of manufacturing domestic and foreign machinery.

Infrastructural utilities procured?

If the project is established in industrial towns (such as Ahvaz Industrial Town 5), infrastructure facilities such as water and electricity, roads, etc. are available.

List of know-how, machinery and equipment concluded?

Technical knowledge of graphite making, technical knowledge of machining large products at high speed, technical knowledge of machining hard products.

Financing agreement for machinery, equipment and know-how concluded? No

Graphite Electrode Production Plan



Financial structure 11. **Financial table:** Local Currency Required Foreign Total Description Currency Exchange Million Rial Euro Euro Required Rate 33,231,16 30,000,000 Total Fixed Investment Costs 1,458,970 451,531 3,231,162 2 15,675,32 Total Net Working Capital Requirements 7,077,893 451,531 15,675,321 0 1 48,906,48 8,536,863 18,906,483 30,000,000 **Total Investment** _ 3 Value Of Foreign Equipment/Machinery: 30,000,000 Euro Value Of Local Equipment/Machinery: 3,231,162 Euro Value Of Foreign Technical Know-How: 0 Euro Value Of Local Technical Know-How: 0 Euro Net present values discounted Net Present Value (NPV): 12/1402 25,133,842 Euro to: Internal Rate of Return (IRR): 49.6% % Normal Payback: 1.5 Year equivalent to 18 months Minimum Attractive Rate of Return: 30% % **General information** new Project 🔽 Explanation / Rehabilitation project 12. Project Type: Name / Company name: -Address: Khuzestan, Ahvaz city, Ahvaz Industrial Estate No 5 Tel: +98 916 3418900 +98 06134451004 Fax: Email: mh_rahimzade@yahoo.com Website: ⊻ Local entrepreneur: Private Sector

government /public sector

