

**Pre-Feasibility Study for**

**Solar Panel Production Plan**



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**Abstract:**

Solar panels are built from semiconductor compositions, which convert solar energy to electrical energy. These panels are known as photovoltaic or solar panels. These are employed to generate electricity.

Solar cells are based on crystal silicon, which has two types, including nanocrystal photovoltaic panels, and polycrystalline photovoltaic panels. Thin layer photovoltaic panels technology is a method to produce solar cells. During this process, one or more thin layers of photovoltaic material are laid on a platform.

The required land area is 7,000 square meters. The required electricity power is 480 kW annually, the water required is 84000 cubic meters annually and the fuel required is 210.000 Liters of gas oil annually. The project is expected to employ 33 people.

**Product Introduction:**

Solar panels are made of semiconductor components, which have the responsibly of converting the sun's luminous energy into electrical energy. These panels are known as PhotoVoltaic or Solar plates.

Photovoltaic panels are technologically divided into three categories.

1- Photovoltaic Polycrystalline Panels

2- Photovoltaic Monocrystalline Panels

3- Thin-Film Photovoltaic Panels

In general, solar photovoltaic panels are commercially produced today, and they can be divided as mentioned below:

**A) Crystalline silicon solar cells**

1- Photovoltaic Monocrystalline panels

Monocrystalline solar cells are made from pure crystals. Their integrated color makes it easy to distinguish the panels with this technology from other panels. These panels are made of silicon crystals with rounded corners. This feature also distinguishes them from the other polycrystalline panels in terms of appearance.

Advantages:

• Highest efficiency among panels (about 21%) due to high build quality and high purity of silicon.

• Monocrystalline panels are most effective in space utilization and they need less space to install and that is why they are best suited for places where there is a shortage of space or the price of the land is expensive.

• They have the highest lifespan among the panels, which is why most manufacturers have a warranty of more than 20 years for these types of panels.

• They have better performance and efficiency in low light conditions compared to polycrystalline panels.

2- Photovoltaic Polycrystalline panels

The process of making these types of panels is easier and the final price is lower.

For this reason, this type of panel has a higher sell rate than monocrystalline panels.

Advantages:

The process of producing polycrystalline silicon is easier and less expensive.

• The amount of silicon waste is lower compared to the monocrystalline silicon.

• Polycrystalline solar photovoltaic panels have lower temperature tolerance in comparison with monocrystalline panels; Although this effect is negligible and can be ignored.

**B)** **Thin Film Photovoltaic panels**

To put is simply, the technology of Thin Film Photovoltaic panels is a method for producing solar cells, during which one or more thin layers of photovoltaic material are placed on a substrate. Different variety of thin-film cells can be divided into the following categories based on the photovoltaic material used:

• Amorphous silicon (aSi)

• Cadmium telluride (CdTe)

• Copper Indium Gallium Selenide (CIS / CIGS)

• Organic Photovoltaic Cells (OPC)

Advantages:

• Easy mass production

These panels can be produced at a lower price compared to the crystalline silicon panels.

• The similar exterior structure and the integrated color gives these panels more appeal in urban applications.

Thin-layer modules can be flexibly manufactured, and this feature creates many potential applications.

• High temperature and shade have the least effect on the performance of these panels.

• Due to lower efficiency compared to silicon crystal panels, these panels are used more in places where there is no space shortage problem.

**Cadmium telluride solar panels**

Cadmium telluride photovoltaic panels are the only thin film panels that can be compared with silicon crystal panels because of their higher efficiency than other thin-film panels. And at the same time a significant share in the market of multi-kilowatt renewable electricity systems is allocated to these panels. The yield benefit of cadmium telluride solar photovoltaic panels is 15% in the created commercial samples. Some of the advantages of these panels include, high efficiency compared to the price and minimum effect by the ambient temperature.

**Review of alternative goods, competitors and analysis and its effects on product consumption:**

This product itself is used as a suitable and cost-effective alternative to existing and conventional power generation equipment, and considering the growing trend of its consumption, it can be understood that it is rapidly being replaced as a new, clean and economical technology in order to produce electricity power.

**1-8- Strategic importance of goods in Iran and foreign markets**

Today, political and economic crises and issues such as limited fossil fuel sustainability, environmental concerns, population growth, economic growth and consumption are all global issues that are widely considered by Scientifics to find appropriate solutions to energy problems in The world has been preoccupied with environmental crises in particular. Fossil resource exploiters have realistically realized that today's extraction of fossil reserves will lead to less productivity tomorrow and ultimately depletion of resources in less time. Meanwhile, the use of renewable energy means the use of energy sources that are constantly being replaced in comparison with human longevity, such as solar energy, wind energy, sea wave energy, biomass energy and etc. are one of the best solutions for human beings.

The amount of solar energy radiation is not the same in different parts of the world and it has the highest amount in the Earth's solar belt. Iran has a high potential to take advantage of this God-given gift due to its location in the solar radiation belt. So that in most parts of the country, including South Khorasan province, there are more than 300 effective sunny days.

The figure below shows the average annual solar radiation to different parts of the earth. The amount of solar radiation in different parts of Iran is estimated between 1800 to 2500 kWh per square meter per year, which is higher than the global average. This favorable potential of solar energy in the country has provided a suitable ground for the use of solar equipment.

In Iran, more than 90% of the country's energy consumption is supplied by fossil fuel power plants. These power plants produce approximately 21.3 kg of oxides, carbon and carbon monoxide, and 685 kg of CO2 per HW of diesel power generation. If natural gas fuel is used, these numbers will be reduced to 6.7 and 477 kg. Due to the increase in air and environmental pollution in major cities of the country, investing in expanding the use of renewable energy is one of the national necessities.

The approved plans of the country show a serious determination to increase the capacity of renewable energy power plants with a capacity of 100 or 200 MW to 5,000 MW, during the 5-year plan. In recent years, good protection laws have been passed in the field of solar energy and photovoltaics. Thus, solar electricity generated up to 16 times the average selling price of electricity is purchased from its producers as a 20-year guaranteed contract.

**Supply and demand situation in Iran and foreign markets**

Demand for solar panels is growing worldwide due to their high economic efficiency and clean energy production.

**Nominal capacity of units under construction Solar panel production**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Progress (%)** | **75-99** | **50-74** | **25-49** | **1-24** |
| Nominal  Capacity | 55000 | 564281 | 204000 | 430000 |
| Practical  Capacity | 38500 | 394997 | 142800 | 301000 |

**Review of product import trends over the past five years**

|  |  |
| --- | --- |
| **Year** | **Import** |
| 2015 | 26,913 |
| 2016 | 23,063 |
| 2017 | 12,003 |
| 2018 | 327,940 |
| 2019 | 1,163,505 |

**Review of consumption trends over the past five years**

According to the information obtained, the demand in previous years has been as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Domestic production** | **Import** | **Export** | **Demand** |
| 2015 | 96,000 | 26,913 | 349 | 122,564 |
| 2016 | 176,040 | 23,063 | 0 | 199,103 |
| 2017 | 176,040 | 12,003 | 3,898 | 184,145 |
| 2018 | 4,080,844 | 327,940 | 2,246 | 4,406,538 |
| 2019 | 4,464,884 | 1,163,505 | 0 | 5,628,389 |

**Domestic production of lime forecasting in the next five years**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Description** | **2020** | **2021** | **2022** | **2023** | **2024** |
| Capacity of active units | 4,772,182 | 4,915,491 | 5,183,821 | 5,267,701 | 4,491,834 |
| Capacity of  75%-90% progress units | 1,160,597 | 1,102,567 | 1,047,438 | 995,067 | 1,221,681 |
| Capacity of  50% to74% progress units | 8,195,782 | 9,717,690 | 11,239,599 | 12,761,507 | 6,673,873 |
| Capacity of  25% to 49% progress units | 23,861 | 24,577 | 25,919 | 26,339 | 22,459 |
| Capacity of  1% to 24% progress units | 2,286,864 | 3,724,210 | 5,034,258 | 6,525,079 | 982,818 |
| Total practical domestic supply | 4,772,182 | 4,915,491 | 5,183,821 | 5,267,701 | 4,491,834 |

**Product demand forecasting in the next five years**

In order to forecast the total demand in the coming years, according to the consumption trends in the last five years, the domestic demand has been estimated. Likewise, due to sufficient domestic production, Import of products has been estimated as zero and export of products are expected to increase by 10% annually.

Product demand = (Domestic Demand + Export) – (Domestic Supply + Import)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Product demand forecasting** | | | | | |
| Description | Year | | | | |
| 2020 | 2021 | 2022 | 2023 | 2024 |
| Domestic Supply | 3,211,834 | 3,477,482 | 3,780,529 | 4,069,878 | 4,174,778 |
| Import | 1,221,681 | 1,160,597 | 1,102,567 | 1,047,438 | 995,067 |
| Domestic Demands | 5,009,873 | 6,147,782 | 7,285,690 | 8,423,599 | 9,561,507 |
| Exports | 16,059 | 17,387 | 18,903 | 20,349 | 20,874 |
| Product Demand | 592,418 | 1,527,091 | 2,421,497 | 3,326,631 | 4,412,537 |

**Analysis and determination of the minimum economic capacity**

## **1- project's fixed costs**

|  |  |  |
| --- | --- | --- |
| # | Description | Amount in Million Rials |
| 1 | Land | 490 |
| 2 | Landscaping and Buildings | 36270 |
| 3 | Facilities | 14798 |
| 4 | Vehicles | 3350 |
| 5 | Equipment and machinery | 2729866 |
| 6 | Office and workshop equipment | 970 |
| 7 | Miscellaneous and unforeseen costs (2% above total) | 55714 |
| 8 | Pre-operation costs | 93594 |
|  | Total | 2935052 |

## Equipment and Machinery

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Machinery | Quantity | Currency cost  (Euro) | Total Costs (Million Rials) |
| 1 | Plasma Etching Equipment | 1 | 10340400 | 2481696 |
| 2 | Surface Etching Equipment |
| 3 | Sintering Furnace |
| 4 | Diffusion equipment |
| 5 | PSG Cell Cleaner |
| 6 | Screen Print Equipment |
| 7 | Furnace dryer |
| 8 | PECVD Furnace |
| 9 | Test cell and classification |
| 10 | Other production line equipments |
| 11 | Shipping, customs and installation costs (10%) |  |  | 248170 |
|  | Total |  |  | 2729866 |

## **2- Estimation of project's working expenses**

|  |  |  |
| --- | --- | --- |
| # | Description | Costs in Million Rial |
| 1 | Raw materials | 426840 |
| 2 | Salary | 23220 |
| 3 | Fuel and energy | 5848 |
| 4 | Repair and maintenance | 47594 |
| 5 | depreciation | 78790 |
| 6 | Unforeseen (2% of rows 1 to 4) | 10070 |
|  | Total | 592362 |

## 1-2- Raw materials

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # | Main Raw Materials | Annual Consumption | Unit | Unit Cost  (Million Rials) | Total Costs in Million Rials |
| 1 | Silicone Wafer | 1600 | ton | 255 | 408000 |
| 2 | Ag metallization paste  Ag-Al metallization paste | - |  |  | 12240 |
| 3 | Other consumables | - |  |  | 1000 |
| 4 | Auxiliary materials and packaging | - |  |  | 5600 |
|  | Total | | | | 426840 |

2-2- Salary Estimate

Salaries are estimated for two categories; production and non-production personnel. Benefits, bonuses and employer premiums for non-production and production personnel are 70% and 90% of the annual salary, respectively. The following tables depict the estimated salaries.

## Non-production personnel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Quantity | Monthly Salary (Rial) | Annual Salary (Million Rial) |
| 1 | Project Manager | 1 | 70,000,000 | 840 |
| 2 | Administrative and financial employee | 4 | 30,000,000 | 1440 |
| 3 | Guardian and attendan | 2 | 24,000,000 | 576 |
| 4 | Driver | 1 | 24,000,000 | 288 |
|  | Total | 8 |  | 3144 |
|  | Benefits, bonuses and premiums | | | 2200 |
|  | Total | | | 5344 |

## Production personnel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Quantity | Monthly Salary (Rial) | Annual Salary (Million Rial) |
| 1 | Engineer | 4 | 46,000,000 | 2208 |
| 2 | Skilled worker | 6 | 40,000,000 | 2880 |
| 3 | Simple worker | 15 | 24,000,000 | 4320 |
|  | Total | 25 |  | 9408 |
|  | Benefits, bonuses and premiums | | | 8468 |
|  | Total | | | 17876 |

2-3- Estimating the amount of required energy and water

In a production unit, in addition to the raw materials needed to produce a product, facilities are needed to operate the equipment and machinery. These requirements, also known as utilities, include: electricity, process water, cooling water, and diesel. In this section, the amount of consumption of each of these components is determined in two categories; the process components (required for manufacturing equipment) and the non-process components (utility and general use).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # | Description | Unit | Annual Consumption | Unit Cost (Rial) | Total cost (Million Rials) |
| 1 | Gasoline | Liter | 210,000 | 7.000 | 1470 |
| 2 | Gasoline | Liter | 4,500 | 20.000 | 90 |
| 3 | Electricity | KWh | 2,400,000 | 1,500 | 3600 |
| 4 | Water | Cubic meter | 84,000 | 7,000 | 588 |
| 5 | Viscosine oil | Liter | 3,000 | 20,000 | 60 |
| 6 | Communications | --- | --- | --- | 40 |
|  | Total | | |  | 5,848 |

**3- Estimating project's circulating capital**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rials) |
| 1 | Raw material storing costs | 35570 |
| 2 | Petty cash | 13794 |
| Total | | 49,364 |

**4- Investment Table**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rial) |
| 1 | Fixed investment | 2,935,052 |
| 3 | Circulating capital | 49,364 |
|  | Total | 2,984,416 |

**5- Annual Production Costs**

The total annual production costs are estimated from the sum of fixed and variable costs.

|  |  |
| --- | --- |
| Description | Total cost |
| Raw material | 426,840 |
| Energy and fuel | 5,848 |
| Personnel expenses | 23,220 |
| Annual wear and tear, repair and maintenance costs | 126,384 |
| **Total** | 582,292 |

**6- Sales Forecast**

It is calculated based on the finished product price, taking into account the market price and deduction of overhead expenses. So the selling price of the product is estimated as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Amount (ton) | Unit Value  (Rial) | Total costs (Million Rial) |
| 1 | Solar Cells | 10,000,000 | 1300,000 | 1300000 |
|  | Total | 10,000,000 |  | 1300000 |

**7- Plan’s Financial Indicators**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Special profit and loss | The rate of return on investment | The period of return on investment | Per capita fixed investment | Per capita total investment |
| 506144 | 0.29 | 3.50 | 52202 | 53698 |

**8- Profit and Loss Calculation Table**

\* All figures are in million rials

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Profit and Loss Forecast Table | | | | | |
| Description | 1st year | 2nd year | 3rd year | 4th year | 5th year |
| Production Amount | 14000000 | 16000000 | 18000000 | 20000000 | 20000000 |
| net sales | 910000 | 1040000 | 1170000 | 1300000 | 1300000 |
| Production Costs | | | | | |
| Raw material | 298788 | 341472 | 384156 | 426840 | 426840 |
| Production staff salaries | 12512 | 14300 | 16088 | 17876 | 17876 |
| Energy Consumption | 4094 | 4678 | 5264 | 5848 | 5848 |
| Maintenance | 33316 | 38074 | 42834 | 47594 | 47594 |
| Unexpected | 7050 | 8056 | 9064 | 10070 | 10070 |
| Wear and Tear | 55154 | 63032 | 70912 | 78790 | 78790 |
| Total production costs | 410912 | 469614 | 528316 | 587018 | 587018 |
| The finished price of the sold product | 410872 | 469574 | 528276 | 586978 | 586978 |
| Gross profit | 499128 | 570426 | 641724 | 713022 | 713022 |
| Operation Costs | | | | | |
| Office staff salaries | 5344 | 5344 | 5344 | 5344 | 5344 |
| Administrative and sales costs | 9100 | 10400 | 11700 | 13000 | 13000 |
| Total operating costs | 14444 | 15744 | 17044 | 18344 | 18344 |
| Operating Profit | 484684 | 554682 | 624680 | 694678 | 694678 |
| Non-operation Costs | | | | | |
| Depreciation before operation | 18718 | 18718 | 18718 | 18718 | 18718 |
| Fixed asset insurance | 3446 | 3446 | 3446 | 3446 | 3446 |
| Total non-operating costs | 188534 | 188534 | 188534 | 188534 | 188534 |
| Pre-tax profits | 296150 | 366148 | 436146 | 506144 | 506144 |
| Special Profit | 296150 | 366148 | 436146 | 506144 | 506144 |
| Yearly profit | 0 | 296150 | 662298 | 1098446 | 1604590 |
| Unprofitable to sell | 0.76 | 1.1 | 1.1 | 1.1 | 1.1 |
| Special Profit to Sell | 0.46 | 0.7 | 0.74 | 0.78 | 0.78 |

**Pre-Feasibility Summary**

|  |
| --- |
| **General Specification** |
| Project Name: Production of solar panel |
| Project Capacity: 10,000,000 thin film types |
| Number of Personnel: 33 |
| Working Days: 300 |
| Product Usage: making electricity |
| Technical Study |
| Land Area: 7,000 square meters |
| Building Area: 2350 square meters |
| Main Raw Materials: Silicone Wafers- Ag-Al metallization paste |
| Supplying Method of Raw Materials: internal resources |
| Power Requirement: 2400,000 kwh annually |
| Water Requirement: 84,000 cubic meters annually |
| Fuel Requirement: 210,000 liters of diesel per year |
| Economical & Financial Study |
| Fixed Investment Cos: 2,935,052 million rials |
| Working Capital: 49364 million rials |
| Total Investment: 1492208 million rials |
| Annual Sale: 1300,000million rials |
| Net Present Value(NPV): 451294 million rials |
| Break Even Point(BEP): 35% |
| Internal Rate of Return(IRR): 29% |
| Investment Return Period: 3.50 years |