

# Prospects of solar energy development in



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Prospects of Solar Energy Development in Pakistan Project Advisor Mr.

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In the name of ALLAH, The Compassionate, The Merciful Peace and prayer be

upon His last Prophet and Messenger DEDICATED TO OUR PARENTS FOR

THEIR LOVE AND SUPPORT PREFACE This report spreads over on 20 pages

which explain the current energy crises of Pakistan and need for solar energy

development as the main source of revenue and electricity production in the

country. This shows tremendous potential in this field as for as production of

electricity is concern and expected extra ordinary profit on the Solar P. V

products. This report covers the vast economic opportunities available for

development in this sector under the government's investor friendly

incentives which include personal and financial security, tax free

environment for promotion of Solar energy and availability of raw materials

at the most affordable and cheap rate. The report clearly, vividly, and

unambiguously indicates the potential available in Pakistan than any other

economic sector of the country. Authors Acknowledgements This is not the

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## INSTALLATION / OPERATION OF SOLAR PV MANUFACTURING & POWER PLANT

IN PAKISTAN 1. SUMMARY Pakistan is an oil importing country and its economy suffers the most by the oil prices inflict. Majority of its power generation is thermal with furnace oil, high-speed diesel and natural gas as fuel; coal is almost nonexistent. Because of fast growing economy and population the demand of energy is rapidly increasing. The electricity generation capacity in Pakistan is over 20, 000 MW. This is not enough to meet our electricity demand. According to GOP estimates the generation capacity needs to grow by 50% by 2010 in order to meet the expected

demand. Pakistan is endowed with various renewable energy resources such as hydel, solar, wind, geothermal and bio-fuel. It can earn dividends if these resources are explored, exploited and developed properly. The use of solar energy either by manufacturing of PV modules or by installation of solar PV Power Plant will be beneficial for the investor and the country. Pakistan lies in an area of one of the highest solar insolation in the world. The average solar radiation is 5.5 KW/m<sup>2</sup> and there are more than 300 clear days. The solar potential is estimated over 2900,000 MW. The minimum profit of \$1/watt can be earned by manufacturing and selling of PV modules. Raw materials, man power and infrastructure are available for the aforesaid production. As the conventional resources are becoming scarce and expensive, the solar PV power plant will be one of the best options to produce electricity on reasonable tariff. Significant Government support and incentives are available for establishment of aforesaid projects.

## 2. CURRENT ENERGY SITUATION

A profile of Pakistan primary energy resources shows its dependence on conventional energy resources. Its share in energy supply mix is highly dependent on oil, liquid petroleum and natural gas. The primary commercial energy supplies during 2007-2008 were 62.9 million tons of oil equivalents (MTOE). The share of natural gas in primary energy supplies during 2007-2008 was 47.5% followed by oil 30.5%, hydro electricity 10.9%, coal 9.2%, nuclear electricity 1.2%, LPG 0.7%, and imported electricity 0.1%. Fig. 1 shows primary energy supplies by source of year 2005. Natural gas production during 2007-2008 was 3,973 million cubic feet per day and oil production 69,954 barrels per day. During 2007-2008, 27 exploratory and 53 developments wells were drilled mostly of gas/condensate, out of which 5 were by Oil & Gas Development Corporation Limited (OGDCL) and 6 by other

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companies. Coal production increased by 13% in 2007-2008 over the previous year due to multifold increased production from Barkhan Coal field in Balochistan. The consumption of coal in power generation increased by 1.3% from 164,397 tons in 2006-07 to 162,200 tons in 2007-08 and the electricity generation during 2007-20 was 95,860 Gwh (including 199 Gwh of electricity imported from Iran). The generation included 66.5% thermal, 30.0% hydel, 3.2% nuclear and 0.2% imported. Presently, the electricity generation capacity in Pakistan is over 20,000 MW. This is not enough to meet our electricity demands and with an average increase of around 1000 MW per year in this demand, the problem will continue to grow. According to Government of Pakistan's estimates, the generating capacity needs to grow by 50% by 2010 in order to meet the expected demand. The high dependence on oil import has a huge negative impact on economy and energy security of the country. The natural gas reserves are not in great position either with proven reserves of 28.62 trillion cubic feet (TCF). At this production level Pakistan's reserves would finish in 24 years. The measured coal reserves are in large quantity (3,303 million tons). However, currently coal is not playing a noticeable role in Pakistan's energy mix. [pic] Figure 1

**3. ELECTRICITY CRISIS OF PAKISTAN** The latest and perhaps the most troublesome crisis faced by the Pakistani nation these days is the shortage in supply of electricity. The country is facing a huge electric power crisis these days. Though it has been more than a year since when the country is facing this crisis, but till now no proper solution has been made to this problem neither any proper planning has come into existence since the symptoms and beginning of this short supply of electricity. While rolling blackouts or load shedding as it is locally known has always been a staple of daily life in

Pakistan, the problem has become acute in the last couple of years. This crisis appears insurmountable in the near or even long-term future, unless proper understanding and correct implementation is undertaken on priority basis. At present total power production capacity in the country is about 19,500 MW, out of which hydel Power is only 6,500 MW, balance of 13,000 MW is thermal either using Natural Gas or Furnace Oil. Small capacity of 450 MW is Nuclear and only 150 MW is through coal. It is very important to understand the consequence of the prevailing situation. Current price of furnace oil is about Rs. 49,000 per ton, which amounts up to Rs. 49/- per kg. On an average, one kg of furnace oil produces 3.8 kWh of electricity. Thus, the cost of furnace oil for generating one unit of electricity is about Rs. 13. On top of this the fixed cost of a thermal plant works out to be about Rs. 3 per unit. Therefore, one unit (kWh) of the electricity produced by all thermal plants using furnace oil is Rs. 16 per unit. According to WAPDA/IPP agreement, the private power producers will charge WAPDA the actual fuel cost for which they have a direct contract with PSO. As we all know that WAPDA tariff charged from the consumers is about Rs. 5 per unit (kWh). The production cost of furnace oil electricity is Rs. 16 per unit, add to it the transmission, distribution cost (including losses), " the total cost of such electricity works out to approximately Rs. 22 per kWh. The difference between WAPDA tariff and the furnace oil electricity is Rs. 17 per kWh. " It is estimated that the country consumes at least 25 billion units of electricity produced annually through furnace oil, which amounts to the total deficit of Rs. 425 Billion. If WAPDA has to balance its books it would require a subsidy of Rs. 425 Billion. This deficit is somewhat reduced due to cheap power produced through hydel energy and natural gas, but the deficit cannot

change substantially, unless bulk of electricity is produced through hydel energy. Obviously, a deficit of Rs. 300-350 Billion cannot be sustained, the government does not have resources to pay such a huge subsidy, and it is also not feasible to increase the power tariff very much. Therefore the power crisis is far greater than what is being perceived. In the absence of extremely heavy subsidy, WAPDA is delaying payments to IPPs and also to the oil companies. The result is that IPPs are now producing much less electricity than their capacity. In this scenario renewable energy like solar is required with relatively less cost and long term benefits.

#### 4. WHY USE SOLAR POWER?

4. 1 REDUCED DEPENDENCE ON FOSSIL FUELS Solar energy production does not require fossil fuels and is therefore less dependent on this limited and expensive natural resource. Although there is variability in the amount and timing of sunlight over the day, season and year, a properly sized and

configured system can be designed to be highly reliable while providing long-term, fixed price electricity supply.

4. 2 ENVIRONMENTAL ADVANTAGES Solar power production generates electricity with a limited impact on the environment as compared to other forms of electricity production.

4. 3

MATCHING PEAK TIME OUTPUT WITH PEAK TIME DEMAND Solar energy can effectively supplement electricity supply from an electricity transmission grid, such as when electricity demand peaks in the summer

4. 4

MODULARITY AND SCALABILITY As the size and generating capacity of a solar system are a function of the number of solar modules installed, applications of solar technology are readily scalable and versatile.

4. 5 FLEXIBLE

LOCATIONS Solar power production facilities can be installed at the customer site which reduces required investments in production and transportation infrastructure.

4. 6 GOVERNMENTS INCENTIVES A growing number of

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countries have established incentive programs for the development of solar and other renewable energy sources, such as (i) net metering laws that allow on-grid end users to sell electricity back to the grid at retail prices, (ii) direct subsidies to end users to offset costs of photovoltaic equipment and installation charges, (iii) low interest loans for financing solar power systems and tax incentives; and (iv) government standards that mandate minimum usage levels of renewable energy sources. Despite the cost, an advantage of photovoltaic systems is that they can be used in remote areas. Anywhere a diesel generator is the technology of choice, many times a photovoltaic system is a much better life-cycle cost option. [pic] Renewable Electrical Energy Potential / Current Installed capacity Stand-alone photovoltaic systems produce power independently of the utility grid. In some off-the-grid locations even one half kilometer from power lines, stand-alone photovoltaic systems can be more cost-effective than extending power lines. They are especially appropriate for remote, environmentally sensitive areas, such as national parks, cabins, and remote homes. The solar power market has grown significantly in the past decade. According to Solar buzz, the global solar power market, as measured by annual solar power system installations, increased from 427 MW in 2002 to 1, 744 MW in 2006, representing a CAGR of 42. 2%, while solar power industry revenues grew to approximately US\$10. 6 billion in 2006. Despite the rapid growth, solar energy constitutes only a small fraction of the world's energy output and therefore may have significant growth potential. Solar buzz projects in one of its forecasts that annual solar power industry revenue could reach US\$31. 5 billion by 2011. Quantum of solar energy reaching Pakistan has 33, 000 million times more potential than its hydropower potential. 5. COST CALCULATION OF SOLAR PV



PANELS Suppose if someone pays \$60 to \$80 every month in his electricity bill. This cost along with the unapprised increase in electricity charges leaves you with little or no saving. On the other hand installation of solar power plant is a onetime expense. For example a single solar panel costs \$1000 to \$1500 only. This is a onetime expense and it includes all the government taxes, rebate and tax credit. Hence it ends up using very cost friendly package because now we are able to enjoy the long term benefits of deploying solar power system. If we analyze the cost associated with the efficacy of solar collectors and solar panels, it is amazing. An average photovoltaic panel has an estimated energy conversion of about 20 to 25%. hence if any panel receives unobstructed sunlight for constant three hours on 1 square meter is about \$0. 05%, therefore it is much lower as compared to use of other biofuels. Here it should also be noted that heat consumption efficiency for solar water heaters is same as the efficacy for oil. Whereas the cost of oil is \$2 per gallon while of sun it is only \$0. 14. Furthermore the life of solar panel system is 25years +. 6. FUTURE OF SOLAR ENERGY 6. 1

LEVELIZED COSTS " The present-day average cost per kWh produced by the turbine / plant over its entire lifetime, including all costs (investments, reinvestments and operation and maintenance costs). The levelized costs are calculated using the discount rate and the turbine / plant lifetime. " 6. 2

ERNST & YOUNG ANALYSIS Ernst & Young analysis suggests Price of solar panels to drop significantly by 2013. To compare the relative cost of solar — usually described in terms of the dollar price of each watt of peak capacity — and other energy sources, analysts consider factors such as upfront expenditure, fuel prices, maintenance and discount rates to calculate the " levelized" cost of each unit of energy. The report predicts that, with

continued support in the short term, the levelized cost of large-scale solar will be no higher than retail energy prices by 2016-19. This suggests that within 10 years companies with large electricity demands will find it cheaper to install unsubsidized solar than to buy energy via the grid in the traditional way.

#### 7. IMPLEMENTATION OF SOLAR PV IN OTHER COUNTRIES

Many developed and under developed countries like America, Germany, Iran, China and India are utilizing Solar PV projects to meet the future demand of energy. The region of Navarra, Spain, is generating 70 per cent of its electricity through solar and wind energy. This region does not have any coal, gas or oil of its own. It's really a classic example of making the best use of renewable energy in any country of the world! But, the question that automatically crops up in one's mind is: If it can be done in Spain, why can't be done in our country? The answer is, (a big yes) absence of will only.

#### 8. DEVELOPMENT AND UTILIZATION OF SOLAR PV ENERGY IN PAKISTAN

**8.1 BACKGROUND** Pakistan lies in an area of one of the highest solar insolation in the world. There are certain regions of south, Quetta valley and Central Punjab that receive maximum solar radiation, the nationwide average, however, have been recorded on daily basis as 5.5 KW/m<sup>2</sup>. This means that there is a vast potential for converting the untapped solar energy source for useful means. This potential can be exploited to produce electricity, which can be provided to off grid communities in the northern hilly areas and the southern and western deserts. According to the Pakistan Energy Book 2004-05, solar energy falling on 0.25% Baluchistan province would be adequate to meet the current requirement of the country with 20% efficient devices.

Solar panels in different powers and sizes are available in the local market, which are imported from America, Europe, China and also being fabricated in

the factory near Hattar (Only Modules are produced from imported solar cells) on a small scale and National Institute of Silicon Technology (NIST). A practical example of the use of solar energy could be seen in some villages of Pakistan where each house has been provided with a solar panel, sufficient to run an electric fan and two energy saving bulbs. Prior to this arrangement, the whole village used to be plunged in pitch dark during night. One such example is the village with the name of Narian Khorian, some 50 kilometers away from Islamabad, where 100 solar panels have been installed by a local firm, free of cost, to promote the use of solar energy among the masses. Through these panels, the residents of 100 households are enjoying light and fan facilities. Had these panels not been installed, the people living in this area wouldn't have even dreamt of getting this facility for decades as the provision of electricity from the national grid was a far cry due to the difficult terrain and high expenses involved. [pic] Solar panels are being used for providing electricity to extract water and drip irrigation system in Nagr Parker

## 8. 2 SOLAR ENERGY

There are two main techniques of power generation through solar radiation; one is Solar PV Technology and other is concentrated solar power technology (CSP). The PV is the best suited for stand-alone power requirement of homes and offices. Although the world has experienced off-grid connected solar PV power plants; still it is a kind of domestic business. On the contrary, the CSP technology is best suited for grid-connected power plants.

### 8. 2. 1 SOLAR PV CELLS

They convert solar energy in to electricity that is used to charge batteries to provide lights during night. Many solar cells combine together to form solar module and many modules combine to form solar array. [pic] [pic] Solar Cell Many Solar modules combine to form array

Solar energy has excellent potential in

Pakistan that receives high levels of solar radiation throughout the year.

Solar Energy is available at a rate of 1000 watts per square meter in Pakistan. This can be converted to DC electricity with the help of Solar Photovoltaic cells, which may be used to pump water, operate fans, TV and telecommunications directly during daytime. The electrical energy generated during the day time (5-8 hours of sunshine), can also be stored in deep cycle lead acid batteries which can be used at night to provide power for lighting, radio, Television and fans. The system will be user-friendly and designed as a stand-alone system for each household, who will be trained to operate and maintain it. The user will only be required to switch on/off the system, as is done in normal home lighting systems. In addition, Solar Photovoltaic Panels can generate enough electricity to pump water from depth of 350 ft, 700 ft and up to 1000 ft.

9. RESOURCE POTENTIAL OF SOLAR PHOTOVOLTAIC

Solar energy is a potentially available renewable energy source in this region. This source can be utilized as an excellent alternative to fossil fuels for these areas. Pakistan covers 796, 095 square kilometers of land between latitudes 24° and 36° north and longitudes 61° and 76° east. At present, it faces serious energy problems: 95 per cent of its electricity generation comes from hydropower, which becomes less productive during the driest, hottest months of the year and cannot keep pace with the sharp rise in energy demand. Also, about 70 per cent of the population lives in some 50, 000 villages dispersed around the country. Many of these villages are far from the main transmission lines of the national grid and, because of their relatively small populations; it is usually not economically viable to connect these villages to the grid. Solar energy, on the other hand, has excellent potential in areas of Pakistan that receive high levels of solar radiation

throughout the year. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy. The solar module / panel are selling for about \$6-7 per watt in limited stocks in Pakistani market with average life of 10-15 years. In one panel, approximately, 72 or more solar cells are used, depending upon the power required and the electric gadgets to run utilizing these panels. Each solar cell is costly, if imported from abroad, with more power rating. These cells would be required in millions or may be in billions if requirement of the complete country is to be met. We cannot import such a huge quantity of solar cells from other countries due to financial constraints and high prices. So, naturally, there would be no other option but to resort to manufacturing these cells in our own country. Hence huge Investment is required to manufacture solar cells in Pakistan, as it has great potential in local and international market. Then three basic requirements i. e. raw material, trained manpower and necessary infrastructure are required by the investor on reasonable rates.

9. 1 RAW MATERIAL The basic raw material (quartz) is available in abundance in the northern areas of Pakistan. This raw material can be made useful after purification and development to a stage where this raw material could be converted into solar cells (PV manufacturing plant). This equipment will have to be imported; but it would be a one-time investment. One would be surprised to know that this raw material is being utilized by the local population of Northern areas for raising the walls of their houses in place of bricks as the poor simpletons don't know its value. The other raw material required to manufacture solar cells is silica (sand) which is available in inexhaustible quantity in River Sindh as water these days is otherwise in less quantity in our rivers. At least we should make use of silica

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in the manufacture of solar cells. So, to venture into manufacturing of solar panels, both the raw materials are available in abundance free of cost. In a solar system, apart from solar panels (which include solar cells), tempered glass sheets, batteries and inverters (to convert DC electricity into AC) are also used. We have innumerable factories producing good batteries and inverters in our country; so this is also available. Regarding tempered glass, we have many glass manufacturing factories in Pakistan. In this case as well, we can augment their existing facilities to produce tempered glass of required specifications. Tempered glass is after all glass and nothing else. Required machinery could be imported and installed in our existing glass manufacturing factories (on partnership basis). There is no need to set up separate, dedicated factories for each item. This raw material will be available from these factories on economical prices.

9. 2 MAN POWER The other requirement is that of manpower. We have the finest and the most hard-working, skilled manpower available in our country. From my personal experience, I could say with conviction that the retired personnel of the defense services who have been working on electronics and telecommunication equipment during their service careers would be the best choice for deployment on the manufacture of solar panels and cells. These people are highly skilled and disciplined and get retired at an early age. Fauji & Shaheen Foundations, maintain an up-to-date computerized record of such personnel who are just on a telephone call away. The expertise of such workers is not less than any worker deployed in the western countries for such jobs. The only difference is that a European worker of such caliber gets US \$ 45 per hour whereas a Pakistani worker, if he is paid \$5 per hour (or even less) in his own country would be the happiest man around.

9. 3

INFRASTRUCTURE Availability of infrastructure for setting up manufacturing facilities would be aided by (Alternative Energy Development Board) AEDB Pakistan.

10. SOLAR PV VALUE CHAIN The solar PV value chain consists of a number of specific and distinct steps from the production of silicon to the end use in solar power plants or in solar panels used for distributed power generation (e. g. solar panels on residence rooftops). Range of business opportunities available along the entire value chain is as flashed. A detailed value chain of entire solar PV industry is also flashed. [pic] Solar PV value chain

10. 1 VALUE CHAIN & KEY INDUSTRY SEGMENTS The solar PV industry value chain comprises a number of sub-segments. It might be useful if they could spend time to analyze the niche areas that are underdeveloped and under serviced where solar PV could be applied. For instance, in Pakistan, following are some of the segments underserved by the current electricity grid and hence could make excellent markets in the context of the solar PV industry:

1. Villages that have no grid connectivity
2. Companies that use diesel generator sets as a power backup
3. Mobile telecom towers in many parts of Pakistan that have little access to the utility grid, and other stand alone commercial and industrial ventures.

The PV technology can be used as both for manufacturing and sale, and for production of electricity and then its sale into grid.

10. 2 BASICS OF MODULES - TECHNOLOGY INVOLVED IN MAKING OF PV MODULES Solar PV modules can be produced using different technologies. Today, crystalline silicon technology leads the Solar PV module production, followed by thin films. There are also other technologies being developed, but crystalline silicon technology and thin film technology will continue to dominate the solar PV module space for the foreseeable future, unless some technology breakthrough happens. As mentioned in earlier

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sections, since thin-films are very nascent,. The important equipments used for the production are discussed subsequently. Once a module is produced, it is important to test and certify them before they can be sold to customers.

Table 2. 1: Comparison Table between Thin Film, Monocrystalline and Polycrystalline Solar Cells | Properties | Thin film solar cells | Monocrystalline cells | Polycrystalline solar cell | | Construction | Thin film is made by depositing one| Monocrystalline cells are cut from a | A polycrystalline cell is cut from | | | or more thin layers (thin film) of | chunk of silicon that has been grown | multifaceted silicon crystal. | | | photovoltaic material on a | from a single crystal. | | | substrate. | | | Cost (As of January 2011) |\$1. 37 per watt (€1. 03 per watt) |\$2. 07 per watt (€1. 55 per watt) |\$1. 95 per watt (€1. 46 per watt) | | Area (Avg. output per per | 0. 623 MW | 0. 98-1MW | 0. 91MW | | 1000 sq. m) | | | | Stability | Less stable | Very good stability | Good stability and better than thin | | | | film solar. | Source: Compiled from various sources

10. 2. 1 GLOBAL DEMAND AND SUPPLY According to the market research firm iSuppli, the Global Solar module capacity is projected to increase by 100% from its 2009 levels by the year 2013. 10. 2. 2

#### INVESTMENT AND RETURNS OF SOLAR PV MODULE MANUFACTURING PLANT

Solar PV Module assembly is one of the preferred routes for a newcomer to the industry. This is because the capital cost per MW for setting up a module assembly plant is relatively low compared to cell manufacturing or wafer production. This section deals with the Costs and Returns. There are two main types of assembly lines — Semi-automated and Fully automated lines. The thumb rule is that if the planned capacity of the plant is more than 50 MW per year a fully automated line is preferred else, a semi-automated line is preferred. However, there are cases where some plants start with a fully



automated line even with a capacity of about 25 MW. Additionally, the decision on selecting the level of automation should also reflect on future expansion plans. It is fairly easy to scale up the capacity if the initial decision incorporates the future expansion. Even though it is possible to start a production facility of as low as 5 MW per annum, it is advisable to start with at least a production capacity of about 10 MW per annum. Depending upon the level of automation, the minimum cost of investment can be about \$110,000/ MW (excluding land). For 10 MW plant cost would be \$110,000 (PKR 9.8 crore) and minimum profit per annum would be \$ 10000000 (\$1/W) 10. 2. 3 LAND REQUIREMENT A 25 MW plant requires approximately 1200 square meters. One of the possible configurations is a line that has the dimensions 60 Meters X 20 Meters. In addition to the production floor, a warehouse for storing the raw materials, semi-finished/finished goods is required and the area for the warehouse would be about 1000 square meters. The office space would require approximately another 300 square meters. The difference between the land requirement for a semi-automated plant and a fully automated plant is not very significant. 10. 3 FORMATION OF SOLAR PV POWER PLANT BY INVESTOR 10. 3. 1 CAPITAL COST OF SOLAR POWER PLANT Solar PV has one of the highest capital costs of all renewable energy sources, but it has relatively low operational costs, owing to the low maintenance and repair needs. For a solar PV power plant, the approximate capital cost per MW is approximately 7million — the precise cost depends on scale. This includes the cost of panels, the balance of systems, the cost of land and other support infrastructures. with about 50% of it going towards solar panels, 25% towards inverters and balance of systems, and final 25% towards installation and other infrastructure. This is to set up a 10 MW Solar

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PV Power Plant. We assume that PV modules will be purchased at a cost of \$6 /Watt. So for 10 MW plant the cost of PV modules would be \$ 60 million. The other cost would be \$9. 06 million dollars. The cost of land is not included in this estimation being so low and has minimum effect as compared to other cost. Therefore, as far as an investor is concerned, the cost of installing a 10 MW PV Power plant will be 69. 06 million US\$. In contrast, the Kalabagh Dam power plant, which has been abandoned for the present, was planned to have a generation capacity of 2400 MW. It was going to cost around 6 billion dollars. The construction cost per watt of electricity generation capacity would therefore have been around \$2. 5/ W. The cost of the 300 MW Chashma Nuclear Power Plant was 1. 033 billion US dollars. For it, therefore, the capital cost was about 3. 44\$ per watt of the Installation capacity.

Sr . No	Break-Up for the Capital Expenses	Amount (\$ US DOLLARS)	Per 10 MW Component
1	PV modules	60 million	
2	Inverter , Balance of System (transformers, cables and wires, tracking devices...), Installation (civil & general works), Evacuation and other pre operative expenses	9. 06 million	
	Total	69. 06 million	10. 3. 2

**AREA REQUIREMENT** The area requirement for a 1 MW power plant that uses crystalline silicon technology would be approximately 5 acres. The installation of a PV cell power plant of 10 MW capacities would require a total of 100, 000 PV panels of 100 watts each for which the required total area of PV panels would be about a quarter of a square kilometer. This gives an idea of the size of the power plant.

**10. 3. 3 FIXED SALE PRICE RESULTS** Total annual revenues from this generation would depend upon the agreed tariff for the purchase of power by the distributor. The state electric power technology distribution utility WAPDA (Water and Power Development

Authority) currently purchases electricity from independent power producers at an average rate of 5 Cents (Rs. 4. 00) per unit (kWh), so total value of electricity produced by the 10 MW PV cell plant in a year would be; Annual = 33  $\times$  106 kWh  $\times$  . 05 \$/ kWh = US\$ 1. 65 million / annum The lifetime of a solar PV plant is very large compared to that of other electricity production sources. Its life time is of 30 years | Quantity Calculated Value Amount in US dollars | | Discount Value of the Investment 69. 06 million US dollars | | Discounted Operation and Maintenance Cost 1. 82 million US dollars | | Discounted Depreciation Cost 21. 9 million US dollars | | Discounted Replacement Cost 22. 88 million US dollars | | Salvage Value 14. 43 million US dollars | | Cost of Production of a Unit of Electricity 9. 03 cents/kWh | | Sale Price of a Unit of Electricity 10. 83 cents/kWh | | Total Discounted Revenue Over 30 Years 119. 39 million US dollars | | Net present Value 13. 92 million US dollars | | Payback Period 19. 5 years | Summary of the Calculated Quantities for a 10 MW Photovoltaic Electricity Generation Plant

10. 3. 4 PROFIT The levelized cost of electricity production from solar PV is 10. 83 cents /kWh according to MNRE, the cost of power generation from solar PV is likely to be competitive with grid tariff by 2017. 10. 3. 5

REDUCTION IN SALE PRICE UNIT OF ELECTRICITY The dependence on investment cost should be the most sensitive factor in determining the generation cost, and hence the sale price of energy, the tariff. The current installation cost of US\$7 to a watt translates in the analysis of this study to an electricity generation cost of 9. 03 cents a kWh, Independent power producers (through renewable energy resource) in Pakistan are currently allowed on the average to charge a tariff of 5 cents a unit on the electricity they sell to WAPDA. In our formulation, the tariff of 5 cents amounts to a

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generation cost of 4.17 cents a unit. It can be achieved through below mentioned way.

10. 3. 5. 1 Indigenous Local Production Indigenization PV cell production can reduce the cost. Importing a set of 1kW PV cell panels and other components costs around Rs 500,000, while at the National Institute of Silicon Technology (NIST), which has a pilot facility of producing crystalline silicon PV cell panels, it costs around Rs 375,000. Furthermore, if PV modules are produced by investor himself then certainly the cost of \$6 / Watt of solar module would be reduced to \$ 3-4 / Watt . By doing this at least 25-30 percent reduction in the capital cost would occur. If the installation cost would come from \$7 a watt to about \$3.35 a watt then sale price of unit of electricity would have been \$ 5 cents/ kWh.

11. MARKET ENTRY Market-support infrastructure is also required. Market-support infrastructure refers to networks of dealers and manufacturer (investor himself), after-sale services and support technologies (COMSATS 2005). This is available; furthermore, export to international markets can also be carried out to earn revenue. Such infrastructure will result in market growth, increased sustainability and further lower renewable energy project costs.

11. 1 USING AN AGENT/DISTRIBUTOR The best way is to appoint local agents to provide market intelligence and to facilitate distribution. These agents typically work on a fixed commission; other agents operate as consultants on a retainer ship basis, receiving their fee regardless of the volume of total sales. The same phenomenon will be developed for the PV products in this regard. Moreover, the most common arrangement is the exclusive agency agreement, under which the supplier agrees neither to appoint another dealer/distributor, nor to negotiate sales through another party. Under this arrangement, the agent receives commissions on all sales of the product

regardless of the channels through which the order is placed. Agency agreements typically extend for a term of one to three years and generally require 30 to 90 days notice by either party for termination. Pakistan is a diverse and challenging market requiring adaptability and persistence.

Careful planning and patience are the prerequisites for success in this emerging market.

**12. INCENTIVES FOR PROMOTION OF SOLAR ENERGY BY GOVERNMENT** Government has planned Medium Term Development

Framework (MTDF) to increase the share of renewable energies from zero availability to 9.20 MTOE by 2030. To achieve the objective, government

has proposed an allocation of Rs. 3.0 Billion for the development of

alternative energy (MTDF 2005 – 2010).

**12.1 EXEMPTION OF CUSTOM DUTIES AND TAXES** Exemption of Custom duties and Taxes strictly on import of capital equipment (plant, machinery, equipment and accessories) for development of solar power plants. Corporate Income Tax holiday for a period of five (5) years for Projects in the Zone from the date of starting commercial operations.

**12.2 GENERAL INCENTIVES FOR RE POWER**

**GENERATORS** The provisions stated below shall be made available to all

qualifying renewable Energy-based power projects falling in any of the

following categories - Independent power projects (IPPs) based on new plants (for sale of power to the grid only) a. Solicited b. Unsolicited - Captive and

grid spillover power projects (i. e., self-use and sale to utility) - Captive power projects (i. e., for self or dedicated use) - Isolated grid power projects (i. e.,

small, stand-alone) a. Solicited b. Unsolicited.

**12.3 GUARANTEED MARKET: MANDATORY PURCHASE OF ELECTRICITY** It shall be mandatory for the power

distribution utilities to buy all the electricity offered to them by RE projects established in accordance with the provisions given in Section 12.4

**12.4** <https://assignbuster.com/prospects-of-solar-energy-development-in/>

GRID CONNECTION, OFF-TAKE VOLTAGE AND INTERFACE Electricity shall be purchased from RE power producers at a voltage of 220 kV at the outgoing bus bar of the power station if the power station is located within 70 km of an existing 220 kV transmission line, or at 132 kV if it is within 50 km of an existing 132 kV transmission line, or at 11 kV if it is within 5 km of an existing 11 kV transmission line, or at 400 V if it is within 1 km of a 400 V distribution feeder. The minimum average power to be supplied in each case would be 1, 250 kW/km, 250 kW/km, 100 kW/km, and 20 kW/km, respectively. The producer may also undertake to lay a new transmission line for connection with the main electricity grid. The power purchase tariff determination will be adjusted accordingly for each of these options.

12. 5 WHEELING RE power producers shall also be allowed to enter into direct (bilateral) sales contracts with end-use customers. Under this arrangement, they would be allowed to sell all or a part of the power generated by them or products to their direct customers and the rest to the utility for general distribution. For direct sales, they shall be required to pay ‘ wheeling’ charges for the use of the transmission and/or distribution grid network used to transport the power from the plant to the purchaser. In practical terms, the IPP shall inject electricity into the grid system at one point (subject to the provisions in Section 12. 4) and would be entitled to receive the same amount at any other location (within the same distance from the grid as the distance of the plant from the system) upon payment of a corresponding wheeling charge, to be determined by NEPRA. This wheeling charge will reflect the cost of providing and maintaining the transmission interconnection, including the energy losses suffered en route, calculated on a utility-wide basis by NEPRA.

12. 6 SPECIFIC INCENTIVES FOR GRID-

CONNECTED RE IPPS Specific incentives are provided under this policy to renewable energy based Independent power producers (IPPs) selling all generated electricity (minus auxiliary consumption) to the grid. The underlying principle is that IPPs based on variable RE resources (such as solar, wind and water flows) shall be made immune to factors which are beyond their control and at the same time shall be rewarded if they perform better than reasonably expected.

### 12. 7 PRODUCTION INCENTIVES

For all power produced above than the benchmark level, a production bonus payment shall be made to the IPP.

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