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THE CALCULATION OF THE EFFICIENCY CRYSTALLINE AND MONO-CRYSTALLINE SILICON SOLAR CELLS IN THE ENVIRONMENTAL CONDITIONS OF LUT DESERT IN IRAN

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Abstract: -

Direct conversion of sunlight into electricity done by photovoltaic the choice of solar cells to generate electricity from solar energy in different regions of the world regarding to environmental and atmospheric conditions of the area should be considered. The diversity of solar cells, the solar cells for each geographical area will help to increase power generation. According to the parameters affecting the efficiency of solar cells as well as the high potential region of the Lut Desert in Iran, to calculate the efficiency of solar cells, Si (crystalline) solar cell and Si (multicrystalline) solar cell in this area will be discussed.

Keywords: - *Efficiency, Si (crystalline) solar cell, Si(multicrystalline) solar cell, Lut desert, Air mass, Global horizontal irradiation*

1.INTRODUCTION

The amount of energy that the Earth receives from the sun is enormous: 1.75 × 1017 W. As the world energy consumption in 2003 amounted to 4.4 × 1020 J, Earth receives enough energy to fulfill the yearly world demand of energy in less than an hour. Not all of that energy reaches the Earth's surface due to absorption and scattering, however, and the photovoltaic conversion of solar energy remains an important challenge.[1] Lut is the world's 25th largest desert. [2] This desert has 360 days of sunshine a year. According to geographical and environmental characteristics of the area and the extent of the desert and the high potential of this region of the solar cell [3]to generate electrical energy for use to calculate the efficiency of solar cells for use in this area will be discussed Iran.

2. Silicon solar cell

Crystalline silicon photovoltaic is the most widely used photovoltaic technology. Crystalline silicon photovoltaics are modules built using crystalline silicon solar cells (c-Si), developed from the microelectronics technology industry. Crystalline silicon solar cells have high efficiency; making crystalline silicon photovoltaic an interesting technology where space is at a premium.
There are two types of crystalline silicon solar cells used in crystalline silicon photovoltaic: [4]

2.1- Mono-crystalline silicon, produced by slicing wafers from a high-purity single crystal ingot [5]
Monocrystalline and Polycrystalline represent the "traditional" technologies for solar panels. They can be grouped into the category "crystalline silicon".
Single Crystal Cell Monocrystalline, or Single Crystal, is the original PV technology invented in 1955, and never known to wear out. Polycrystalline entered the market in 1981. It is similar in performance and reliability. Single crystal modules are composed of cells cut from a piece of continuous crystal. The material forms a cylinder which is sliced into thin circular wafers. To minimize waste, the cells may be fully round or they may be trimmed into other shapes, retaining more or less of the original circle. Because each cell is cut from a single crystal, it has a uniform color which is dark blue.

2.2- Mono-crystalline silicon, made by sawing a cast block of silicon first into bars and then into wafers[6]
Mono-crystalline cells are made from similar silicon material except that instead of being grown into a single crystal, they are melted and poured into a mold. This forms a square block that can be cut into square wafers with less waste of space or material than round single-crystal wafers. As the material cools, it crystallizes in an imperfect manner, forming random crystal boundaries. The efficiency of energy conversion is slightly lower. This merely means that the size of the finished module is slightly greater per watt than most single crystal modules. The cells look different from single crystal cells. The surface has a jumbled look with many variations of blue color. In fact, they are quite beautiful like sheets of gemstone. In addition to the above processes; some companies have developed alternatives such as ribbon growth and growth of crystalline film on glass. Most crystalline silicon technologies yield similar results, with high durability. Twenty-five-year warranties are common for crystalline silicon modules. Single crystal tends to be slightly smaller in size per watt of power output, and slightly more expensive than polycrystalline.

The construction of finished modules from crystalline silicon cells is generally the same, regardless of the technique of crystal growth. The most common construction is by laminating the cells between a tempered glass front and a plastic backing, using a clear adhesive similar to that used in automotive safety glass. It is then framed with aluminium.
The silicon used to produce crystalline modules is derived from sand. It is the second most common element on earth, so why is it so expensive? The answer is that, in order to produce the photovoltaic effect, it must be purified to an extremely high degree. Such pure "semiconductor grade" silicon is very expensive to produce. It is also in high demand in the electronics industry because it is the base material for computer chips and other devices. Crystalline solar cells are about the thickness of a human fingernail. They use a relatively large amount of silicon.
Mono-crystalline silicon solar cells have higher efficiencies than multicrystalline silicon solar cells.
In crystalline silicon photovoltaics, solar cells are generally connected together and then laminated under toughened, high transmittance glass to produce reliable, weather resistant photovoltaic modules. The glass type normally used for this technology is rolled low iron glass such as Pilkington Sunplus, often in toughened form, combined with an anti-reflective coating, to ensure that the maximum solar radiation reaches the crystalline silicon solar cells. It is also possible to use low iron float glass such as Pilkington Opt white.

3. **Lut desert environment characteristics:** Important environmental characteristics in calculation of the efficiency of solar cells are effective include: Regional temperatures [7]

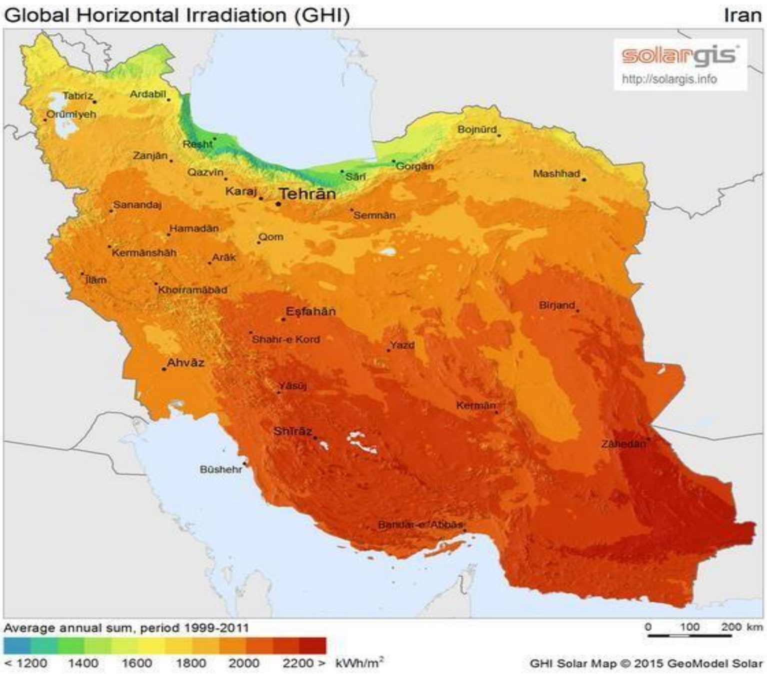
Table 1: Average annual temperatures in Lut desert of Iran (Kerman province

Month	Minimum temperature (K)	Maximum temperature (K)	Month Average (K)
January	286.1	296.1	291.1
February	284.9	294.4	289.6
March	292.1	303	297.5
April	299.2	309.9	304.5
May	304.6	315.8	310.2
June	306.1	318.3	312.2
July	305.6	318.2	311.9
August	302.5	314.4	308.5
September	298.7	309.8	304.3
October	288.2	298.3	293.3
November	283.8	294.1	298
December	282.7	292.3	287.5
Min average :294.5 K	Max average: 305.4 K		Average: 299.9 K

1- Global horizontal irradiation

Global horizontal irradiation in Lut desert is assumed 2200 kWh/m^2 (Global horizontal irradiation is the most important parameter for evaluation of solar-energy potential of a particular region and the most basic value for PV simulations.)[8]

Fig 1 (Global horizontal irradiation in Lut desert)



2- Air mass (air mass is a large volume of air in the atmosphere that is mostly uniform in temperature and moisture.) Air mass in this area is 1.1. [9]

3- Type of solar cell

Each type of solar cell, a range of wavelengths to most of the rest is converted into electricity. The efficiency of solar cells in the same environment will depend on the type of cells.

4.Why silicon solar cells

In addition to the advantages of silicon solar cells which are listed below, other factors are involved in this selection.

1- General Advantages[10]

Unlimited supply of raw material
Well-developed materials and device technology
Well-developed understanding of physics
High solar cell efficiency
Well established long term solar cell stability

2- According to Figure 3 Lut desert in an area which is relatively high amount of incoming UV. [11]. So care must be in the choice of solar cell solar cells is the choice we have worked best in wavelength UV.

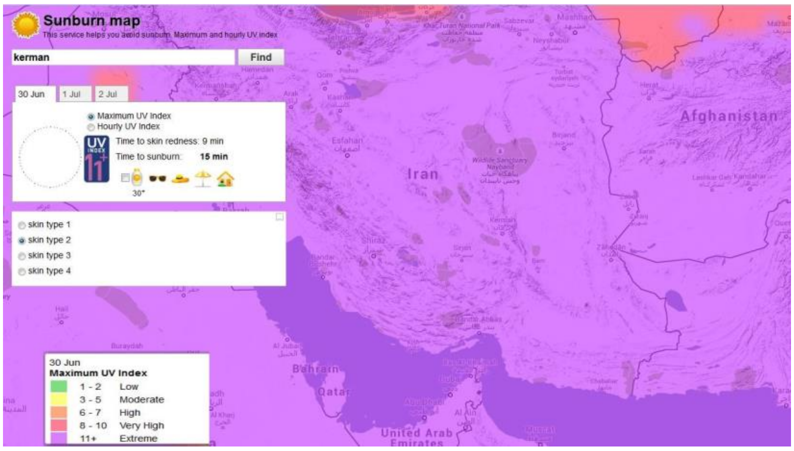


Fig 2: ultraviolet absorption in Lut desert and Iran

Range of wavelengths suitable for different solar cell is shown in Figure 3. [12] In this figure, observed that silicon solar cells in whether range of wavelengths to be more efficient. [13] Given the items listed it seems a good option to choose silicon solar cells for use in this area.

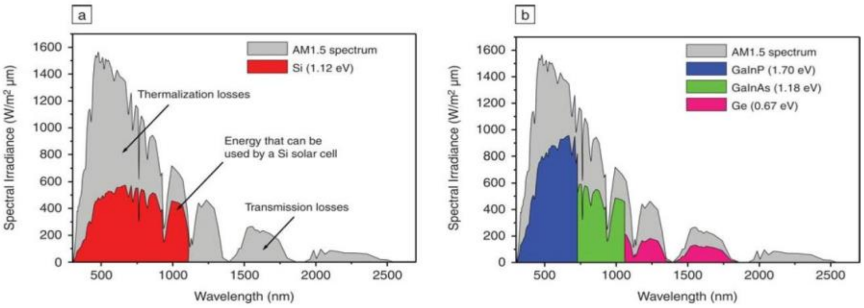


Fig 3: spectral irradiation for different solar cells

3- Bang gap for crystalline solar cells is 1.1 eV. [9][14]

5.The calculation of the efficiency crystalline and mono-crystalline silicon solar cells in the environment of Lut Desert in Iran

Table 2: Lut desert environmental conditions

environmental conditions	Air mass	Global horizontal irradiation (kWh/m^2)	mean temperature(k)
	1.1	2200	**299.9**

The formula used to calculate the efficiency of silicon solar cells that are used are [9]

$$(1): V_{OC} = \frac{KT}{q}(\frac{I_l}{i_0} + 1)$$

$$(2): j_{SC} = n^0 e$$

$$(3): j_0 = DT^3 e^{(\frac{-\varepsilon_g}{KT})}$$

$$(4): P_m = V_{OC} I_{SC} FF$$

$$(5): FF = \frac{P_m}{V_{OC} I_{SC}} = \frac{\eta A_C E}{V_{OC} I_{SC}}$$

$$(6): \eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

In this formula**:** **Isc** is the short-circuit current, **FF** is the fill factor and, P_m *maximum power* point and η is Efficiency.

Table 3: Confirmed terrestrial cell and sub module efficiencies measured under the global AM1.1 spectrum (2200 Wm^2) at 299.9 k

TYPE OF SOLAR CELL	Bang gap (ev)	V_{OC}(V)	J_{SC}(mA/cm^2)	FF	Efficiency
Si(crystalline)	1.1	0.659	87	83.89	21.86
Si(multicrystalline)	1.1	0.657	81.3	83.85	20.35

Results and conclusion: according to the growing importance of renewable energy and the future of this type of energy, study and research in this area are essential. Renewable energy as a clean energy source and free from environmental pollution such as carbon dioxide have an important role in reducing emissions and other greenhouse gases. Solar energy for sunny countries like Iran is an option for electricity generation. Choose a type of solar cell and environmental factors should be considered characteristic of the solar cell. Considering the amount of UV radiation is high in the Lut desert, the calculations predicted that high-efficiency by using silicon solar cells.

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