IMPLEMENTATION OF SOLAR LED LIGHTING IN SHTIME

Vehbi Sofiu [1],Veis Šerifi [2], Zamir Dika [1], Isuf Krasnići [1]
[1] South East European University, Tetovo-Skopje, Macedonia,
[2] SaTCIP Ltd, Vrnjacka Banja, Serbia,
vsofiu@yahoo.com, serifiveis@yahoo.com

Abstract: Exploitation of solar energy takes on the global proportions. Its mobility and autonomy raised many fields of application in the public and private life. Infiltration process of advanced technology, once on the film screen, provides an expression of expecting environment. Thus, the human imagination is allowed to design the environment in a completely new principles. In addition, practice has shown that the quick and effective solutions are the best for implementation.

Kew words: solar energy, solar panels, LED lighting.

1. INTRODUCTION

To more accurately determinig the angle of hours which figures in the equations for the azimuth and elongation, is necessary to know the local time of the observed point. However, widespread use of the time that is related to an entire meridiam belt or an hour zone, is characterized by its geographical limits of validity-border meridians. How the Earth turns round on its axis in 24 hours as well as its size is divided by the same number of time zones, ie. hourly zones. To each zone corresponds 15^o latitude. The very idea of division the planet was realized at an international conference in Washington, 1884 year, and as the prime meridian (0^o longitude) was taken meridian that passes throught the astronomical observatory at Greenwich in London. Therefore is often used the term of Greenwich Mean Time, GMT. All other time zones are coordinated with respect to this initial (*Coordinated Universal Time* – UTC) [1-7].
The countries that belong to the zone of **UTC+01:00** are: *Albania, Slovenia, Macedonia, Norway, Sweden, Denmark, Germany, the Netherlands, Belgium, Metropolitan France, Switzerland, Austria, Poland, Czech Republic, Slovakia, Hungary, European Spain, Italy, Croatia, Serbia, Tunisia, Algeria, Nigeria, Cameroon, Angola, Kinshasa.*
Now when the time is known in a wider band of longitude, with the aim of determining the precise position of the Sun in relation to the horizontal plane, the local solar time can be determined. Only two points on the planet at the same time may have the same solar time, one on the north and another in the southern hemisphere. Solar time is different for 4 min for each degree of longitude, is determined in relation to solar noon (the moment when the Sun reaches its highest point during the day). That’s why this time varies in relation to the time zone where the observed point belongs. Further deviation, which is even changed during the year, enters the elliptic orbit of the Earth around the Sun and „change“ the axis of rotation-solar declination. Correction in local time is required. The difference in 24 h during the day and the solar day is calculated by the equation of time („*Equation of Time* (**E** ili **EoT**)” and by correction in relative longitude represents the difference between the meridian for local time zone , „*The Local Standard Time Meridian* (**LSTM**)“, and local longitude, „*local longitude* (**L**)“). Approximate equation of time follows:

$$EoT = 9.87\sin(2\beta) - 7.67\sin(\beta + 78.8^o)(\min)$$

where,

$$\beta = \frac{360^o}{365.25}(N-81)$$

β is an angle given in degrees, while number 81 is 22 March, N is the number of days since the beginning of the year.

Graphic of given function can be seen in Figure 1.

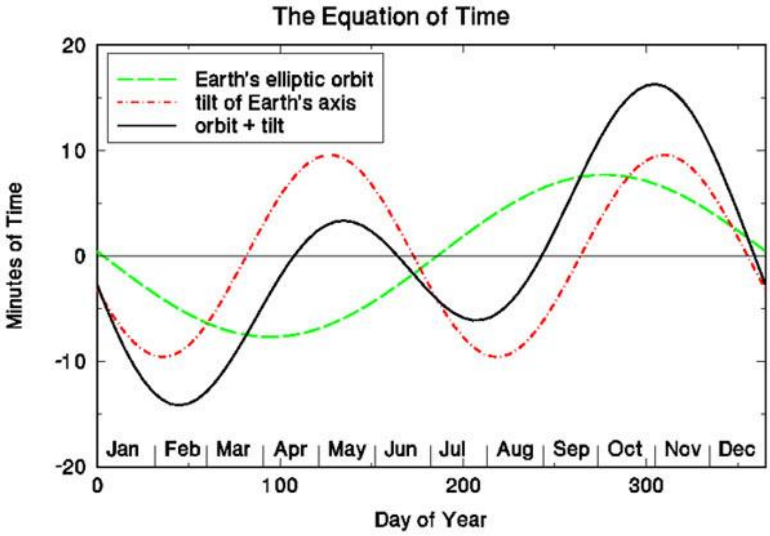


Figure 1. Change of value of the corrective member EoT during the year [1-7]

Local solar time LST is determined:

$$LST = CT + \frac{4\min}{stepen}(LSTM - L) + EoT$$

where CT stands as abbreviation for „*Clock Time*" and represents the time in local time zone. There is only important that in calculation to be taken into account the shift hours, ie. needs to subtract one hour if the day is during the season of summertime calculation.

Parameter, which is involved in determining the position of Sun is an „*Hour angle* (H ili HRA)". It converts solar time LST in an angle where position of the Sun catches in the equatorial coordinate system (Figure 2). Their value, by definition, is 0^o in solar noon. In the morning is negative and in the afternoon is positive.

$$H = \frac{360^o}{24h}(LST - 12h)$$

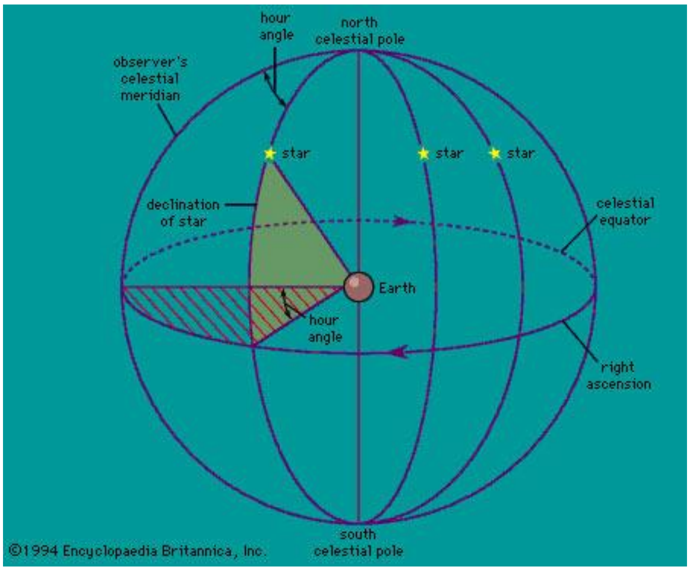


Figure 2. Hour angle [1-7]

2. MOVEMENT OF PLANET EARTH

Movement of Planet Earth has two components: A rotation around its own axis (or „spin“ of the Earth) and circular motion around the Sun, ie. revolution of Earth.
Earth rotates from west to east, however, the duration of rotation is determined by the stars and not in relation to the Sun, ie. based on stellar days („sidereal day“), where reference is the position of the stars. The reason is in itself a revolution of the Earth when the Earth veers every day for about 1^o. Sideral day lasts 23 h 56 min and 4.09 s when the Earth makes 2π rad (seen from the point of the vernal equinox); if you look at solar day („solar day“ – the length of time that elapses between the moment when the Sun reaches its highest point in the sky two times consecutively, a day is shorter or when you make the complete rotation of the Earth to the Sun when it is returned to the same initial meridian) duration is 24 h where the angular crossing of the Earth is $360.98^{o.}$ Even the moment of the vernal equinox changes periodically with a period about 26000 years. Own axis of rotation of the Earth is not normal from the level at which the Earth moves around the Sun. This level combines the Sun’s and the Earth’s center. „Circle“ at which the Sun apparently moves around the Earth, seen from the surface of the Ground and is located in this plane, is called the ecliptic, while the very plane of the ecliptic plane. In figure 3 can be seen positions of the ecliptic and celestial equator. The angle of axis of rotation of the Earth with the right normal to the plane containing the orbit of the Earth (the ecliptic plane) and where the sun rays are parallel is 23.45^o (Figure 4). This angle is called the Solar declination or axial angle δ_o. During the year, from the ground point of view, this angle changes apparently, which is manifested through the change in height of the Sun on the horizon. It is as a circle inscribing the axis of rotation (Figure 5, left). This is important because it can be concluded why the Northern Hemisphere in summer gains more intensity of the light and the south less, and less in winter while the southern more [1-7].

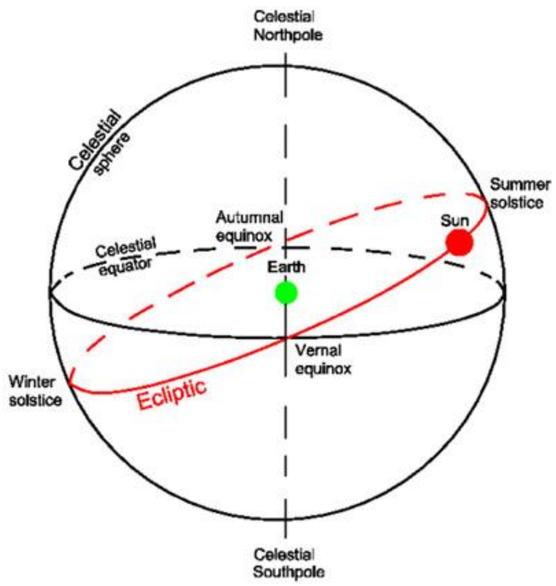


Figure 3. **The positoin of the ecliptic and celestial equator in geocentric system [1-7]**

Apparent motion is just the cause of the age-old observation of Earth as the center of the Univers (geocentric system of the world). It is interesting to note that this angle changes from 22.1^o (in some sources figures the cipher 21.5^o, 21.8^o) to 24.5^o with the period of 41000 years, and currently has a direction of decrease (the second of three cycles of Milutin Milanković) (Figure 5, right).

In summer, the Northern Hemisphere is closer to the Sun, has more hours of sunshine and the light intensity is higher. In winter it's opposite. This fact is important to the position of the solar panels during the year (in the case of systems with one or two degrees of tracking the Sun).

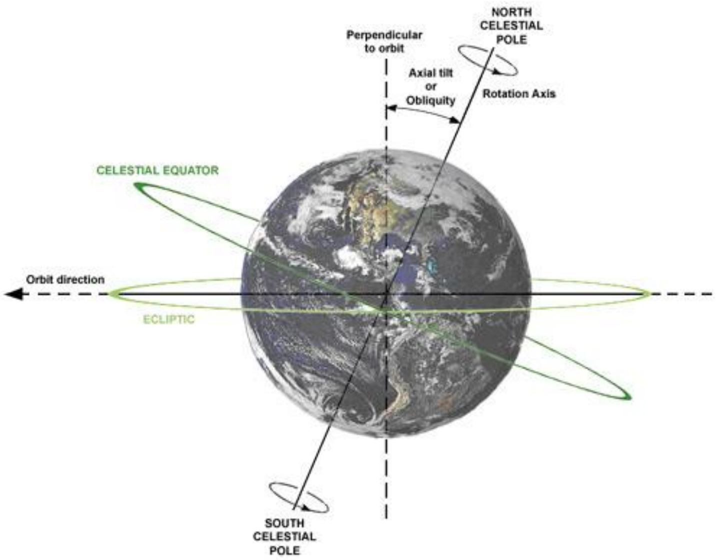
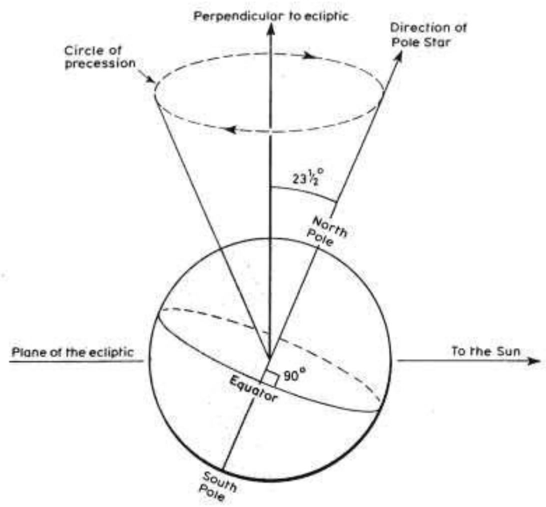


***Figure 4*. Axial angle**



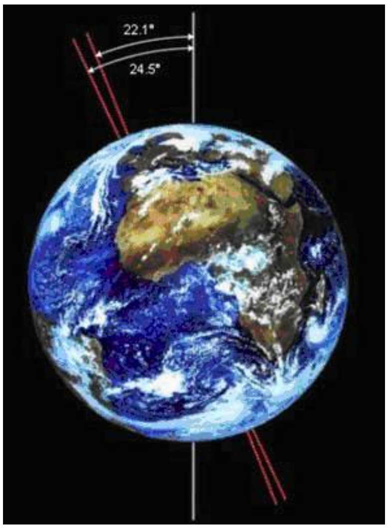


Figure 5. The apparent movement of the axial angle (left) and View of changes of the axial angle during the period from about 41000 years (right) [1-7]

At the time of equinox the sun's rays fall perpendicular to the equator ie. Sun Center is located in the equatorial plane, $\delta_o=0$ (Figure 6, right). As starting point is taken vernal equinox, to describe the apparent changes δ_o that occurs about 81 days in a year and that is 20/21. March. Here are some general equations that describe a given change and chart of those changes in Figure 6, left:

In order to obtain a complete rotation picture it's worth to mention the speed of rotation. The very speed of rotation of points on Earth depends on latitude. Point on the equator, where the volume of the planets is 40,075.036 km, during the stellar days 23 h 56 min 4.09053 s, go around a full circle. Dividing these two values the speed of rotation of the Earth is obtained at the equator. For any point it's needful to multiply this angle with cosine of latitude. It determines the speed of apparent movement of the Sun and therefore the dynamic monitoring of solar panels.

The second component of movement is the revolution of the Earth around the Sun. Initially it was thought that the orbits are, the orbits of planet around the Sun, a circle with a constant diameter. However, by means of detailed measurements it was found out that it is an eliptical path Figure 7, with the consequence that the distance changes during the year. The seasons are not due to an eliptical shape, but it's changing an insolation of the planet's surface to 6 %. There are three main consequences of the revolution and rotation: Change of length of day and night, the existance of climate zones, four seasons. All three strongly influence the energy that we get during the year at the set solar system.

$$\delta_o = 23.45^o \sin\left(\frac{360^o}{365}(N-81)\right), \quad (1)$$

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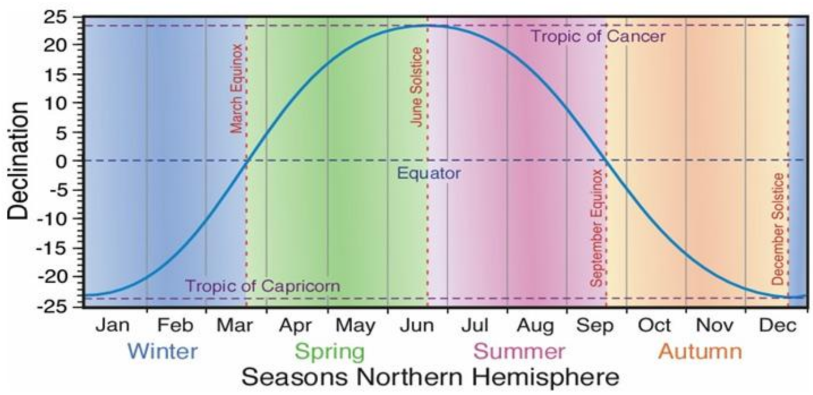
$$\delta_o = 23.45^o \sin\left(\frac{360^o}{365}(N+284)\right). \quad (2)$$



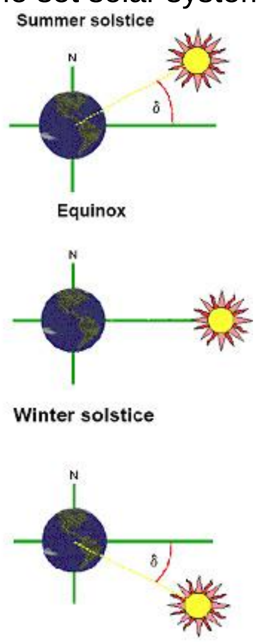


Figure 6. Changing the angle of solar declination δ_o (left) and Position δ_o in characteristic moments of the year (right) [1-7]

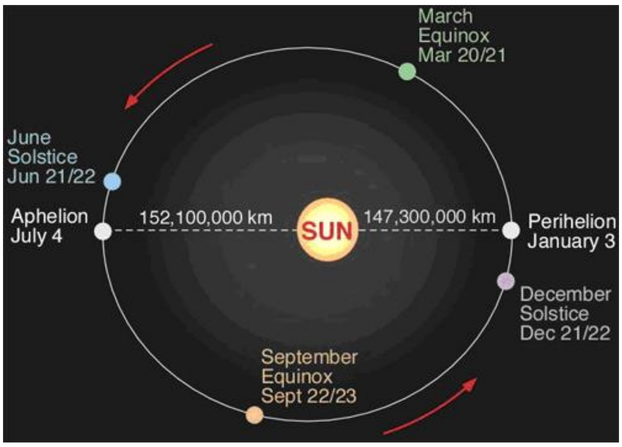


Figure 7. **Eliptical orbit of Earth around the Sun**

Celestial motion of the Earth, revolution, is carried out in 365.256366 days of sunshine (Sun reference), with the orbital speed of 107,218 km/h. Itself the orbital plane with respect to equatorial plane of the Sun is making an angle of 7.155^o („inclination"). The popint where the distance of Earth from the Sun is at least is called preihel (147,098,074 km), 3rd of January, and the point of maximum distance aphelion (152,097,701 km), 4th of July. Then the intensity of solar radiation on the surface of planet is minimum and maximum, respectively. Mean distance is 149,597,887.5 km. In addition to the vernal equinox there is an autumnal equinox 22/23. of September. In addition to these dates important are and time when the Sun reaches its highest altitude (the North Hemisphere is observed) and starting a „descent“ to it, point of summer solstice or the north return point, date of 21/22. of June. When the Sun reaches the lowest level over the horizon and begins to „lift“ to the equator, the point is of winter solstice or South feedback point, date 22/23. of December. Figure 8 clearly shows the position of the Earth for these four dates as well as the position of the axis of rotation as compared to the plane of the ecliptic. Thus, the angle δ_o remains the same but its position in relation to the sun changes , which results its apparent change.

Due to information let's note that the orbital eccentricity changes periodically from 0.005 eccentricity(nearly circular) to 0.058 eccentricity, with a period of 100,000 years (the first cycle of Milutin Milankovića). The current is 0.017. Even the position of the axis of rotation of the Earth is periodically changed in relation to the planet's Polaris (Polaris Star) and Vega with a period about 23000 years (this figure varies from 22000 to 26000 years), the third cycle of Milutin Milankovića. This results in changing the role of aphelion and i perihelion [1-7].

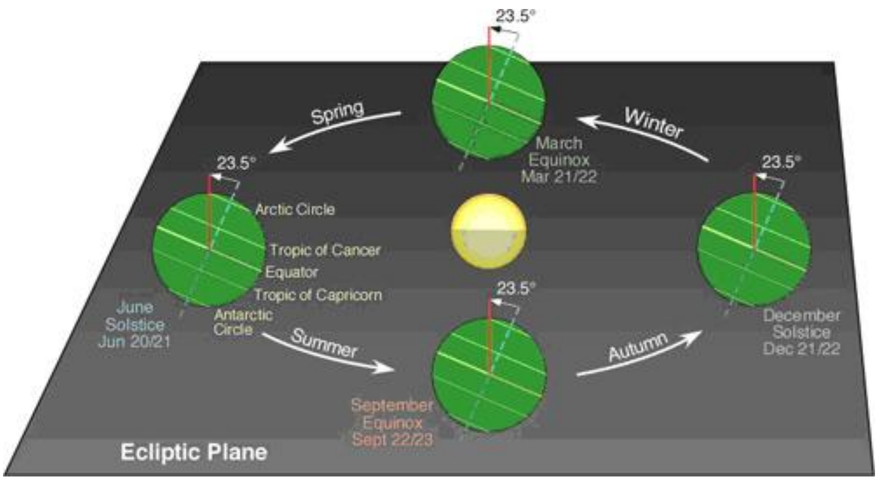


Figure 8. **The revolution of the Earth and the postion of the axis of rotation for specific dates**

3. IMPLEMENTATION OF SOLAR STREET LIGHTING IN SHTIME

Exploitation of solar energy takes on the global proportions. Its mobility and autonomy raised many fields of application in the public and private life. Infiltration process of advanced technology, once on the film screen, provides an expression of expecting environment. Thus, the human imagination is allowed to design the environment in a completely new principles. In addition, practice has shown that the quick and effective solutions are the best for implementation. With the trend of reducing the costs of installation and electricity, any investors in future will save a lot of money, both direct and indirect (constant consumption of electricity from the grid). In the spirit of these changes, today begins the implementation of solar LED lighting systems with increased energy efficiency and ecological approach to the environment. There were presented two new concepts. The first is the use of solar energy for lighting supply with complete independence from the city's network (although there's a connection possibility). In the event of a failure in the network light will not be turned off; not to mention the need to the light in extreme weather conditions and special situations [1-8].

According to the purpose LED lighting can be divided into:
- Public LED lighting**,**
- Lighting for industry**,**
- Lighting for home and office**.**

LED's bulbs are with extremely power from 10-60W, tipical 30W, with the equivalent emmision of light radiation, or even better compared to competing. Accepting the LED tehnology, which may not been conditioned by solar power, the energy consumption can be reduced up to 10 times.
Solar LED lighting has a wide range application:
- Lighting at outdoor parking space,
- Lighting in parks and promenades,
- Lighting of cyclic and jogging tracks,
- Lighting at docks and banks,
- Street lighting and marking of larger and/or significant signs on the road,
- Lighting of courtyards, homes, schools, playgrounds,
- Lighting of farms and factory plants,
- Application in military bases.

According to the distribution of luminous flux there are direct or semi-direct lights with a wide or extremely wide distribution depending on the needs. They can provide a cold white, neutral white and warm white light, which on average make 24-30 led lamps. In terms of environmental standards, these lamps belong to the category of „environmentally friendly" ie. they have a slight negative impact on the environment in which they are placed. They possess a small dissipation, CO_2 emission is reduced by 350 kg/yr. on average. In addition, it does not contain heavy metals as well as in the spectrum of light has no ultraviolet lights, which are far better for the environment than the prescribed standard.
The role of lightimg is not just limited to lighting of road of the traffic participants, but it can be viewed in different social context. Good lighting helps in reducing crime and fear of crime, improve the tourism offer of a given place, facilitate trade.
In order to ser the lighting project must be in accordance with the standards. The basic standards are contained in the standards BS EN 13201 of Europe with three parts and an additional document PD CEN/TR 13201-1, and the British standard BS 5489 with its two parts, which is a bit stricter (other standards contain these two, for example. DIN EN 13201 in Germany). The European standard requires especially precise definition of performance lighting, their implementation, and measurements obtained by light. In addition, the class of lighting is determined that depends on the purpose of the illuminated area and the environment. Today there are two approaches to determining the class lighting incorporated into those standards. The first refers to the main road network so the requirements are more stringent and is based on the luminosity-brightness (cd/m^2). The second refers to all other areas of various purposes and is based on light-illumination (lx≡lux).
In Shtime was implemented the project which included the construction of:
1) 8 closed systems (off-line) of solar energy for lighting the park on the existing structures for lighting poles,
2) 30 closed systems (off-line) of solar energy for street lighting on the existing constructions for lighting poles,
3) 15 closed systems (off-line) of solar energy for street lighting on new constructions for lighting poles.

Figure 9. Model MBEL-SSLD60w

Model MBEL-SSLD60w (Figure 9):

- Solar module: 100WP / 12VDC * 2pcs
- Solar module support structures: 100WP / 12VDC * 2pcs
- Battery: free-maintained lead-acid battery 100AH/12V * 2pcs.
- Battery box: 100AH/12VDC * 2pcs
- Controller/regulator: 15A/24VDC
- Light source: High power street light 60W/12VDC
- (Luminous lumen: 5400-6000 LM, center lux: 28-30 lux base on 8m)
- Wiring and other install material
- Metal pole: 8 - 9 m
- Work temp: - 40 ° C ~ 55 ° C. Wind-stand> 120 km\h
- Operate time: 10-12 hours/per day. Keep 3 rain days.

Figure 10. Model MBEL-SSLD70w (left) i MBEL-SSLD15w (right)

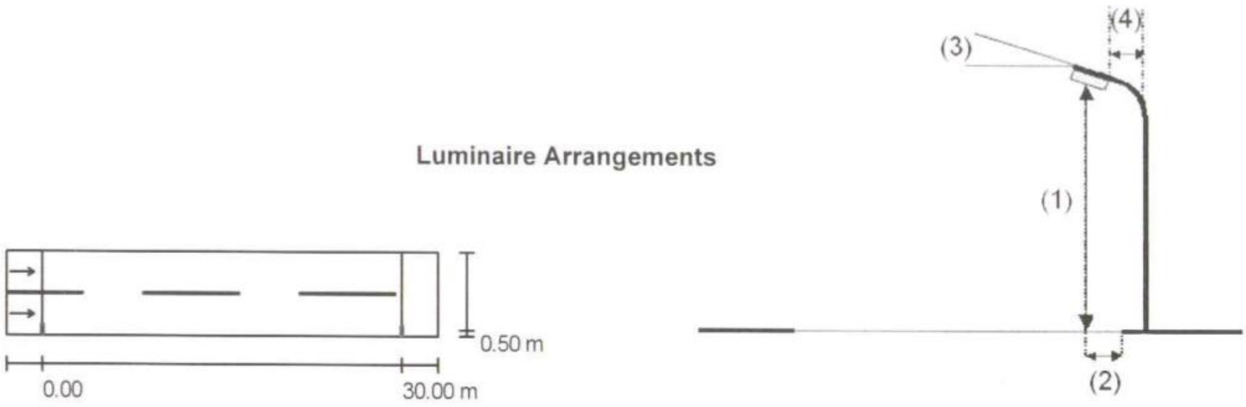
Model MBEL-SSLD70w (Figure 10, left):

- Solar module: 120WP / 12VDC * 2pcs

- Solar module support structures: 120WP / 12VDC * 2pcs
- Battery: free-maintained lead-acid battery 120AH/12V * 2pcs.
- Battery box: 120AH/12VDC * 2pcs
- Controller/regulator: 20A/24VDC
- Light source: High power street light 70W/12VDC
- (Luminous lumen: 6300-7000 LM, center lux: 28 lux base on 9m)
- Wiring and other install material
- Metal pole: 8 - 10 m
- Work temp: - 40 ° C ~ 55 ° C. Wind-stand> 120 km\h
- Operate time: 10-12 hours/per day. Keep 3 rain days.
- Basic solar irradiation: 4 - 5 kWh/m2/day.

Model MBEL-SSLD15w with 2 branches (Figure 10, right):
- Solar module: 50WP / 12VDC * 2
- Solar module support structures: 50WP / 12VDC * 2
- Battery: free-maintained lead-acid battery 65AH/12V * 2
- Battery box: 65AH/12VDC * 2
- Controller/regulator: 10A/12VDC * 2
- Light source: High power flood light 15W * 2
- (Luminous flux: 1500 LM)
- Wiring and other install material
- Metal pole: 3.5 - 5 m
- Work temp: - 40 ° C ~ 55 ° C. Wind-stand> 120 km\h
- Operate time: 10 hours/per day. Keep 3 rain days.
- Basic solar irradiation: 4 - 5 kWh/m2/day.

When designing a lighting system, it is necessary to know how to set the carrier and how many lighting units need to be installed on it because proper analysis can significantly reduce costs. Secondly, if the lighting class for the given surface is known, it can be determined whether it is necessary to se one or more lamps, as well as their position. From these initial analysis, further designing of other parameters arises (Figure 11).



Luminaire:	TRILUX 9341/100-150HST/60 (150W) COMP Post-top and bracket-mounted luminaires 934···		
Luminaire Luminous Flux:	17500 lm	Maximum luminous intensities	
Luminaire Wattage:	176.0 W	at 70°:	425 cd/klm
Arrangement:	Single row, bottom	at 80°:	361 cd/klm
Pole Distance:	30.000 m	at 90°:	123 cd/klm
Mounting Height (1):	7.000 m	Any direction forming the specified angle from the downward vertical, with the luminaire installed for use.	
Height:	7.106 m		
Overhang (2):	0.472 m	Arrangement complies with glare index class D.4.	
Boom Angle (3):	15.0 °		
Boom Length (4):	1.000 m		

Figure 11. Street Profile – Roadway 1

When presenting the characteristic of lights there figure photometric parameters (photometry is the sub-branch of optics that deals with the measurement of light sources, properties and measuring luminous flux and the proporties and measurement of luminous surface):

- Luminous flux Φ (lm),
- Luminous intensity I (cd),
- illumination E (lux),
- brightness L (cd/m^2).

In this project it was necessary to apply the aforementioned parameters in the selection, because today emerged many products whose use depends on their values. Luminous flux is the total amount of light energy emitted by the light source into the environment per unit time, ie. one second .. Luminous intensity is the amount of light that a source (point source) transmitted each second in a particular direction defined by unit spatial angle.. Brightness is the amount of light energy that falls on every second to unit area. Luster is the amount of light coming from the observed surface in unit time. Color temperature lamps can be graphically explained. According to this parameter there can see exactly what color gives the lamp. Higher color temperature means that the light is "cooler"..
Luminous efficiency is a ratio of obtained luminous flux and input energy ŋ (lm/W). It is important to know that every light has an exploitation life (lifetimeand the flux decreases with time sheening operations. Electrical power of the light bulb is a parameter by which is calculated the consumption. At the end of this list of important parameters is the price of cost and maintenance. In addition to the parameters are important and graphics that give the distribution of luminous intensity in space **(**isocandel diagram-light distribution). Characteristics are usually the norm for 1000 lm, respectively expressed in cd / klm. The area around the lamp is divided into several planes called C system level. For example 0o-180o plane perpendicular to the longitudinal axis of the lamps, and marks the C0-180.

According to the symmetry of which it denounces are divided into: rotational symmetrical, axis symmetrical and asymmetrical.
Another item was used in the project implementation in Shtime, essential in setting the light: one needs to know the average wind speed for that location. We know that the wind roses are significant in this location. Mainly this analysis does not attach importance to urban areas but at the docks, banks, mountain light is necessary to adjust the height, diameter and the basis of thebearing pole. So they defined three categories with corresponding heights of 30-20 depending on the needs of traffic and abundant wind.

4. CONCLUSION

In modern constructional and architectural trends of lighting is expected quality light, low power consumption, reliable operation and time operation over 40,000 hours, low-cost maintenance**.**
As a solution many possibilities are offered, but one stands out for cost and quality. In fact, this is a new kind of lamps based on LEDs (LEDs correctly, what you see in the title of "Light Emitting Diode"), based on the technology of white LEDs: As a final layer is added one or two layers of yellow phosphorus to be source of blue light gets green light. Today's LEDs have a cold or street moderate white light with light utilization over 120lm / W, while the forecasts go beyond the fantastic 150lm / W. In this way, become competitive lamps high pressure sodium (200lm / W) [8.
The world needs more and more energy. Steady increase in population brings to the constantly increasing needs for energy and humanity is in a continuing search for energy sources that would adequately cover energy needs. There are times when the demand for energy is temporarily reduce the (global financial crisis and global recession), but such events are transient and after they finish, the hunger for energy is still bigger and bigger. In the long run, demand for energy is increasing all the time [6].
Currently the world is covering its energy needs mainly with thenon-renewable sources of energy, mostly fossil fuels - coal, oil and natural gas. As its name suggests, these energy sources are renewable, which means that it can not last forever and at some point will be spent. Fossil fuels are very harmful to the environment due to release large amounts of carbon dioxide (CO2) emissions, environmental pollution in the form of oil spills at sea, causing smoke, which is very harmful to health. The time now is perhaps the most pronounced negative effect of fossil fuel global warming - perhaps the greatest challenge with which the mankind encountered in its short history [6]

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