Estimation of the Operational duration of Solar Cells (Chinese and German) According to Specific Properties of Components for Short Time Series Design in Baghdad's Streets City

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Abstract

The objective of this study is to assess the operational age for the night lighting solar systems (the Chinese and the German equipment) installed in some of the streets of Baghdad, considering it an essential factor in choose between them through the following factors:

The design features of the system components set by the manufacturing company, the ways of foundation, testing and operation, review of the maintenance program prepared by the executing direction for the period from 1/1/2009 to 1/1/2010 to follow-up the incidents of damage, Analyzing the damage for each equipment, and determining the extent of the damages. The statistical analysis for the breakdowns which had been experienced during the period above, for comparison among these systems and to identify preference between them.

The results showed the German product represents highly increasing of advantage in the duration better than the Chinese product in all the studied components. The proposals and recommendations to avoid disruptions and improve the performance of the systems are included.

Keywords: Solar Cells; Solar Radiation; Time Series; Night Light; Solar Design Systems.

تخمين العمر التشغيلي لمكونات منظومة الإنارة بالطاقة الشمسية (الصينية والألمانية) في ضوء بعض المواصفات التصميمية لسلسلة زمنية قصيرة في عينة من شوارع مدينة بغداد

الخلاصة

إن الهدف من هذه الدراسة تقدير العمر التشغيلي لمنظومات الإنارة الليلية بالطاقة الشمسية الصينية والألمانية التي نصبت في بعض شوارع مدينة بغداد والمفاضلة بينهما بالاعتماد على كفاءتهما المستنتجة من دراسة العوامل الآتية :

المواصفات التصميمية لمكونات المنظومات ، طرائق التأسيس والفحص والتشغيل ، استعراض برنامج الصيانة المعدّ للمدة من 2009/1/1-2010/1/1 لمتابعة حالات العطلات وأسبابها ، تحليل العطلات لكل معدة ، وتحديد الأسباب. فقد تم إجراء التحليل الإحصائي للأعطال التي تمت معالجتها اثناء المدة المذكورة انفا" واعتمادها لإجراء المقارنات بين هذه المنظومات وتحديد الأفضلية بينهما .

وقد أسفرت نتائج التحليل عن ارتفاع عمر البقاء للمكونات المبحوثة لمنظومة الإنارة بالطاقة الشمسية للمنشأ الألماني مقارنة بالمنشأ الصيني . المقترحات والتوصيات لتلافي الأعطال وتحسين أداء المنظومات.

1. Introduction

Energy is a key input on economic growth. There is a relationship between the availability of energy and the future growth of a nation [1]. The energy from the sun in the form of radiation is the solar energy. The solar energy can be converted into the thermal energy, electricity and photosynthesis [2]. The pollution of the environment due to the use of the energy by conventional methods and the future consideration for petrol reserve in the world. Nations should think seriously to produce the energy from solar energy which does not cause a pollution or noise to the environment. Thermal from the sun can be collected by using a solar collector (photovoltaic). In the solar photovoltaic system (S.P.V). The electricity generated from solar energy, when light falls on a certain metals like silicon, the electrons get stirred and escape from the metal, and these are collected by another metal and passed through wire in a steady steam. The electrons flow thus set and constitute the electric current. The basic unit of S.P.V is a solar cell which is a wafer of electron emitting metal [3]. This way of utilization of solar energy is appealing considering the framework solar radiation condition and large requirement of electricity for decentralized application. The energy installation and maintenance absence of noise and pollution and longevity make S.P.V system favourable for use in remote and isolated areas, forests, hilly and desert regions. The maximum output of power of the cell is given by [4]:

$$Pmax = Imp \times Vmp.$$

Where Vmp = external load voltage, Imp = the current and the conversion efficiency (μ) for a maximum power output is given by:

$$\mu max\ power = Pmax/Pin = \mu max.$$

2. Components of System

2.1 Solar cells (panel)

The solar cells are made from singular wafers of silicon; the back of the wafer painted with aluminium and heat-treated then the aluminium is painted with material that helps in the proliferation of electrons. The wafer is dried and sprayed with phosphorus and put in an oven to reach 1000 C to enable the phosphorus to cover the wafer, the solar panel consists of several solar cells with electric capacity (175-200), voltage 35V, current and efficiency of (10%-18%) [5].

2.2 Control system

The control system consists of an electronic monitor to display the particular information of the system and to control the operation through:

The protection of the battery and the solar cells .The supply of the reflector with ongoing voltage (24 V D.C).Charge ability for the (voltage and current) that passes through the reflector to turn the light on. Protection of the re-operation of the light after an obligatory shutting down when the battery is low [6].

2.3 Reflector device

This transfers the on-going voltage to alternating voltage; it consists of an electronic circle that transfers 24V to 400V alternating sinusoidal voltage with 40 KHZ frequency. It transfers the voltage after 1/10 second to 115V alternating voltage with triangle wave signal and frequency 20KHZ where the first voltage is about 400V, 40KHZ this will work as a catalyst for the ionization of sodium gas inside the lamp to spark voltage and after that the voltage will turn to the second amount 115V alternating with triangle wave signal and frequency 20 KHZ to keep the lamp working and glowing. The electronic circuit also contains a protection circle which gives the directive to the system that there is no lamp attached when the first voltage 400V- 40KHZ is present and after 3 seconds the first voltage moves to zero which means there is no lamp attached.

2.4 Battery

The lighting system consists of two batteries in series with capacity 24V-150A to get a total capacity 1800 Watt [7].

2.4.1The Box

A container that gathers the system components with suitable size and anti-rain and dust casing, the battery is surrounded with a box in order to protect it from water.

2.4.2The lamp- sodium gas

It works on alternating voltage 400V- 40KHZ start operation and ongoing voltage and withdrawn power of 66 WATT with current about 0.55 A, this lamp works on the principle of gas ionization by focusing a high ignition voltage with a high frequency to stimulate the gas interaction and the output of this interaction is an emission of strong and visible light in addition to emitted heat, this technique of lamps contains sodium gas is characterized with giving a high signal by the use of a low electric power by 1\40, which means that the intensity of the emitted light needs a high power but because of this gas the power will be less 40 times which represents high economy [8,9].

3. Method

The system is linked according to the following contexts:

3.1 Solar Panel

The solar panel array contains solar cells connected in series and in parallel in order to make the emerging voltage from the array request in accordance with the required specifications. When the system is set up, the following must be done [10]:

1. The solar panel is set towards the sun at 51° angle with the ground.

2. There are no obstacles in front of the solar panel to avoid shadows.

3. There is no discrepancy system accessory.

4. Connect the poles of the battery the positive and the negative to the control system.

5. Put the battery in the box to protect it from water.

6. Put the dust of silver on the poles of the batteries to ensure that it is working properly in winter time.

3.2 Lamp

1. The connected wire should have good isolation features at more than 300V at a length of less than 18M.

2. Fixing the lamp on its base parallel with the surface of the ground to give a strong signal.

3. Be sure that the lamp is fixed and stable.

4. Be sure that the reflector is connected with the lamp.

3.3 Control System

1. When the control system is connected it should be noted that :

2. The correct connection of the negative and positive poles.

3. The presence of five lights on the control panel from left to right with different colours to indicate the system status.

4. In case there are two or more pieces of solar cells they should be connected it in parallel but the charging current should be less than the current that returns to the control [7].

3.4 The battery

1. The battery acts as the storage power to the reflector during the night , and the reflector will transfer the ongoing power to alternating power, the discharging operation will be through the control system to keep the battery in ongoing status and to take into account when connecting the battery with the system the following:

2. Leaving a suitable distance between the batteries at least 1 CM.

3. Put it in a place with good ventilation with temperatures between (10-30) °M.

4. Cleaning the external surface of the battery from dust.

5. Testing the voltage, charging and discharging, and measuring the rate of the capacity and protect the material from salt formation.

3.5 Reflector

1. When we link the system with the reflector we follow the following :

2. Link the reflector with the lamp.

3. Make sure that the poles and the battery are tied in the correct way.

4. Testing and operation of the system [11].

The following table represents the failure analysis for each component of the solar cell of the lighting system.

Table 1. Sources and causality of failure analysis for each component of the solar cell of the lighting system

Failure	Remarks
Control panel does not work when it is linked to the battery	• Error or damage in the control panel. • Battery is not charged. • Poles of the battery do not work. • No tightness in joints.

Lamp does not work in the evening.	• Damage in lamp. • Damage in the ballast
The control panel does not indicate the battery voltage	• The battery is not totally charged • Check battery in good weather. • Control panel does not work. • Examine the size and the components of the solar panel and the capacity of the battery.
Lighting works in a fixed time daily	Control panel organized with the key time
Lighting works in the daytime	• Control panel is not working. • There is no voltage going out the solar panel • Bad connectivity of the components of the solar panel.
There is a voltage going out of the control panel	• Error in the circle • Link joints are weak
There is no charging after panel connect.	• The link of the battery is reflected • Defect in the battery
At the beginning the lamp works intermittently.	• If the frequency of the flashes is slow this means that the control panel is not working • If the frequency of the flashes is deficient means that the ballast is not working.
Lighting works for a short time every day.	• Battery capacity is weak • Solar panel is deficient. • The efficiency of charging is low • A significant decline in the solar panel ability • Incline of the panel is incorrect

4. Findings and Results

The following table represents the failure in solar call system during 1/1/2009-1/1/2010.

Table 2. Original Censored Data (OCD) type II for the studied items of the two (Sources) for different of the studied item's properties

No.	**Item (Properties)**	**Sources**	**Period in month/failure occurrence**											
			1	2	3	4	5	6	7	8	9	10	11	**12**
1	Solar cell (panel)	Chinese	0	0	0	1	0	0	1	0	0	0	1	**0**
		German	0	0	0	0	1	0	0	0	0	1	0	**0**
2	PV controller	Chinese	0	0	0	1	0	1	0	0	0	1	0	**1**
		German	0	0	0	0	1	0	0	0	0	0	1	**0**
3	Ballast (inverter)	Chinese	0	1	0	1	0	0	0	1	0	0	0	**1**
		German	0	0	1	0	0	0	1	0	0	0	1	**0**
4	Light	Chinese	0	0	0	0	0	0	1	0	0	1	0	**0**
		German	0	0	0	0	0	1	0	0	0	0	0	**0**
5	Battery	Chinese	0	0	0	1	0	0	0	1	0	0	1	**0**
		German	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**

0: (zero) indicating success and (1): indicating failure

Which indicated that a three and four periods having a (zero) respondent and had Berkson [2] corrected through exchange of (P=0) by the extreme value ($p = 1/2n = 0.05$) then obtained:

($Zt = n_t p_t = 10 \times 0.05 = 0.5$).

Table 3. Summary statistics of censer cases respondents to failure through the period of censoring (per month) for the studied items of the two (Sources)

Stat.	**Item (Properties)**	**Sources**	**Period in month**											
			1	2	3	4	5	6	7	8	9	10	11	**12**
nt	Solar cell (panel)	Chinese	10	10	10	10	10	10	10	10	10	10	10	**10**
		German	10	10	10	10	10	10	10	10	10	10	10	**10**
R	Solar cell (panel)	Chinese	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	2	2	2	2	3	**3**
		German	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	1	1	2	2	**2**
P	Solar cell (panel)	Chinese	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	**0.2**
		German	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	**0.2**
Stat.	Item (Properties)	Sources	**Period in month**											
			1	2	3	4	5	6	7	8	9	10	11	**12**
nt	PV controller	Chinese	10	10	10	10	10	10	10	10	10	10	10	**10**
		German	10	10	10	10	10	10	10	10	10	10	10	**10**
R	PV controller	Chinese	0 (0.5)	0 (0.5)	0 (0.5)	1	1	2	2	2	2	3	3	**4**
		German	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	1	1	1	2	**2**
P	PV controller	Chinese	0	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	**0.4**
		German	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	**0.2**
Stat.	Item (Properties)	Sources	**Period in month**											
			1	2	3	4	5	6	7	8	9	10	11	**12**
nt	Ballast (inverter)	Chinese	10	10	10	10	10	10	10	10	10	10	10	**10**
		German	10	10	10	10	10	10	10	10	10	10	10	**10**
R	Ballast (inverter)	Chinese	0 (0.5)	1	1	2	2	2	2	3	3	3	3	**4**
		German	0 (0.5)	0 (0.5)	1	1	1	1	2	2	2	2	3	**3**
P	Ballast (inverter)	Chinese	0	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	**0.4**
		German	0	0	0	0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	**0.3**
Stat.	Item (Properties)	Sources	**Period in month**											
			1	2	3	4	5	6	7	8	9	10	11	**12**
nt	Light	Chinese	10	10	10	10	10	10	10	10	10	10	10	**10**
		German	10	10	10	10	10	10	10	10	10	10	10	**10**
R	Light	Chinese	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	2	2	**2**
		German	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	1	1	1	**1**
P	Light	Chinese	0	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	**0.2**
		German	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	**0.1**
Stat.	Item	Sources	**Period in month**											

(Properties)			1	2	3	4	5	6	7	8	9	10	11	12
nt	Battery	Chinese	10	10	10	10	10	10	10	10	10	10	10	**10**
		German	10	10	10	10	10	10	10	10	10	10	10	**10**
R	Battery	Chinese	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	1	2	2	2	3	**3**
		German	0 (0.5)	0 (0.5)	0 (0.5)	0 (0.5)	1	1	1	1	2	2	2	**2**
P	Battery	Chinese	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	**0.3**
		German	**0**	**0**	**0**	**0**	**0**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**

5. Data testing and Algorithm of estimations

Step (1): Goodness of fit testing operations was tested for the results in table 3 according to the statistical hypothesis which says that the observations would be followed Binomial distribution function [12]. By applying the Statistic of (Person Chi Square):

$$R(B)=\sum_{t=1}^{K}\frac{(Z_t-n_t p_t)}{n_t p_t q_t} \qquad (1)$$

$$p=\frac{\sum_{t=1}^{12} Z_t}{\sum_{t=1}^{12} n_t}$$

And then prob. of failure is equal to: (q= 1- p). (2)

Which presence that binomial distribution would be proved for all studied properties in both sources [1].

Next step determined in estimating the initial values of the parameters:

$$\hat{\boldsymbol{\beta}}_{\phi}=\frac{\sum_{t=1}^{k}\boldsymbol{\lambda}_t}{\boldsymbol{k}}-\hat{\boldsymbol{\beta}}_1\frac{\sum_{t=1}^{k}\boldsymbol{Z}_t}{\boldsymbol{k}} \qquad (3)$$

$$\hat{\beta}_1=\frac{k\sum_{t=1}^{k}\lambda_t Z_t-\sum_{t=1}^{k}\lambda_t\sum_{t=1}^{k}Z_t}{k\sum_{t=1}^{k}Z_t^{2}-(\sum_{t=1}^{k}Z_t)^2} \qquad (4)$$

These were obtained through applying Logistic transformation by :

$$\lambda_1(t)=Ln\left[p_t/(1-p_t)\right] \qquad (5)$$

Table 4. Initial Parameters estimates with goodness of fit by applying Logistic transformation.

Properties	Sources	ANOVA		Initial estimates	
		F	P-value	$\hat{B}_{\phi}$	$\hat{B}_1$
Solar cell	Chinese	36.03	0.000	-3.076	0.1272
	German	71.61	0.000	-3.285	0.1602
PV	Chinese	142.08	0.000	-3.284	0.2377
	German	48.75	0.000	-3.223	0.1403
Ballast	Chinese	120.71	0.000	-3.292	0.2234
	German	51.39	0.000	-3.403	0.2234
Light	Chinese	27.63	0.000	-3.477	0.1706
	German	139.74	0.000	-3.305	0.2075
Battery	Chinese	72.35	0.000	-3.422	0.1822
	German	36.03	0.000	-3.076	0.1272

Step (2): Now, Logistic Response Function in equation (5) indicating the relation between the probability of response (Pt) and the explanations variables , which can be given by :

$$p_t = \frac{e^{x'B}}{1 + e^{x'B}} \qquad (6)$$

Which it's Continuous and increased in the interval [0,1]. Through using the following formula:

$$\text{Min} \quad \left(\sum_{t=1}^{k} \frac{(O_t - E_t)^2}{E_t} \right) \qquad (7)$$

We have that:

$$\lambda_{(t)} = \sum_{j=1}^{g} X_{tj} \beta_j \qquad ; \quad t = 1,2,\ldots\ldots, k \qquad (8)$$

$$j = 1,2,\ldots\ldots, g$$

Where λ(t), Xt correlated linearly with simple linear regression model:

$$\lambda_{(t)} = B_0 + B_1 X_t + a_t$$

(9)

Step (3): In this step we assumed that the suitable and mostly method that would be applicable to obtaining the final parameters estimates, which known by (Min. Chi square) [12]. Substituting equation (6) in equation (1) gives that:

$$R(B) = \sum_{t=1}^{k} \frac{Z_t - n_t \dfrac{e^{X'B}}{1+e^{X'B}}}{n_t \dfrac{e^{X'B}}{1+e^{X'B}} \cdot \dfrac{1}{1+e^{X'B}}} \qquad (10)$$

Second partial derivatives with respect of (B) gives that :

$$\frac{\partial^2 R(B)}{\partial B B'} = -\sum_{t=1}^{k} \left[\frac{Z_t^2}{n_t} e^{-X'B} X_t X_t' + \frac{(Z_t - n_t)^2}{n_t} e^{X'B} X_t X' \right] \qquad (11)$$

Then finally through Substituting equation (11) in the following formula (Newton Raphson technique) [12]:

$$\hat{B}^{(L+1)} = \hat{B}^{(L)} + \left(- \frac{\partial^2 L(B,Z)}{\partial \hat{B}_j^{(L)} \partial \hat{B}_j^{(L)}} \right)^{-1} \frac{\partial L(B,Z)}{\partial \hat{B}^{(L)}} \qquad (12)$$

We arrived to the final formula which gives the best estimators of creating the statistical distribution functions for studying the survival times of censoring data type II:

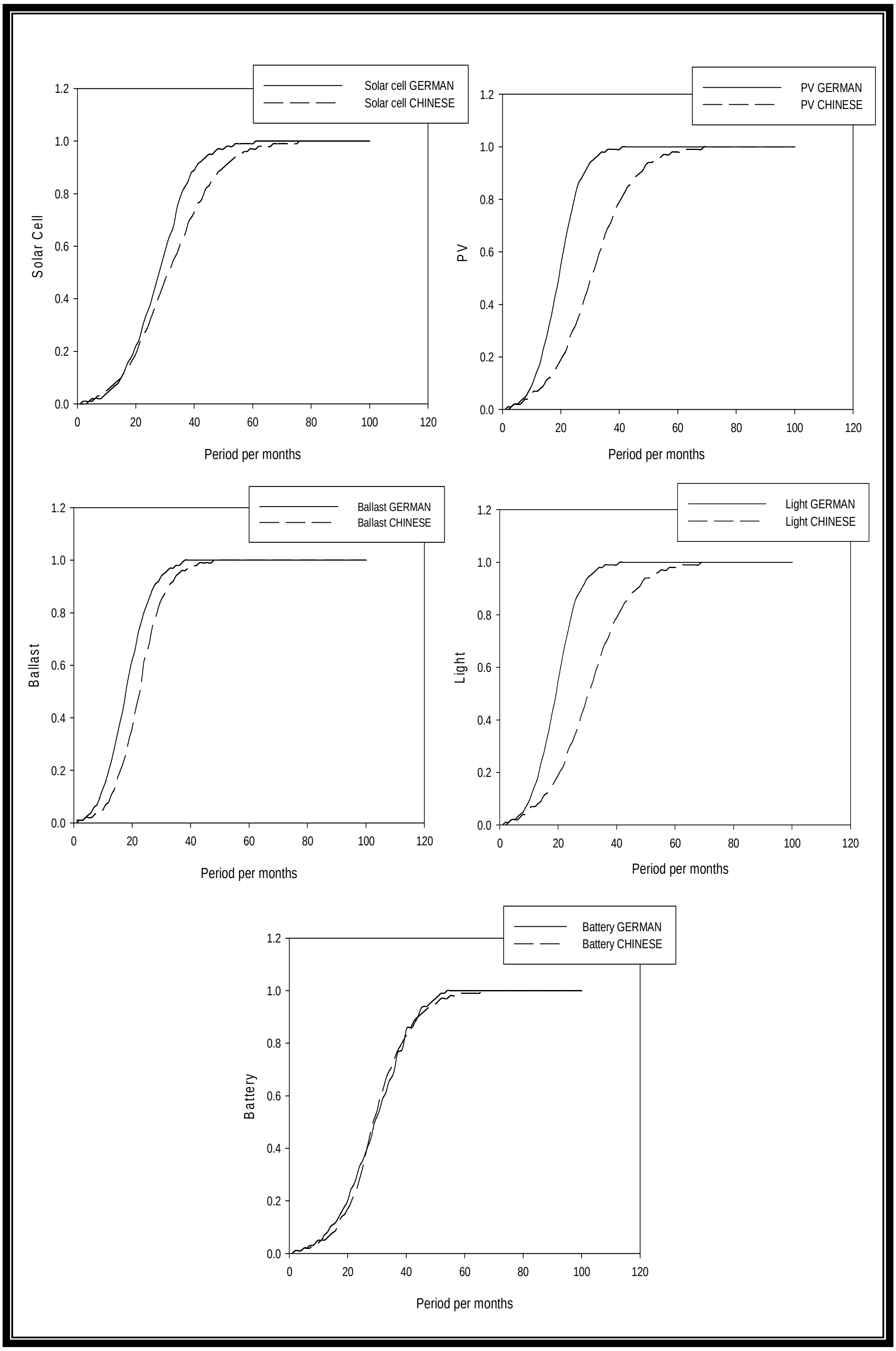
$$\hat{B}^{(L+1)} = B^{(L)} + (X'VX)^{-1} X'y \qquad (13)$$

Table 5. Final Parameters estimates with through applying Logistic model
through applying Logistic model and using Min. Chi-Square method

Properties	Sources	Final estimates	
		$\hat{B}_\phi$	$\hat{B}_1$
Solar cell	Chinese	-3.011	0.1108
	German	-3.212	0.1245
PV	Chinese	-3.234	0.2156
	German	-3.200	0.1167
Ballast	Chinese	-3.015	0.1998
	German	-3.266	0.1789
Light	Chinese	-3.336	0.1689
	German	-3.241	0.1997
Battery	Chinese	-3.367	0.1356
	German	-2.789	0.0989

Then according to the final parameters estimates $B\phi$, B_1 which were obtained at the specific of suitable iterations which had been occurred with applying the Logistic model and using Min. Chi Square method of estimating.

Step (4): The final step is to determining the expected of probable responding estimates which are access in the next fighter 1. These should be achieves in 100 circle in order to be sure which period of times that each of the studied properties would be survived, and enable to compare between the two different sources of each Solar system researched. Simulation technique had been applied through generating error term for standard logistic distribution function , with mean zero and standard deviation one , which is for the first time as far as (as we know) [1] .



Fighter 1. The expected of probability responding estimates (P_t)

through applying Logistic model and using Min. Chi Square method per (month)

Figure 1 showed the band charts of the expected responding estimates (P_t) through applying Logistic model through using Min. Chi Square method Per (month) which representing the long term trend curves of the predictive and forecasting life time of the studied components in the both sources of the solar cells equipments. The preceding results indicating that the German life time equipments illustrated advantage in the duration better than Chinese product.

The following table 6 represents the predicted periods of life (Survivals time) that each of the studied components would be continued works in the system until to the last individual death would be.

Table 6. Predicted periods of life (duration per month) that each of the studied components would be continued in works up to the last individual

Sources	Solar cell	PV	Ballast	Light	Battery
Chinese	53	40	37	50	60
German	65	68	47	73	75

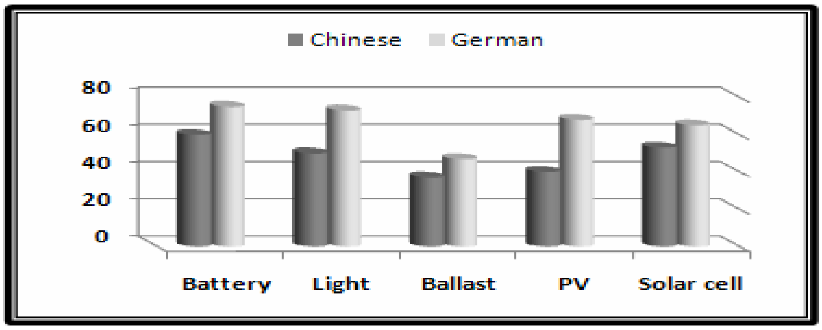


Figure 2. Predicted periods of life (duration per month) that each of the studied components would be continued in works up to the last individual

6. Conclusions

1. Solar cell in German product represents 18.5% of increasing advantage in the duration better than Chinese source.

2. PV controller in German product represents 26.5% of increasing advantage in the duration better than Chinese source.
3. Ballast (inverter) in German product represent 21.3% of increasing advantage in the duration better than Chinese source.
4. Light in German product represent 31.5% of increasing advantage in the duration better than Chinese source.
5. Battery (inverter) in German product represents 20% of increasing advantage in the duration better than Chinese source.

For summarizing the obvious items, German life time equipments illustrated advantage in the duration better than Chinese source.

7. Recommendations

1.Expected of probability responding estimates (Pt) can be estimated through applying another models such as Extreme value distribution type I & type II.

2.Another method of estimating can be used such as Max. Likelihood method.

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