



Khalifa University of Science Technology and Research

ENGL 220: Technical Writing

## Feasibility Report

---

Solar Mobile Phone Battery Charger

### **DONE BY:**

Aamena Alhammadi 100020202

Hanan AL-Hosani 100020263

Reem S.K Ashour 100033124

### **SUBMITTED TO:**

Ms. Sabina Ostrowska

**SUMMER 2011**

## Contents

Table of figures .....	3
1. Abstract.....	4
2. Introduction.....	5
2.1 Purpose.....	5
2.2 Scope.....	5
2.3 Procedure .....	5
2.4 Background .....	5
3. Discussion.....	6
3.1 The problem.....	6
3.2 The solution .....	7
3.3 Technical details and implementation.....	7
3.3.1 Solar cells.....	8
3.3.2 The process of charging mobile phone battery with solar cells .....	10
3.3.3 The connection of the thin film solar cell to the mobile phone battery.....	10
4. Limitations and future improvement.....	13
5. Costumer response .....	13
6. Conclusion .....	14
7. References.....	15
8. Appendixes .....	16
Appendixes A.....	16
Appendixes B.....	17
Appendixes C.....	18

## Table of figures

Figure 1: The result of the survey shows if the mobile battery is an issue or not. ....	6
Figure 3: The result of a survey conducted at Khalifa University shows the usage time of the mobile phone. ....	6
Figure 2: The percentages indicate the mobile phone charging time a day according to the survey. ....	6
Figure 4: Solar cell components.....	8
Figure 5: Flexible thin film solar cell [6] .....	9
Figure 6: Many modules in one array [7].....	10
Figure 7: Solar cell in one module [7] .....	10
Figure 8: Photovoltaic system components.....	10
Figure 9: The first incorrect connection of the solar cell to the mobile phone. ....	11
Figure 10: The efficient connection of the thin film solar cell to the mobile phone. ....	12
Figure 11: The efficient connection of the thin film solar cell to the mobile phone battery shown the way of transferred energy.....	12
Figure 12: The result of the survey shows the students opinion about the innovation.....	13

## 1. Abstract

The feasibility report presents a solution for the short life of the mobile phone battery. To address this issue we suggest using the thin film solar cell in order to extend the mobile phone battery which will be charged from different sources. A survey and interviews with professors and students at Khalifa University were employed to examine the feasibility of the solar mobile battery charger. The criteria followed to accomplish the solar mobile battery charger started with a deep look into the thin film solar cell and its work concept, followed by the connection of the solar battery and a mobile phone to innovate a high performance process of charging the battery. Finally, the limitation and customer responses were briefly discussed. The result we obtained achieves the long life mobile phone battery by charging it directly when its power is running out. The objectives we intend to achieve in this report are to consider this idea as a starting point of improving the mobile phone battery and to shed light on the renewable sources because of its advantages.

## **2. Introduction**

### **2.1 Purpose**

The purpose of this report is to present the results of our investigation in attaching solar cells to the mobile phones in order to achieve longer battery life using renewable energy sources.

### **2.2 Scope**

The report covers the details of the problems people face with present mobile batteries, and then it proposes a solution for these problems. After that, the report goes over the technical details and describes the solar panel and the connection. In addition, the report raises some points that may limit the availability of this invention at the moment. Finally, it concludes with some customer response.

### **2.3 Procedure**

To begin with, 50 students at Khalifa University were asked to complete a survey (Appendix A). The purpose of the survey was to come up with a new idea that our target customers may think about in order to improve our product and innovation. In addition, some information was gathered from several sources such as books and websites.

### **2.4 Background**

With the fast increase of technology and science in engineering disciplines, new innovations are created in every single minute. As the populace relies more and more on mobile phones, features always are requested to be improved, applying the latest technology. That's why extending the mobile phones battery life will be of great benefit for all people.

### 3. Discussion

#### 3.1 The problem

The increasing need of the mobile phone among the society requires increasing in its applications which use up most of the mobile phone energy. The mobile phone is used to be carried out everywhere but what is the benefit of carrying it when its power is running out?

Figure 1 shows the results of a survey filled by 50 students in Khalifa University. There are 38 students agreed that the short mobile battery life is considered as a serious problem for any mobile phone users, as they charge it twice or more a day.

In fact, the issue of the mobile phone battery leads the user to face other serious problems, one of these problems is affecting the environment by resuming a huge amount of the nonrenewable sources (electricity), since each user needs minimum 12 volt to charge a mobile phone once a day while the average life – time of the battery depends on the user and the applications used as well. Moreover, the conducted survey shows that 84% of the students use their mobile phones 10 or more hours a day. As a result, 72% of them need to charge their mobile phones twice or more a day especially Smartphone users. One respondent mentioned that “nowadays we can accomplish our duties easily using our mobile’s applications such as following emails and updating the social networks like Facebook and Twitter” (Respondent 1, Appendix C).

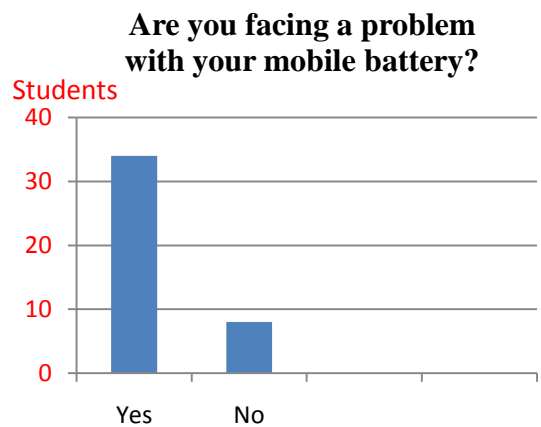


Figure 1: The result of the survey shows if the mobile battery is an issue or not.

#### For how long do you use your mobile phone a day?

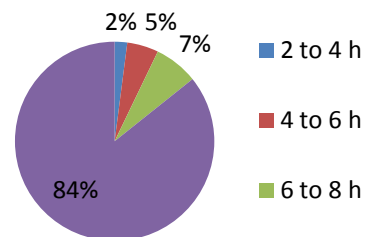


Figure 2: The result of a survey conducted at Khalifa University shows the usage time of the mobile phone.

#### How many times do you charge your mobile phone a day?

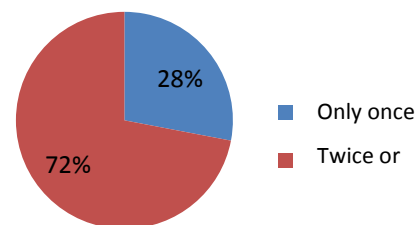


Figure 3: The percentages indicate the mobile phone charging time a day according to the survey.

According to Opara, Efemena and Felix [1], the mobile operator profits reduce in the range of 10 – 14% when their mobile subscribers are either out of network coverage area or when their batteries are out of the power. In addition, carrying cables everywhere to avoid the sudden mobile phone's switching off which makes the usage of the device unpractical. Therefore, our new innovation will focus on solving this issue using an efficient and convenient ways.

### **3.2 The solution**

This problem is worth to be solved according to its importance and its beneficial effects to the society. Our solution focuses on using the solar energy to recharge the mobile phone battery. As we all know, from the birth of the universe, the sun shines, glows over our world and sends huge amount of solar radiation every day. This energy can be used to produce electricity for different purposes using solar cells. Therefore, in our innovation we used solar cells to convert the solar energy into electricity. We did that by attaching the solar cells to the mobile phone electrical battery to be recharged and to extend its life, which will be discussed in more details later. Whenever there is light, the solar battery works, so the electronic battery can be recharged and its life time can be extended. Solar cells or solar energy have been chosen to be the solution of this problem because of many reasons. First, it reduces the dependency on the finite recourses such as the petroleum. Second, it is environmentally friendly since it has less effect on the environment. Furthermore, it is clean, renewable and infinite energy sources. Moreover, it is flexible and it doesn't need a station. It can be used in the place of the demand. But there are small problems in the solar cells such as the cloudy days and density, which are going to be solved by using new type of solar cells which is the thin film solar cell.

### **3.3 Technical details and implementation**

There are two basic components to construct our innovation. The first component is mobile phone and the other one is solar cells. In this part of the report, we will cover all the details and the information needed to understand the component of the innovation well and how it works. First, we will take a deep look at the solar cell and understand how it works. Then, we will discuss how the electricity that is generated from the solar cells is going to be used in order to recharge the mobile battery. Moreover, a comparison between the electric battery and

the solar cells will be presented. Finally, this paper will demonstrate how the solar cells will be attached to the mobile phone.

### 3.3.1 Solar cells

Solar cells are the main unit of the solar panel. It is also called Photovoltaic (PV) cell, "the name implies (photo meaning "light" and voltaic meaning "electricity")"[2]. The main function of the PV cell is to convert the sun light which consists of photons to electricity. In our innovation we are going to use a specific type which is called thin film solar cells. According to Figure 4, solar cells consist of layers. These layers are: the glass cover, antireflective coating, contact grid, two semiconductor layers and back contact. The most important layers will be explained in the next section.

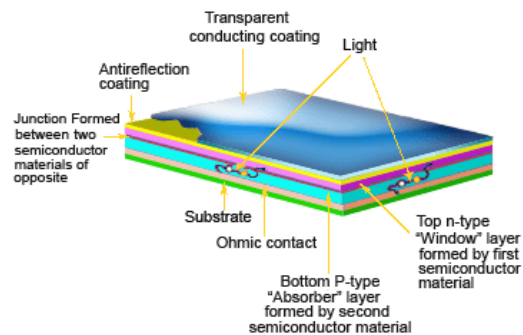


Figure 4: Solar cell components

One of the main layers is the Glass Cover, which is a non colored material. Its purpose is to allow the sun light to hit the semiconductor layers in order to use the solar energy and to protect the inner layers. The second important layer is the Antireflective AR Coating; "it is made of thin film and it causes the intensity of the light reflected from the inner surface and the light reflected from the outer surface of the film to be nearly equal"[3]. In fact, this layer reduces the reflections on the surface. In our innovation, we will double this layer to enhance the efficiency of the solar cell and to avoid the reflection and increase the absorbed light. The Contact Grid and the Back Contact are made of metal to conduct the electricity.

On the other hand, the most important layers are the Semiconductors layers since it is required to generate electricity. The semiconductor material can be doped. Doping "is the addition of controlled amounts of specific impurity atoms with the sole purpose of increasing either the



electron or hole concentration” [4]. The location of these layers is in the middle as Figure 4 shows. In general, when photons are sent from the sun to the solar cell, they are absorbed by a specific material. If the energy of the photon is sufficient enough it can excite electron from its level to higher level of energy. The excited electron comes to its original state, but in our situation we don't want that to happen. Therefore, we should have an electric field that forces the electrons to move in one direction. This electric field can be constructed by attaching two layers of doped semiconductors. This is going to force the excited electrons to flow in one direction. Finally, an electromagnetic force (emf) is produced with 0.5 volt. Electricity is produced and ready to be used.

In our innovation we choose the thin layer solar cells for many reasons. First, this type has exactly the same functionality as the traditional solar cells but it is made of thin layer. Moreover, this type was chosen to solve the problem of the cloudy days or the density as well as the thickness. According to Harris [5], “thin-film solar cells have light-absorbing layers that are just one micron thick. A micron, for reference, is one-millionth of a meter (1/1,000,000 m or 1  $\mu\text{m}$ )”. Furthermore, as [6] clarified, the thin film is easy to handle. It is flexible so that it can take the shape of the mobile phone (see Figure 5). Finally, it exists as thin wafer sheets and it is cheaper than traditional solar cells.

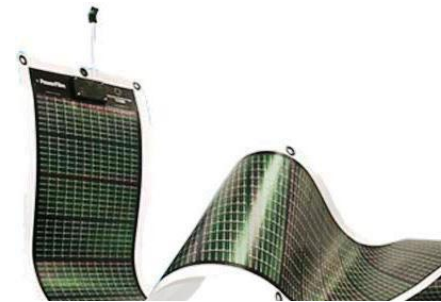


Figure 5: Flexible thin film solar cell [6]

Nevertheless, according to Nelson [7] there is a small problem which is that the voltage constructed is very small to recharge the mobile phone battery if it was 0.5 volt. The mobile battery needs 12 Volt to operate. Therefore, as Nelson [7] mentioned, we need a package of 36 PV cells connected in series to create a module with 12 volt (see Figure 6). Moreover, a Group of modules is called arrays as shown in Figure 7. In the array, the modules are connected in series to increase the voltage needed and in parallel to increase the efficiency of the system. Connecting modules to each other will give us an electricity generator that is called solar panel. Solar panel generates electricity that can be used and saved at the same time in order to recharge the mobile phone battery. What happens to that electricity in order to reach the mobile phone battery and recharge it?

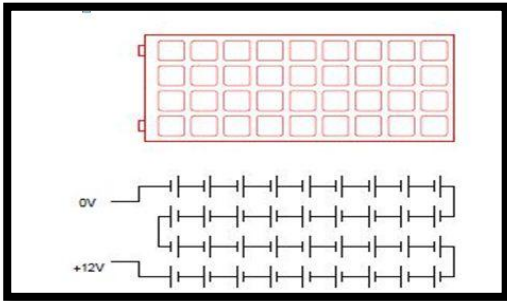


Figure 7: Solar cell in one module [7]

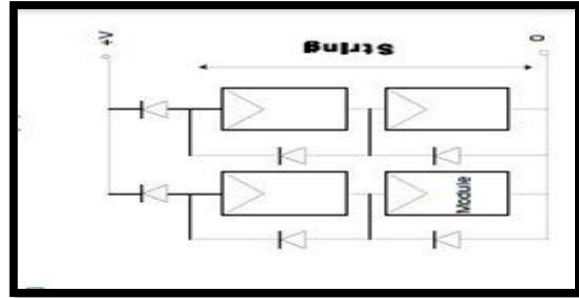


Figure 6: Many modules in one array [7]

### 3.3.2 The process of charging mobile phone battery with solar cells

After the solar cells absorbed the light from the sun, the main process for charging the solar battery will start by passing through the photovoltaic (PV) panels.

According to Figure 8, the PV panel converts the solar energy into Direct Current (DC). Therefore, it helps the solar energy to enter to the system.

In the second step, the current will be regulated by passing through the charge controller which controls the charging and discharging functions.

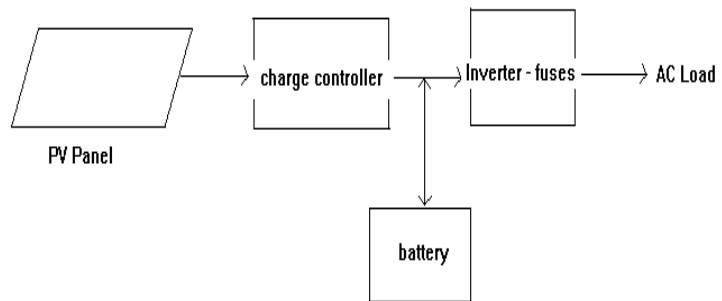


Figure 8: Photovoltaic system components

After that, the current will be haggard from the battery achieving our innovation by extending the battery life time. This step is only needed when the current should be converted from one type to another appropriator. According to a study conducted by us at the charging process, we found that the appropriate current in our innovation is the AC current. The reason is that the amounts of electrons in the alternative current AC are moved from both directions while in the direct current (DC) flows only in one direction. Finally, an electric field will be created which leads to create an output current that goes to the mobile battery which it's connected with and the current will help in generate power and recharge the battery.

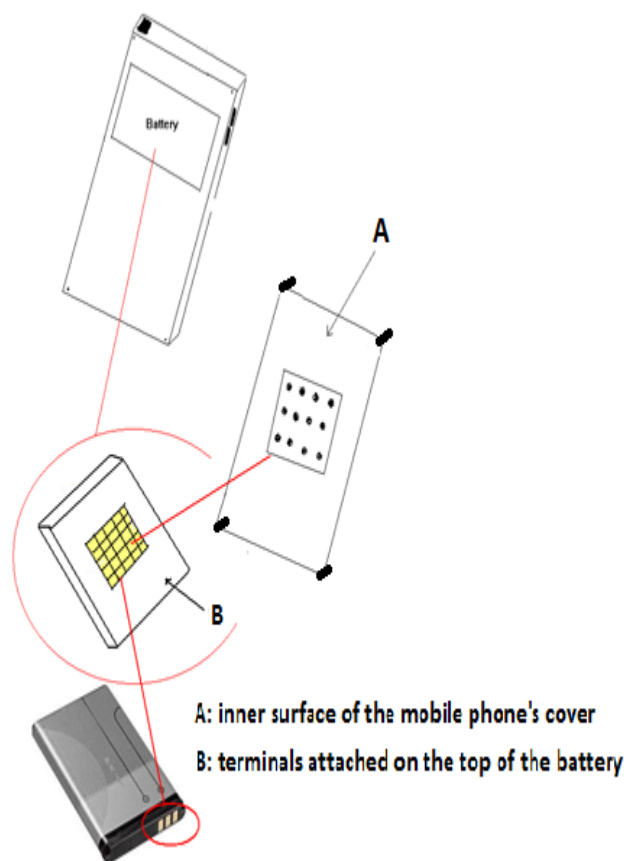
### 3.3.3 The connection of the thin film solar cell to the mobile phone battery

The primary idea for this innovation is to charge the mobile phone battery using attached thin film solar cells which will absorb the energy from different sources. Therefore, the components

used in the innovated connection will mostly depend on the thin film solar cell and terminals. In general, the terminals are made of Copper which helps in transferring the energy or electrons between parts. In addition, terminals are connecting to the voltage sensor which controls the charging current as mentioned in 3.3.2. Therefore, terminals in the mobile phone act as a conductor between. In fact, in this connection two things will be add to derive the energy to the device. First to add terminals on the top of the battery, this will increase the cost of the mobile phone. the solar cell and the battery terminals to deliver the energy inside the battery to start the innovated charging process. Here two methods of connections were studied in order to accomplish this innovation with achieving the aims of reducing the electricity usage.

### ***3.3.3.1 The first connection***

In this method, a thin film solar cell should be attached in to the inner surface of the mobile phone cover as what in Figure 9(A). In addition, terminals will be attached in the top of the battery phase as in Figure 9 (B). This will allow the thin film solar cell and the terminal to connect with each other. This connection will allow transferring the energy from the absorbing light to the terminals and then the charging process will start. Second, the mobile phone battery cover should be made of a specific material which allows absorbing operation. Therefore, we came up with a more efficient connection which will solve the previous limitations.



**Figure 9: The first incorrect connection of the solar cell to the mobile phone.**

### 3.3.3.2 The second connection

In this connection we will add small modifications to improve the previous method. Therefore, the thin film solar cell will be a part of the mobile phone cover. As Figure 10 shows, no surfaces will be behind or in front of the cell. As a result of the above method, the light absorbing operation will be easily created. Moreover, the flexibility and the protective layers of the thin film solar cell are great factors for its location and no problems will be faced. In addition, small wires will be attached with the thin film solar cell and no additional terminals will be required. As a result, the direct connection between battery and the thin film solar cell will be achieved as shown in Figure 11. In our innovation wires will help in transfer the energy from the thin film solar cell to the battery in order to achieve the solar battery charging process which can deliver the power to the mobile phone.



Figure 10: The efficient connection of the thin film solar cell to the mobile phone.

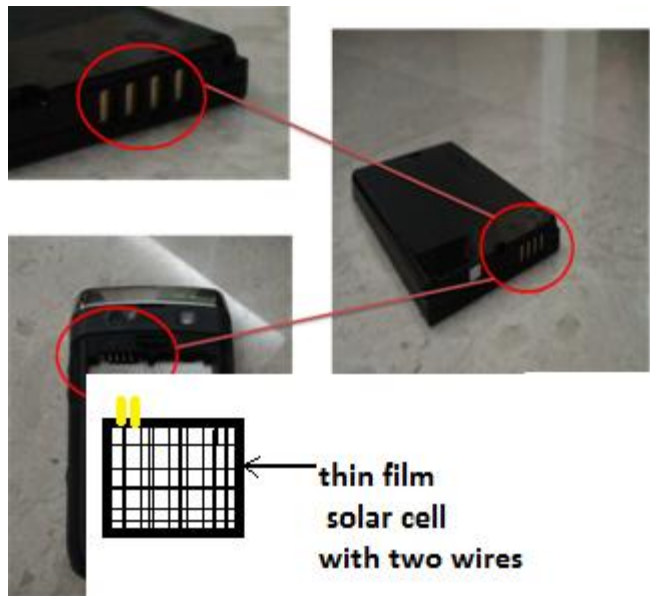


Figure 11: The efficient connection of the thin film solar cell to the mobile phone battery shown the way of transferred energy

#### 4. Limitations and future improvement

With the threat of global warming and the gradual depletion of petroleum supplies, it is natural to ask why we don't use more solar energy. One of the most important problems is the high cost of the technology used to run this type of energy production [6]. Although solar energy saves money as the full energy comes from the sun, solar cells and other technology that are needed to convert this energy are expensive

The thin-film solar cells used in our innovation are better than other cells in many things like cost and thickness. However, there are few drawbacks that have so far limited the use of thin-film solar cells. First, thin film solar cells have less efficiency than other solar cells. Only 20-30% of the sun light is converted into electricity. Second, the users need to be very careful in handling thin-film solar cell. This may make mobile phone not so practical and may annoy the users [6].

In the other hand, in spite of all the disadvantages of the solar energy technologies, the fact of having the sunlight for free with no costs will encourage people to develop their ideas and use this power in several fields. This will make it competitive with petroleum power, as it cost lots of money to turn on machines. Furthermore, small solar panels will be available in the future. So, having materials with practical size and reasonable price will be ideal choice for manufactures.

#### 5. Costumer response

To ensure the success of the innovation, two surveys were made to get the ideas that our target customers may think about in order to improve our product and innovation. The first survey has been conducted on 50 students at Khalifa University before working on the innovation. One of the survey questions was (What do you think about attaching solar cells to your mobile in order to extend battery life?). As shown in Figure 12, the students have different answer with different ideas and reasons. 11.9% of the students think that

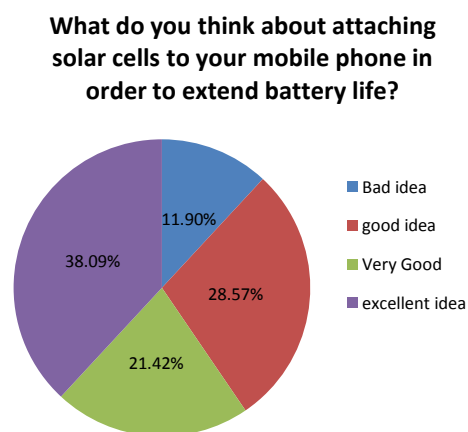


Figure 12: The result of the survey shows the students opinion about the innovation

attaching solar cells to mobile phones is a bad idea because solar cells need large space that will not fit small mobile phone and because the sun is not available every time and everywhere. Their ideas have been taken into consideration, for that we decided to use thin-film solar cells to solve these two problems. However, 88.1% of the students think that attaching solar cells to mobile phones is a good idea because they believe that solar cells are environmentally friendly, save the earth from global warming, and help a lot in saving renewable resources. The second survey has been conducted on approximately 25 students at Khalifa University after presenting our innovation. This survey includes the same question, but since the students understand well the design and the features of our innovation, all of them encourage us to complete our research and put this product on the market as soon as possible.

## **6. Conclusion**

This feasibility report demonstrates a solution for a real daily problem. This solution can be the start of a great research and great innovation. The objective was to facilitate continuity of the communication between people 24/7 by building a solar charger. Connecting a solar charger into mobile battery allows us to extend mobile phone battery life by recharging the mobile phone battery. Using thin film solar cell allows us to enhance our innovation since it has the desired thickness and the option of absorbing light from light bulbs.

There were some limitations that we couldn't get over it like the size of the solar panel. Therefore, we recommend the scientist to focus more on this area because if this problem is solved, then our innovation will be applied to all smart phones and portable devices. In addition, another constraint that can be solved with time is the low efficiency of the thin film solar cells. Hence, we think that more research about the thin film solar cells should be done to increase its efficiency. Moreover, scientist should focus on the connection and attaching solar cells to the mobile phone battery in order to insure its stability and working. Finally, as recommendation the companies should start applying this innovation in order to consider users response and to focus on finding alternatives to the limits.

## 7. References

[1] F.K. Opara, O.E Efemena and E. Felix, "Solar Solution for Mobile Charging Centers in Nigeria", *International Journal of Academic Reasearch, Part II*, vol. 3, no. 1, pp. 418-426, Jan. 2011.

[2] J. Toothman and S. Aldous. How Solar Cells Work: Photovoltaic Cells: *Converting Photons to Electrons*. (n.d) [online]. Available <http://science.howstuffworks.com/environmental/energy/solar-cell.htm>.

[3] T. Bedinghaus. (January 06, 2009). *Anti-Reflective Coating* [Online]. Available: <http://vision.about.com/od/basicvision/g/ARCoating.htm>

[4] S.Singh (2011) Electronic Circuits and Devices I : Semiconductors [lecture].KUSTAR. Electronic Department

[5] W. Harris. (n.d.) *How Thin-film Solar Cells Work: What is a Thin-film Solar Cell?* [Online]. Available: Howstuffworks: <http://science.howstuffworks.com/environmental/green-science/thin-film-solar-cell1.htm>

[6] Vysakh. (Jun-2011). *Thin Film Solar Cell* [Online]. Available: CircuitsToday <http://www.circuitstoday.com/thin-film-solar-cell>

[7] J. Nelson, *The Physics Of Solar Cells*. Imperial College, UK, 2003.[Online]. Available at : [http://www.worldscibooks.com/etextbook/p276/p276\\_chap1.pdf](http://www.worldscibooks.com/etextbook/p276/p276_chap1.pdf)

## 8. Appendixes

### Appendixes A First survey

#### Survey about extending mobile phone battery life

---

*Could you please help us by answering these quite questions?  
It will not take a lot of your time but it will help us a lot*

1. For how long do you use your mobile phone a day?  
2 to 4 h      4 to 6 h      6 to 8 h      > 10 h
2. Do you face a problem with your mobile phone battery life?  
Yes              No
3. **IF YES** Do you wish to have a solution for this problem?  
Yes              No
4. How many times do you charge your mobile phone a day? Why?  
Once only      Twice or more  
-----  
-----
5. Do you have any idea about solar cells?  
Yes              No              Not sure
6. If there is a mobile phone that would charge itself using solar cell, will you buy it even if its cost is a **bit** more expensive than a normal mobile phone?  
Yes              No              Not sure
7. Do you think that this innovation will decrease your electric bill cost (saves you money)?  
Yes              No              Not sure
8. What do you think about attaching solar cells to your mobile in order to extend battery life? Why?  
Bad idea      Good idea      Very good idea      excellent idea  
-----  
-----

*Thank you for your help*



## Appendix B

### First Survey results (1)

Questions	Answers			
	2 to 4 h	4 to 6 h	6 to 8 h	> 10 h
For how long do you use your mobile phone a day?	2%	5%	7%	84%
	yes		No	
Do you face a problem with your mobile phone battery life?	80.9%		19.1%	
IF YES Do you wish to have a solution for this problem?	80.9%		19.1%	
	Once only		Twice or more	
How many times do you charge your mobile phone a day? Why?*	28%		72%	
	yes	no	Not sure	
Do you have any idea about solar cells?	69.04%	7.16%	23.8%	
If there is a mobile phone that would charge itself using solar cell, will you buy it even if its cost is a bit more expensive than a normal mobile phone?	52.38 %	11.9 %	35.71%	
Do you think that this innovation will decrease your electric bill cost (saves you money)?	66.6%	7.1%	26.1%	
Do you think that this innovation will be published over the world?	69.04%	4.7%	26.16%	
	Bad idea	Good idea	Very good idea	Excellent idea
What do you think about attaching solar cells to your mobile in order to extend battery life? Why?*	11.9%	28.57%	21.42%	38.09%

Table 1: The results of the survey in percentage

\* Please check Appendix C to know why.

## Appendix C

### First Survey results (2)

4. How many times do you charge your mobile phone a day? Why?

Once only

Twice or more

nowadays we can accomplish our duties easily using our mobile's applications such as following emails and updating the social networking like Facebook and twitter.

Respondent 1

4. How many times do you charge your mobile phone a day? Why?

Once only

Twice or more

I made a lot of calls, and I want it to be available all the day.

Respondent 2

8. What do you think about attaching solar cells to your mobile in order to extend battery life? Why?

Bad idea

Good idea

Very good idea

excellent idea

because the solar is big in size which make it difficult to carry and the small solar will take long time to charge

Respondent 3

8. What do you think about attaching solar cells to your mobile in order to extend battery life? Why?

Bad idea

Good idea

Very good idea

excellent idea

Because some time we loose our Mobile Energy when we are outside the Home and we might use it for Emergency Cases; by having these cells the battery life will be extended and users will feel comfortable.

Respondent 4

8. What do you think about attaching solar cells to your mobile in order to extend battery life? Why?

Bad idea

Good idea

Very good idea

excellent idea

Save earth from global warming

Respondent 5

8. What do you think about attaching solar cells to your mobile in order to extend battery life? Why?

Bad idea

Good idea

Very good idea

excellent idea

\* Because this is a good way to reduce the use of electricity.

Respondent 6