Towards Strategic Plan for Lights Replacement in Residential Sector of Libya

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ABSTRACT

This study focuses on the strategic plan proposed to get rid of incandescent bulbs in residential sector of Libya and replace them with another types of economic bulbs such as CFL lamps, and LED lamps. The strategy was divided into two main stages. Getting rid of the incandescent lamps of type of 100W as a first stage, followed by elimination of 60W incandescent lamps for the second stage.
Two types of energy saving bulbs were used in each stage, for the first stage a 20W of LED bulbs type and 22 W of CFL bulbs type were used to replace the incandescent lamps, while a 12W bulbs LED type and 15W of CFL bulbs type were chosen to replace the incandescent lamps for the second stage.
The economic and environmental benefits resulting from the application of this strategy was analyzed and presented in this paper, the results show that three years are enough for the implementation of this strategy to compensate the overall cost of the project.

KEYWORDS

Energy saving, Energy efficiency, bulbs technology, Incandescent bulb, LED bulb, CFL lamp, strategy plan

1. INTRODUCTION

Rationalize energy consumption means using it in a rational utilization and reduce wasteful consumption. That includes practical number of procedures to be followed to reduce wasteful energy systems different classifications, especially in the field of lighting the residential sector as the most consumed sector.

As the economic operation optimized for light bulbs is the most effective way in this area. The process of searching for energy alternatives and use them as a substitute for the traditional lamps will achieve environmental and economic gains.

More ever, many studies have been conducted around the world to improve the energy efficiency, and reduce the average consumption in the buildings [1],[2],[3]. Abdunabi and brawen[4] have study the replacement of electric water heaters with solar water heaters in Libya. They have suggested strategy over 15 years to replace 800,000 systems all over Libya. The result showed, at the end of the replacement programs over then 73 million US Dollar can be saved yearly.

As a complement to previous study published in IREC in Tunisia 2012 which showed the proportion lighting energy consumption in the residential sector, which amounted to 2865.99 GWh / year and the saving amounted to 54% and 74% by using CFL and LED bulbs respectively as shown in figure 1. [5]

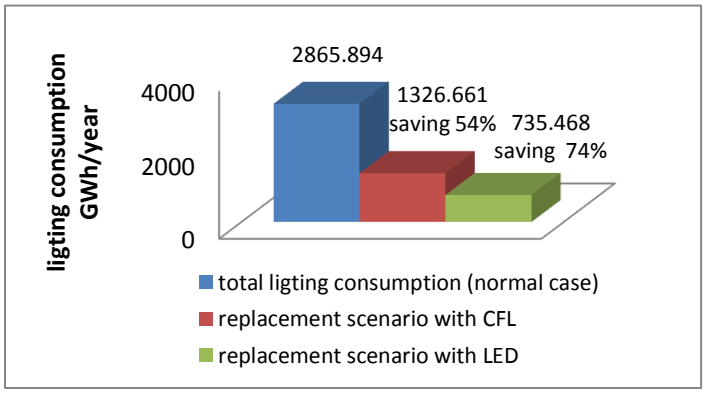

Figure 1. Annual energy saving.

The aim of this study is to reduce the electricity consumption in the lighting of the main consuming sectors of electrical energy, which is the residential sector by putting strategy plans to get rid of incandescent bulbs with applying mechanism and estimated years to apply this strategy and the economic, environmental benefits that can be get from the applying of this strategy.

2. STRATEGIES FOR SOME OF THE WORLD COUNTRIES TOWARDS ENERGY LIGHTING CONSUMPTION

1. Cuba in 2005 replaced all traditional bulbs with energy-saving bulbs and banned the use of incandescent bulbs. [6]
2. India is about to replace 400 million traditional bulbs with energy saving bulbs through 2012. [6]
3. Philippines, Australia and Argentina will ban sale of traditional bulbs during 2012, following them the United Kingdom during 2013, also the European Union and Canada after the year 2012, Malaysia in 2014, as well as some U.S. states in the later stages. [6]
4. Russia has taken a series of actions towards halting the production of incandescent bulbs and replacing them with energy saving bulbs. [6]
5. The Lebanese Center for Energy Conservation project work during 2013 aims to distribute three million energy-saving bulbs on Lebanese homes to supply every house with three bulbs and they covered so far 66% of homes in Lebanon. [7]

3. SOME OF THE STRATEGIES THAT MUST BE FOLLOWED TO RAISE EFFICIENCY AND ENERGY SAVING

There are many actions and programs that help to conserve energy and reduce waste energy, some of them:

1. Establish seminars, forums and workshops to raise awareness of the energy efficient lighting, targeting mainly the traders and import-export companies. primarily focuses seminars on specifications and standards, the new regulations for the application of technical rules relating to energy efficiency and exit a set of recommendations and standards, and that the application of these rules will protect citizens and consumers and will allow access to the importation of goods into the local market with efficient and high quality and energy-saving and a longer lifespan.

2. Promote scientific and applied research in the field of energy saving and the establishment of scientific conferences and to provide material and moral support.

3. Raise the awareness among citizens and providing outreach programs through the guidance office and outreach to the electricity sector through the visual media and audio-visual shows the importance of consumer energy conservation and defined systems of energy-saving lighting and the resulting economic gains when used.

4. The Ministry of Electricity initiative use energy saving bulbs by sale them through centers of distribution-collection as it is a direct link between the customer and the company. This can be done by the monetary or installments system, and giving a guarantee. In the case of installment, the monthly installment is collected from the electricity bill.

5. Also the Ministry of Electricity within their awareness program, sells the energy saving bulbs by half cost price to encourage citizens to buy them for a certain period, for example (where they will be selling 7 million lamp at a maximum of 6 bulbs per subscriber), as a step from the state to support this program.

6. Develop an implement plan within a certain period of time, supported with a number of legislations, laws and procedures. These can be summarized as follows: -

    - Prohibiting the import of 100watt bulbs and above as a first step to get rid of them and put high rate taxes on importers.

    - Banning the purchase bulbs 100watt and 60watt as a second step with current inventory depletion.

    - Phasing out incandescent bulbs that have different capabilities and replace them with economic bulbs with a commitment to the international specifications for light intensity and reduced price through state support for its cost.

4. STRATEGY TO REPLACE (60-100)WATT LAMPS

4.1 Methodology

It may be difficult and costly if we change all incandescent bulbs at the same time, but we will

change them gradually. This can be achieved by the following steps:

1. Provide the total number of installed incandescent bulbs type of (100, 60) watt.
2. Replace incandescent bulbs (100,60) watt by using LED lamp as case1 and CFL as case2
3. Calculate the annul energy saving after replacing the bulbs for each case , then calculate the cost of this saved energy
4. Calculate the price of each replacement bulbs for each case (LED&CFL).
5. Calculate the estimated time for compensating the bulbs cost.

The details and results of these steps are provided in the next section.

4.2 Data Analysis and Results

The average number of 60,100 watt lamps in the Libyan home is shown in Table 1. [5].

Table1. Total number of (60,100) W lamps in residential sector of Libya.

Type	flat	villa	Common houses	Total
60 W	877,270	1,191,252	5,049,960	7,118,482
100W	1,228,178	1,389,794	5,049,960	7,667,932

4.2.1 First Stage

In this stage we will replace incandescent 100W bulbs and show two different cases:

Case 1: replace 7,667,932 of 100W incandescent bulbs with 7,667,932 of 20WLED bulbs.

Case 2: replace 7,667,932 of 100Wincandescent bulbs with 7,667,932 of 22WCFL bulbs.

- The annual energy saved by 7,667,932 bulbs can be calculated according to the following equation:

$$\text{energy saving(MW)} = \text{no.bd}_{100} * \frac{100 - \text{A}}{0.9} * 4 * 365 * \text{D} \qquad (1)$$

With Taking into account that:

***no.bd*$_{100}$:** no. of distributed bulbs instead of 100w.
100: power of incandescent bulbs that will be replaced.
A: Power of alternative bulb with 100w bulb.
0.9: estimated power losses in the network which amount to 10%.
D: economic disruption rate of lamps where an estimated 0.85 which is 15%.
4: daily average lighting operating hours. [5]
365: number of days per year.

$$case\mathbf{1}: 7{,}667{,}932 * \frac{100 - 20}{0.9} * 4 * 365 * D = 845858.10\ MW$$

$$case\mathbf{2}: 7{,}667{,}932 * \frac{100 - 22}{0.9} * 4 * 365 * D = 824711.65\ MW$$

The energy saving per year and the cost of annual energy saved for both actual (0.11 LD/kWh)[13] and subsidized (0.020 LD/kWh)[13] prices are shown in the Table 2.

Table2. Annual energy saving and their cost for stage1.

No.	Annual Energy saving(MWh/yr)	saving cost(m LD)	
		subsidized	actual
Case 1	845858.10	17.0	93.5
Case 2	824711.65	16.5	90.7

The cost of LED lamps is $8 [9] and the cost of CFL is $5 [8] then the total cost of all replaced bulbs is given in Table 3 below.

Table3. Price of energy saving lamps for stage1.

	Typeof bulb	bulb Price($)	Total cost of replaced bulbs(m LD)
Case 1	20W LED	8	79.747
Case 2	22W CFL	5	49.842

- The estimated years for compensating the bulbs cost are shown in Table 4:

Table4. Results of calculation for stage1.

	Fixed cost (m LD)	Getting cost (m LD)	Remainder cost (m LD)	Years of compensated remainder cost(year)	
				subsidized	actual
Case 1	79.747	7.668	72.079	4.5	1
Case 2	49.842	7.668	42.174	3	0.5

The getting money means, which the money gets from consumer by buying the lamps by 1 LD, and the rest cost is the fixed cost minus getting money.

The estimated years to compensate this rest money are calculated from the cost of annual energy saved.

4.2.2 Second Stage

In this stage we will replace incandescent 60W bulbs and show two different cases:

Case 1: replace 7,118,482 of 60W incandescent bulbs with 7,118,482 of 12W LED bulbs.
Case 2: replace 7,118,482 of 100Wincandescent bulbs with 7,118,482 of 15W CFL bulbs.

- The annual energy saved by 7,118,482 bulbs can be calculated according to the following equation:

$$\text{energy saving(MW)} = \text{no.bd}_{60} * \frac{60 - \text{B}}{0.9} * 4 * 365 * \text{D} \quad (2)$$

With Taking into account that:

***no.bd*$_{60}$:** number of distributed bulbs instead of 60W.
60: power of incandescent bulbs that will be replaced.
B: Power of Replacement bulb with 60w bulb.
0.9: Estimated power losses in the network which amount to 10%.
D: economic disruption rate of lamps where an estimated 0.85 which is 15%.
4: daily average lighting operating hours. [5]
365: number of days per year.

$$case\ 1: \quad 7{,}118{,}482 * \frac{60 - 12}{0.9} * 4 * 365 * D = 471148.60\ MW$$

$$case\ 2: \quad 7{,}118{,}482 * \frac{60 - 15}{0.9} * 4 * 365 * D = 441701.88\ MW$$

The energy saving per year and the cost of annual energy saved for both actual and subsidized prices are shown in Table5.

Table5. Annual energy saving and their cost for stage2.

no	annual Energy saving(MWh/yr)	saving cost(m LD)	
		subsidized	actual
Case 1	471148.60	9.42	51.83
Case 2	441701.88	8.83	48.59

- The cost of LED lamps is $6.5 [10] and the cost of CFL is $4 [8] then the total cost of all replaced bulbs is given in Table 6 below.

Table6. Price of energy saving lamps for stage2.

No.	Type of bulb	Price bulb($)	Total cost of replaced bulbs (m LD)
Case 1	12W LED	6.5	60.15
Case 2	15W CFL	4	37.02

- The estimated years for compensating the bulbs cost are shown in Table7.

Table7. Results of calculation for stage2.

	Fixed cost (mLD)	Getting cost (m LD)	Remainder cost(m LD)	Years of compensated remainder cost(year)	
				subsidized	actual
Case 1	60.15	7.118	53.032	5.5	1.5
Case 2	37.02	7.118	29.902	3.5	1

4.3 The Environmental Impact Resulting From the Application of This Strategy

The most important results and positive externalities of this strategy to reduce carbon dioxide emissions which today is of interest to researchers, scholars and environmentalists, international organizations and humanitarian ; but the generation of electricity in Libya characterized at present by a factor of emissions equal to 0.87 tons equivalent of carbon dioxide / MWh [12].and the strategy will enable to provide millions of tons equivalent of carbon dioxide, Table 8 shows the calculated results By the following equation:

$$\text{CO}_2 \text{ saving} = 0.87 * \text{total Energy saving(MW)} \quad (3)$$

Table8. CO_2 Saving.

No.	CO_2 Saving (ton/MW)	
	Stage1	Stage2
Case 1	735897	409899
Case 2	717499	384281

In addition of saving money, the environmental consideration can be carried out, if we take into account that:

0.001016 kg CO_2 = 1 k Calorie. [12]

The amount of heat released to the environment that can be avoid for case1 and case2 are about $7.2*10^{11}$ and $7.06*10^{11}$kcal per year respectively in stage1. In stage2 the amount of calories avoided of will be $4.03*10^{11}$ and $3.78*10^{11}$kcal per year for case1 and case2 respectively.

In this way will be canceled work by (60,100)W lamps which form a large load of lighting load in the residential sector, and then trend to get rid of the 40watt lamp and other incandescent bulbs.

4.4 Proposed Strategic Plan

As the CFL lamp lasts about 15 thousand hours at least; and LED about 25 thousand hours at least approximately, the period of operation of this strategy will be as follows:

$$\frac{15000}{4 * 365} = 10.27\ years \qquad for\ CFL$$

$$\frac{25000}{4 * 365} = 17.12 years \qquad for\ LED$$

The duration of the project organizational of Clean Development Mechanism according to the United Nations standards and rules set forth on climate change on 10 years. [11]

If we assume controversy that this strategy will be as usual, and the first stage will be implemented in two years from the start of implementation, and this period is sufficient to reach lamps all consumers. By reference to Table 6 be the third year estimated to compensate for the basic price of the lamps, And then start the implementation of the second stage of this strategy in one and half year, Where the third year and a half of the fourth year enough to reach lamps all consumers. With reference to Table 10, the half of the fourth year and the fifth year estimated to compensate for the basic price, and work is canceled by (60,100) watt lamps within 3.5 years. The application of this strategy is detailed in The following Table9.

Table9. Duration planning of strategy implementation

	Type	Proposed of distribution years	Operating years	
			compensated Years of initial cost	Profits years
Stage 1	Case 1	2	1	9
	Case 2	2	0.5	9.5
Stage 2	Case 1	1.5	1.5	8.5
	Case 2	1.5	1	9

In addition of saving money, the environmental consideration can be carried out, if we take into account that:

1GWh=874132 kg CO_2

0.001016 kg CO_2 = 1 k Calorie.[11]

The amount of heat released to the environment that can be avoid for case1 and case2 are about $7.2*10^{11}$and $7.06*10^{11}$kcal per year respectively in stage1. In stage2the amount of calories avoided of will be $4.03*10^{11}$ and $3.78*10^{11}$kcal per year for case1 and case2 respectively.

5. CONCLUSION

Replacement strategy has been developed in this paper; by making a mechanism to get rid the incandescent bulbs gradually. The study focused on 100watt lamps and 60watt lamps, as the most common and widely used in Libya. This is done in two stages, the first stage is to get rid of 7,667,932 incandescent lamps type 100W, and replacement them by 7,667,932 LED bulbs type 20W as first scenario, then by CFL bulbs type 22W for the second scenario, where the amount of energy save dare 845.86 GW and 824.71GW, with cost of 93.5 m LD and 90.7 mLD annually for LED and CFL respectively. The second stage where was to get rid of 7,118,482 from 60watts lamps and replacement them with 7,118,482 lamps of (12W LED) & (15W CFL) lamps, and the energy saving reached to 471.15 GW, 441.70 GW with cost of 60.15 m LD, 37.02m LD annually For LED and CFL respectively.

The important future environmental benefits of the replacement are the huge, such as reducing the emission of CO2 and releasing the heat to the environment.

Three years were proposed to complete this strategic plan, in which it got a good results and recover all the money supported for this strategy.

Finally, replacing incandescent bulbs by CFL bulbs may be affordable compared to LED lamps, but it needs to study the possibility of disposal of the mercury inside the bulbs when it damage.
While replace incandescent lamps by LED lamps is the best from the environmental point of view, but faces a challenge in the purchase price of the lamp, but their length of life, and their energy efficiency, makes them saved for financial cost throughout the period of operation.

6. REFERENCES

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