IEREK PRESS
Academic Research Community
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ISSN (Print: 2537-0154, online: 2537-0162)
International Journal on:
The Academic Research Community Publication

DOI: 10.21625/archive.v2i4.386

Availability and Feasibility of Demand Side Management Projects in Egypt

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Abstract

Demand Side Management (DSM) results in energy consumption reduction accompanied by lower cost according to the feasibility study for each project. In Egypt, DSM projects are scarce due to lack of good studies proving their underlining profitability. This paper studies the major types of DSM programs and their availability to be executed in Egypt. Tips to measure feasibility for these projects are given using the Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI), Payback Period (PP) and Discounted Payback Period(DPP). Different factors affecting the projects to study like the inflation factor and the discount rate are studied. This paper also investigates a new sustainable way for natural illumination called the sun tunnel. This method is presented with its different types: rigid and flexible as a case study

Keywords

Day Light; Demand Side Management; Energy Efficiency; Sun tunnel; Sustainable Lighting

1. Introduction

Energy shortage and increasing energy price in Egypt force many researchers and companies to reduce energy consumption as well as studying new ways for sustainable energy generation from renewable energy by users, although energy cost increasing is a main hurdle which motivates to find new ways to reduce energy consumption. This paper may serve as a reference for studying any project to take a decision about its execution. It also includes a case study for installing a sun tunnel.

DSM Demand Side Management

NPV Net Present Value

IRR Internal Rate of Return

PI Profitability Index

PP Payback Period

DPP Discounted Payback Period

O&M Operation and Maintenance (O&M)

WACC Weighted Average Cost of Capital

2. DSM

DSM has considerable potential to reduce power system generation, transmission and distribution costs. However, the integration of DSM into existing restructured electricity markets is not straightforward. DSM has been receiving increasing attention, particularly with the widespread of advanced metering systems, like smart meters, which facilitate more detailed monitoring and control of customer loads.

The main goals of DSM are: peak clipping, valley filling, load shifting, strategic load growth and strategic conservation [1].Distributed generation and energy storage can also be classified as DSM [2].

2.1. Classification of DSM Programs

There are three main different programs of DSM. They have been discussed in [3] and can be classified as shown in Fig.1

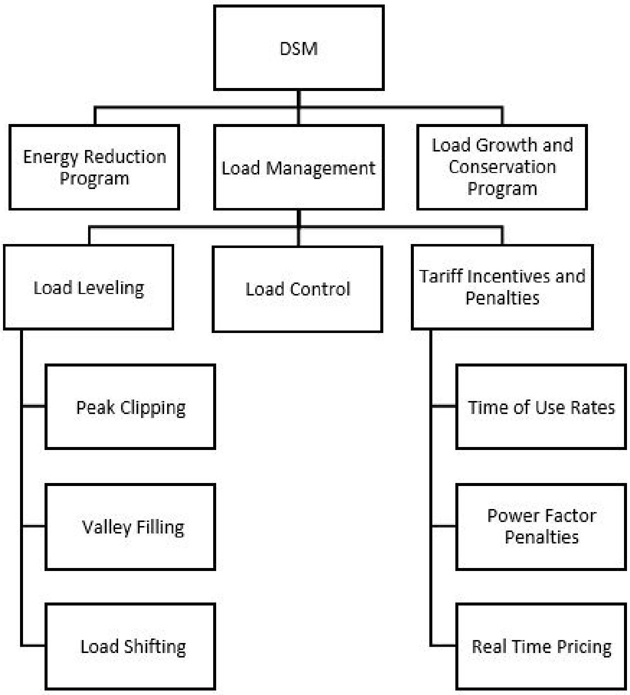

Figure 1. Classification of DSM Programs

2.1.1. **Energy Reduction Programs (Energy Efficiency):**

Energy reduction programs are considered as cost negative due to energy saving. They provide a large number of energy saving tips in all sectors. This can be implemented by more efficient processes, buildings and equipment. In Egypt, it can be extended to lighting, motors and boilers.

2.1.2. **Load Management**

It aims to change the load pattern and encourage less demand at peak times and peak rates and this can be done by three different ways:

Load Leveling

Improved generation without increasing the reserve capacity. This is done by peak clipping, valley filling and load shifting using thermal energy storage for water, space heating and reducing the peak demand.

Load control [4]

Direct control of particular loads such as air conditioning, hot water systems and swimming pool pumps remotely by the utility. In this case, the utility offers special low kWh prices for customer and this method is not available in Egypt.

Tariff Incentives and Penalties

There are three different programs regarding tariff incentives and penalties:

– Time of use rates: Utilities have different charges for power use during the day to reduce peaks. This method is not used in Egypt.

– Power factor penalties: A penalty is applied in Egypt for any given factor less than 0.9 inductive for industrial loads.

– Real time pricing: according to utilities loads. It may be continuous or by the hour pricing. This method is not used in Egypt.

2.1.3. **Load Growth and Energy Conservation**

Load growth

By improving the customer productivity, this increases the market share of the utility and imposes its ability to fill valleys and shave peaks. This is done in Egypt by distributed generation using renewable energy projects.

Conservation programs

This result from utility-stimulated programs directed to customers. These programs are used in Egypt.

3. Energy saving tips

Declaring energy saving tips is required by users to be award with different projects for different loads as following:

3.1. Industrial and commercial sector:

Energy saving tips for Boilers, that are most commonly used in industry can be found in [3]. Also tips to avoid leaks in steam systems is studied in [3]. Lighting is considered as one of the most important ways to reduce energy consumption. using LED instead of fluorescent lamps and using interactive lighting scenarios are found in [5]. High efficiency motors and motors drives are used in most of factories to save energy. Compressed air system saving tips in [3] are very important, because in an average facility, 70% of the generated compressed air is used in air blow applications, 10% for actuation with the remaining 20% are lost through leakage. Actions must be taken to solve leakage problems and to adapt pressure for minimum requirement. For the devices which need higher pressure, pressure booster can be used.

3.2. Household

There are many practices for houses for energy saving like sealing, insulation, hot water cylinder, washing machines, heaters, and lighting, energy saving tips are applied [3]. The most applicable module is saving energy using lighting programs by changing lamps, using intelligent lighting systems and using natural lighting like sun tunnel if applicable.

4. Economic Analysis

Economic study is the most important part in any project related to DSM. Most of these projects need feasibility studies to be executed. The following section will describe this.

4.1. Net Present Value (NPV) [4]

The method used to perform the economic analysis is NPV since it is commonly used to measure the viability of engineering projects. NPV is defined as the difference of all cash inflows and outflows taking into consideration the time value of money. Inflows refer to revenues and outflows refer to capital cost as well as Operation and Maintenance (O&M) costs. The NPV can be calculated using relation (1):

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^t}$$

Where,

B_t = Benefits at the end of each year of the project

C_t = Cost for each year of the project

n = Number of years

i = Discount rate

4.2. Profitability Index (PI)

PI is actually a modification of the NPV method. While NPV method gives an absolute measure for project; the profitability index gives a relative ratio for it. The project that has a PI above 1 should be accepted. PI as discussed in [6] is calculated by comparing the NPV with the initial investment as shown in (2).

$$PI = \frac{NPV}{(Initial\ investment)}$$

4.3. Payback Period

Payback period is a procedure used to calculate the period of time needed to make up for the initial expenditure by discounting future cash flow. The payback period is calculated when the inflows equal the outflows. it can be calculated using formula (3):

$$Payback\ Period = (T-1) + \frac{|CCF_{T-1}|}{CF_T}$$

Where,

T is the year when the cumulative cash flow begins turning zero or positive

CCF_{T-1} is the cumulative cash flow at the year T-1

CF_T is the cash flow of the year T

4.4. Discounted Payback Period (DIPP)

DIPP, as reviewed in [7], is a procedure used to calculate the period of time needed to make up for the initial expenditure by discounting future cash flow and also taking in consideration the time value of money (discount rate). The discounted payback period is calculated when the inflows equal the outflows. DIPP can be calculated using formula (4):

$$DIPP = (T - 1) + \frac{|NC_{T-1}|}{DCF_T}$$

Where,

T is the year when the cumulative NPV of cash flow begins turning zero or positive

NC_{T-1} is the NPV of the cash flow at the year T-1

DCF_T is the discounted cash flow of the year T

4.5. Internal Rate of Return (IRR)

IRR as defined in [8] is the discount rate at which the NPV equals zero. If the IRR is above the planning discount rate that means, that the project is economically viable. When comparing two or more mutually exclusive project. The project that has the highest value of IRR should be accepted.

To calculate IRR, relation (1) is solved for i , such that NPV = 0.

5. Sun Tunnel

Sun Tunnel brings natural light into even the darkest and most isolated spaces through a specially designed high reflective tunnel that passes from roof to ceiling, it is a better solution for any place has working hours during day time There are two types of sun tunnel.

Flexible type, as shown in Fig.2 [9], is more suitable for shorter distances, cheaper to purchase, easier to install and allowed negotiating around obstructions in the roof space. Due to the build of the flexible tube. Light will reflect less in a flexible sun tunnel, effectively directing the light away from its required destination, resulting in less light reaching the required room.

Rigid type, as shown in Fig.3 [9], gives a better light transmittance than the flexible sun tunnel. The less the light bounces off the internal surface of the tube, the more natural reaches the required room.

Figure 2. Flexible sun tunnel

Our study is for a room with dimensions 2.5m width x 6m length x 2.8m height to maintain an approximate illuminance of 500 Lux. Room dimensions and the required illuminance data were inserted in DIALux program. Using luminaire type: Philips noted as ”Finess TCS198 2xTL5-14W/840 HF C6”, the distribution of the required luminaires is shown in Fig.4

Figure 3. Rigid sun tunnel

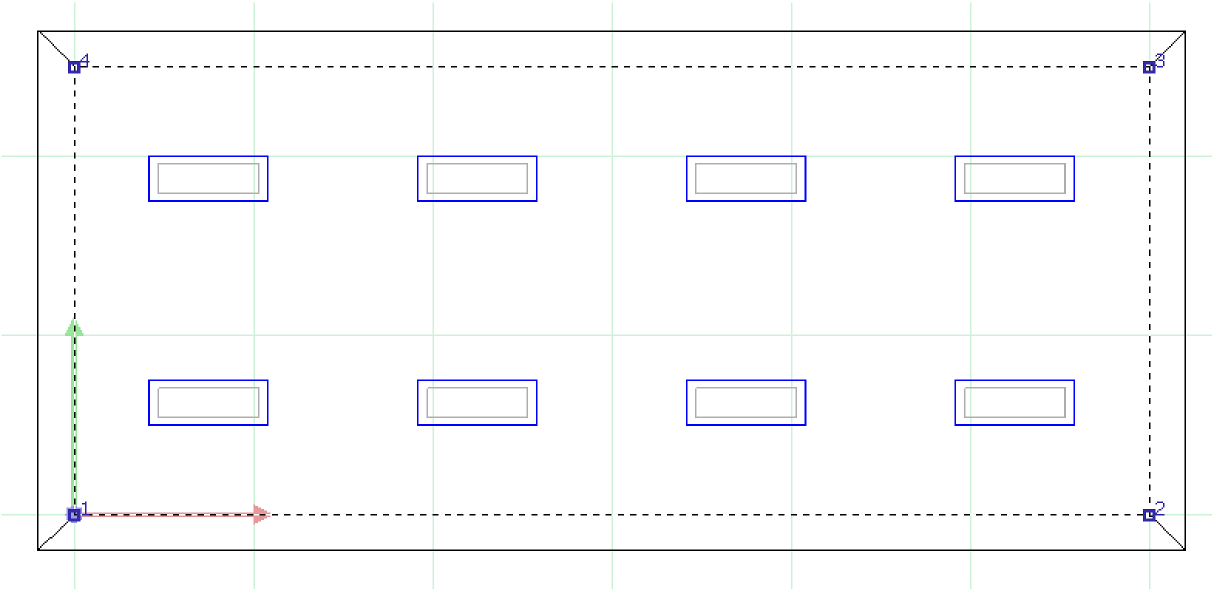

Figure 4. Luminaire Distribution Using DIALux

There are different parameters that need to be taken into consideration when performing this kind of analysis.

A. Project life

The lifetime of project will be 20 years.

B. Project costs

The cost of the project for 8 TL5 luminaires that includes luminaires cost, electrical cables and switches, 5 times lamps replacement and maintenance cost for 20 years and equal 150$ Sun tunnel type is studied in [10], and the results for the room data is 2 X Flexible sun tunnel TWF, 14" diameter and its cost as given by [11]was 198.41$

C. Inflation

Inflation is the annual rate of change in prices that reduces the purchasing power of the customers. O&M costs are affected directly by this parameter; therefore, it needs to be considered in this study. Inflation is arbitrarily assumed to be 12% in Egypt as repeated values for all years.

D. Discount rate

Discount rate is explained in [12]. It reflects the time value of money. It is the rate at which any investor can expect to earn on his invested money. It is assumed at 18% for this study.

E. Weighted Average Cost of Capital (WACC)

WACC [13] is the minimum acceptable rate of return at which a company yields returns for its investors. If project return is less than WACC this means that the project is losing value. Here we considered WACC= 18%.

F. Depreciation

Depreciation is a measure of the decrease of the financial value of an asset over time due to the use and wear. Depreciation is used to calculate the income tax for a project.

G. Income tax

There is a fixed percent income tax rate that applies to any project or economic activity that has not been carried out 12 months before the date of the exemption request.

H. Energy price escalation

The escalation rate chosen for this study is set at 2%, based on the present change in price of energy. Based on these values for sun tunnels, we can conclude that for 20 years life time, we will find NPV and IRR as shown in table1

Table 1. Project data and economic results

Project life	20 years
Total cost for sun tunnel include taxes	440$ = 7920L.E
TL5 luminaires project cost for 20 years	300$=5400L.E
kWh cost for residential between 351 to 650 kWh layer [14]	0.75 L.E
Discount rate	18%
NPV	2560 L.E
PI	1.424
Payback Period	3years
DIPP	4 years
IRR	21%

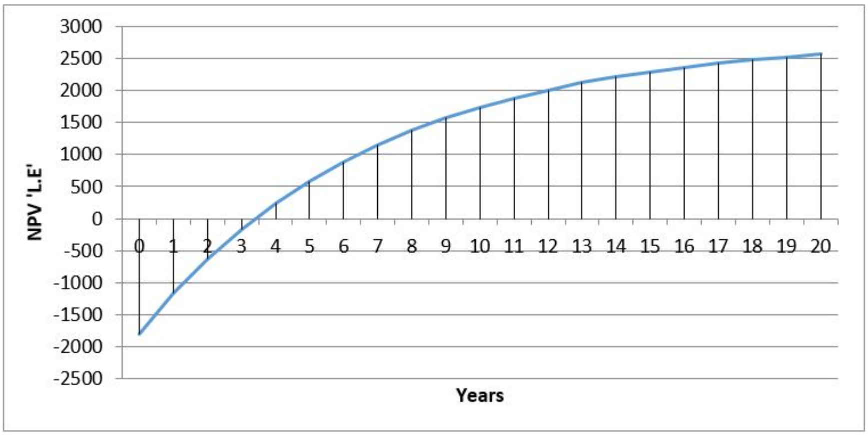

Figure 5. NPV over 20 years project life

According to these values, NPV is positive and IRR is greater thans 12% WACC. That means that the project is acceptable and is beneficial.

6. Conclusion

The increasing electricity selling price, enhanced the use of using the DSM. There are different programs for DSM but not all of these programs are available in Egypt. Sun tunnel project, which is considered as one of peak clipping program projects is profitable. This study shows its profitability according to NPV and IRR.

7. References

1. Z. Hungerford, A. Bruce and I. MacGill, ”Review of Demand Side Management Modelling for Application to Renewables Integration in Australian Power Markets,” in IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), Brisbane, QLD, Australia, 2015.

2. J. A. Deysel, M. Kleingeld and C. J. R. Kriel, ”DSM Strategies to Reduce Electricity Costs on Platinum Mines,” in International Conference on the Industrial and Commercial Use of Energy (ICUE), Cape Town, South Africa, 2015.

3. ”Sustainable Energy Regulation and Policymarking for Africa ,Module 15.,” May 2017. [Online]. Available: http://africa-toolkit.reeep.org/.

4. J. R. Matagira-Sánchez and A. A. Irizarry-Rivera, ”Feasibility Study of Micro Pumped Hydro for Integration of Solar Photovoltaic Energy into Puerto Rico’s Electric Grid,” in North American Power Symposium (NAPS), Charlotte, NC, USA, 2015.

5. R. Kathiresan, Y. J. Kenneth and S. K. Panda, ”An Interactive LED Lighting Interface for High Energy Savings,” in IEEE Innovative Smart Grid Technologies - Asia (ISGT ASIA), Kuala Lumpur, Malaysia, 2014.

6. I. Giriantari, I. Kumara and D. Santiari, ”Economic Cost Study of Photovoltaic Solar System for Hotel in Nusa Lembongan,” in International Conference on Smart Green Technology in Electrical and Information Systems (ICSGTEIS), Kuta, Indonesia, 2014.

7. L. Wei, Y. Li and Y. Su, ”Research on Economy and Technology Feasibility for Centralized Solar Power Development in Qinghai-Tibet Plateau,” in IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), Xi’an, China, 2016.

8. Z. Qiao, H. Zhang and Z. Qiao, ”Research on Estimation Methods of Internal Rate of Return in Hydraulic Engineering Project,” in 2nd International Conference on Information Engineering and Computer Science, Wuhan, China, 2010.

9. ”VELUX SUN TUNNEL Skylights—Flexible and Rigid.,” May 2017. [Online]. Available: http://www.veluxusa.com /products/suntunnls.

10. ”VELUX sun tunnel lux calculator.,” May 2017. [Online]. Available: http://www.velux.co.uk/products/ suntunnels/lux-calculator.

11. ”Flexible Sun tunnel (TWF/TLF) Roof Superstore.,” May 2017. [Online]. Available: https://www.roofingsuperstore .co.uk.

12. ”Discount, Inflation, and Interest Rates _ PVEducation.,” May 2017. [Online]. Available: http://www.pveducation. org/node/708.

13. ”Weighted Average Cost of Capital.,” june 2017. [Online]. Available: http://www.investopedia.com/terms /w/wacc.asp/.

14. ”Electricity Price & Tarrif.,” June 2017. [Online]. Available: http://egyptera.org/en/t3reefa.aspx.