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STUDY OF OPTIMIZATION OF ENERGY IN HOUSE HOLD WITH THE HELP OF LINEAR PROGRAMMING

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ABSTRACT

In this paper, for efficient energy consumption through the residential demand response in smart grid, an optimization algorithm is proposed. In order to minimize the average electricity price based on time varying electricity price in conjunction with the peak hourly load, we establish a mixed integer linear programming problem considering various energy consumption patterns of home appliance.

Linear programming method was used to optimize the allocation of budget in order to maximize the energy savings of a hypothetical household in Syria. It is used for energy conservation methods. It is also changing normal incandescent bulbs to fluorescent light bulbs, also changing the quality of appliances i.e. C class appliances is changed with A class window. It is very important that we use energy where we require and optimization is very important. By this we can support to healthy life and strong economy for today and future as well. By efficient use of energy we also decrease environment pollution.

Keywords: ***Optimization, Renewable Energy, House Hold Energy Conservation, Linear Programming, Syria, Smart Grid.***

I. INTRODUCTION

The planning of an eco city has multiple functions. It includes consumption of energy by the building, carbon emission by the environment. This also involves the cost on the initial basis and also the implementation cost. There are many theories which are working on that issue that how could we make an eco city. There are basically three categories in which we are going to work like energy consumption of building, emission of carbon in carbon dioxide and cost for initialization.

In any electric energy system, the customer's is to minimize their energy cost, Whereas utilizes are not only concerned about the cost, but also other issues such as load shape, peak load etc. In this context, a two tier hierarchical scheme is used in energy hub man-agreement system in order to distinguish between-en the different objective of the customer's an-d utility.

The objective is to optimize the energy consumption from the utility's point of view.

II. MODELLING APPROACH

The energy hub is a concept recently developed with multiple energy carriers. Hub is defined as a center of activity; Hence, energy hub is any location where energy system activities of different energy carriers, take place. In this work, house hold; are considered as multi-carrier energy hubs with energy demand, generation; and storage capabilities.

III. ENERGY CONSERVATION METHODS IN BUILDINGS

The materials and techniques employed in order to improve the energy efficiency in buildings vary greatly. The main listed steps to achieve energy conservation in residential buildings as follows:

i. Passive design by considering climate effects so as to decrease heating, cooling, dehumidification, lighting, equipment and hot water loads.

ii. Improving the efficiency of the mechanical and electrical equipment used in the building.

iii. Replacing fossil fuels with renewable sources for the supply of primary energy.

Heating and cooling systems make up for a significant portion of the total expenditure of households. Heating systems like boilers, heat pumps and cooling systems like air conditioners are expensive to install and operate; consequently the entire energy requirement of a building cannot solely be met by using such equipment as far as energy efficiency is concerned. Therefore, using insulation materials to minimize heat loss (or gain) is essential to achieve meaningful energy conservation. Windows lose energy more readily than walls or a floor, therefore using insulation materials in windows is the most straightforward approach to minimize heat loss. The most common technique applied for insulating windows is double glazing, in which double or triple glass window panes separated by an air-(or other gas)-filled space are used to reduce heat transfer across a part of the building envelope.

IV. COSTS AND ENERGY SAVINGS

In this study, the following methods were chosen to improve the energy conservation in a household:

- Installing photovoltaic cells on the roof where the area occupied is a variable
- Installing double-glazed windows where the window area is a variable
- Replacing incandescent bulbs with compact fluorescent bulbs where the number of bulbs is a variable
- Replacing the C-Energy Class appliances by A-Energy Class ones.

V. MATHEMATICAL MODEL

The proposed general form of the optimization model for the residential sector is as follows:

Min J = objective function …….(1a)

$$\text{s.t.} \sum_{i \epsilon A} Pi\ Si\ (t) \leq\ P^{max}\ (t), \forall tT \quad (1b)$$

Device i operational constraints, $\forall i \epsilon A$ (1c)

Constraint (1b) ensures that maximum power consumption at a given time does not exceed a specified value. For customers who participate in critical peak power reduction programs provided by various utilities, this constraint can be used to integrate automatic responses to the utility operator's power reduction requests during critical times for the system.

5.1 Objectives

In this project we are using linear programming. This programming is used for the optimization of budget. For this we are using a building which is situated in the hot climate region. This method is designed as in the minimum budget we can get maximum savings of energy and quality of energy as well. In this problem we are using two store building, which is having seven rooms. This design is taken because it is simple and we see many of buildings of this type. By taking this type of building we can do our calculation very easily.

Dimension of the building is well known to us. We have taken 140 m2 roof area of the building. In the total of roof area we are installing solar panel in the half of the area. Area taken for double glazed window is known to us. Total window are is 32 m2. In the building 7 living rooms are available. In that 10 incandescent bulb is used which is sufficient for the lighting of the building.

5.2 Linear Programming Approach

In problem we used Lingo 12.0 software for energy savings:

The linear approach we designed by using the cost and saving of data.

x, y_i, z, a, b, c are the decision variable of the problem:

MAX $Z_z = (Q_x * x) + (\sum_{i=n}^{n} Qyi) + (Q_z * z) + (Q_r * a) + (Q_p * b) + (Q_t * c)$……(01)

$(C_x * x) + (\sum_{i=1}^{n} Cyi * y_i) + (C_z * z) + (C_r * a) + (C_p * b) + (C_t * c) \leq$ W………(02)

$\sum_{i=i}^{n}(y_i * a_i) \leq$ q…………………………………….(03)

Z $\leq$ v

Where

x, y_i, z, a, b, c are non-negative and y_i is integer.

a, b, c are binary variable.

i= 1, 2, 3, ………., n

a= {1 if C class dishwasher is changed by A class 0 otherwise

b = {1 if C class washing machine is changed by A class 0 otherwise

C = {1 if C class refrigerator is changed by A class 0 otherwise

Q_x , energy savings rate by installing 1 m^2 of double-glazed window, W

Q_z , energy consumption rate difference between incandescent and CFL light bulbs, W

Q_r , adjusted energy consumption rate difference between C- energy class and A- energy class dishwasher, W

Q_p , adjusted energy consumption rate difference between C- energy class and A- energy class washing machine, W

Q_t, adjusted energy consumption rate difference between C- energy class and A- energy class refrigerator, W

C_x , average purchase and installation cost of 1 m^2 double-glazed window, ∈

C_z , average cost of one CFL light bulb, ∈

C_r , average cost of one A- energy class dishwasher, ∈

C_p , average cost of one A- energy class washing machine, ∈

C_t , average cost of one A- energy class refrigerator, ∈

K, total window area(physical constraint for double glazed window installation), m^2

v, maximum number of CFL light bulbs that can be purchased for the house.

Table(01) Budget optimization and energy savings, low range budget.

Budget (∈)	Double-Glazed Windows (m^2)	CFL bulbs (#)	Appliances			Total energy savings (w)
			RFG^a	WMC^b	DSW^c	
450	16	10	0	0	0	5345.4
1250	32	10	0	0	0	10,024.8
2450	32	10	0	0	0	10,465.7
3650	32	10	0	0	0	10,975.7

a Refrigerator, b Washing machine, c Dishwasher

Table(02) Budget optimization and energy savings, medium range budgets.

Budget (∈)	Double-Glazed Windows (m^2)	CFL bulbs (#)	Appliances			Total energy savings (w)
			RFG^a DSW^c		WMC^b	
6050	32	10	0	0	0	11,950.7
10,050	32	10	0	0	0	13,498.7
14,050	32	10	0	0	0	15,099.7

a Refrigerator, b Washing machine, c Dishwasher

Table(03) Budget optimization and energy savings, high range budgets.

Budget (€)	Double-Glazed Windows (m^2)	CFL bulbs (#)	Appliances			Total energy savings (w)
			RFG^a	WMC^b	DSW^c	
20,050	32	10	0	0	0	17,500.7
28,050	32	10	0	0	0	19,497.7
36,050	32	10	0	0	0	19,500.7
40,050	32	10	0	0	0	19,498.7

a Refrigerator, b Washing machine, c Dishwasher.

VI. RESULTS

After study , we got the results that installing double-gazed window and CFL is the optimum choice throughout the entire budget range, as a result of the high energy saving opportunity. Renewing household appliances did not emerge as very profitable options, due to the low energy savings when compared to other techniques. Double glazed window installation and purchasing compact fluorescent light bulbs was the optimum combination because of the relatively low cost.

When the data in Table (01) is studied, it was seen that at low budgets the most feasible methods to improve energy efficiency are CFL bulbs and having double gazed windows installed. Table (02) also gives similar results to those tabulated table (01). As it can be seen in table (03), the maximum amount of energy saving (19,497.7 w) that can be obtained in a budget range of € 28,050 -€ 32,050. The model we presented can be modified as desired for different households, climate conditions, or countries so that the final results would be completely different.

VII. CONCLUSION

In this study, linear programming method was used to maximize energy savings subject to budget for a hypothetical household in Syria. The methods involved to decrease the building's energy consumption were installing photovoltaic solar panels on the roof, replacing incandescent light bulbs with compact fluorescent light bulbs, installing double-glazed windows and replacing C-Energy Class appliances with A-Energy Class versions.

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