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# The Essential Factors To Reduce Energy Consumption In Iraq

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**Abstract.** In this paper, an inclusive study has been prepared that aims to minimize energy waste of domestic purpose in Iraq that is considered an important aspect which is almost neglected at the present time as energy sources tend to be exhausted as excessive use causes other problems such as environmental pollution and global warming, and it shows the solutions as duties of each people and the government to be performed regularly in order to achieve the goal of the study. It also addresses some obstacles and how to overcome them through the cooperation of all concerned collections for developing strategic plans and energy management programs that can be implemented and monitored through the committees of specialized experts. The results of energy rationalizing show that the reduction of the domestic electrical consumption in the summer season in Iraq is about 52% of total power and 25% in a winter.

**Keywords.** Energy; Rationalization; Management; Consumption; Economy, Awareness, Analysis, Solar Energy.

## INTRODUCTION

Iraq as its location has hot and long summer season associated with full sunny days while average temperature about (45-48) C° and continuous for a five months, winter also is very cold and the temperature approach to 0 C°, so it's an important to keep conditioned zones inside buildings to remain cold (in summer) and warm (in winter) for long time and reducing the use of air conditioning devices and heaters by minimizing the heat flow and preserving the desired temperature as possible that reached if there is good insulation techniques of buildings, [1] Fig.1 shows the average max temperature values during summer seasons of the 12 years for the stations (a) Baghdad and (b) Basra [1].

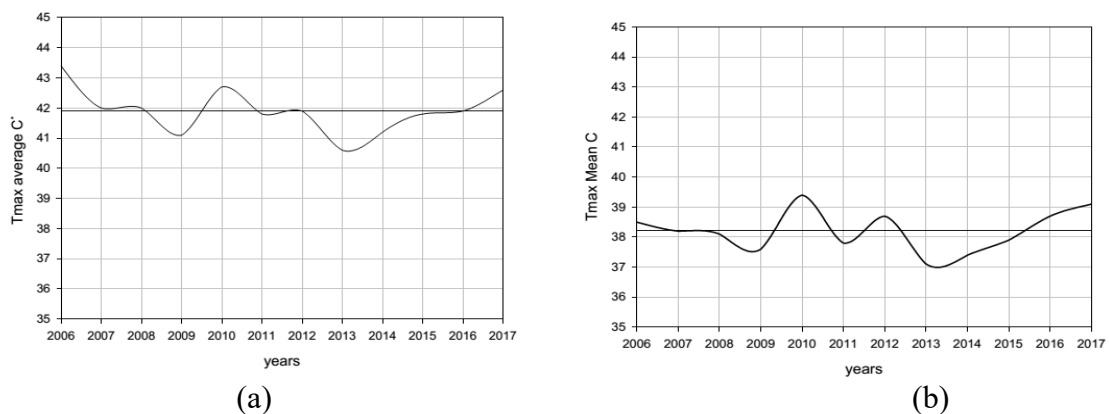
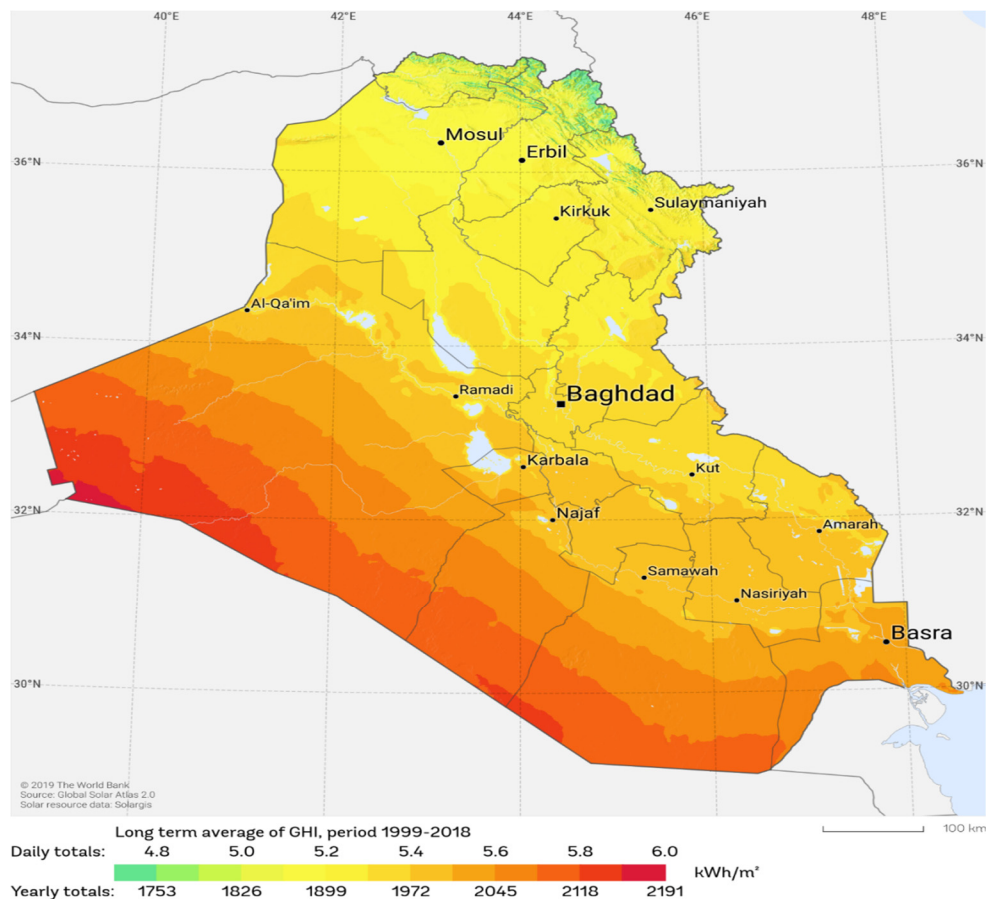


FIGURE 1. The Average Max Temperature Values during Summer Seasons of 12 years [1]

The other matter is related to the result of the circumstances of Iraq during the difficult past years the country went through, this led to poor planning for how to conserve energy and not use it wisely, in addition to this the absence of an awareness of rationalization among people and use old inefficient appliances which spend more power and there is no concern to turn off unnecessary loads and lighting, there is no specific protocol for buildings material and construction also bad installation of doors and windows that allow infiltrating of unconditioned air which negatively affect energy consumption and that lead to insufficiency of electricity providing (about 10 h/day) during hot months and (about 14 h/day) cold season. The high rates of continuous population growth require an increase in the demand for energy, especially the almost total dependence on traditional energy sources. It is necessary to consider also other energy sources such as solar energy and its important applications in energy conservation [2].

The solar energy has two aspects, one of which is negative (causes high temperature), which is to protect from it and use good insulators and the other side is positive (solar radiation energy), it is the source of clean and renewable energy that is not well utilized and the average intensity of solar radiation during the year, which appears at its highest values in the months of May, June, July, and August [3].

Iraq occupies a strong geographical location place allowing it to obtain a normal global solar radiation dose on an average horizontal surface about (5-5.6) kWh/m<sup>2</sup>/day, as shown in Fig..2[4].

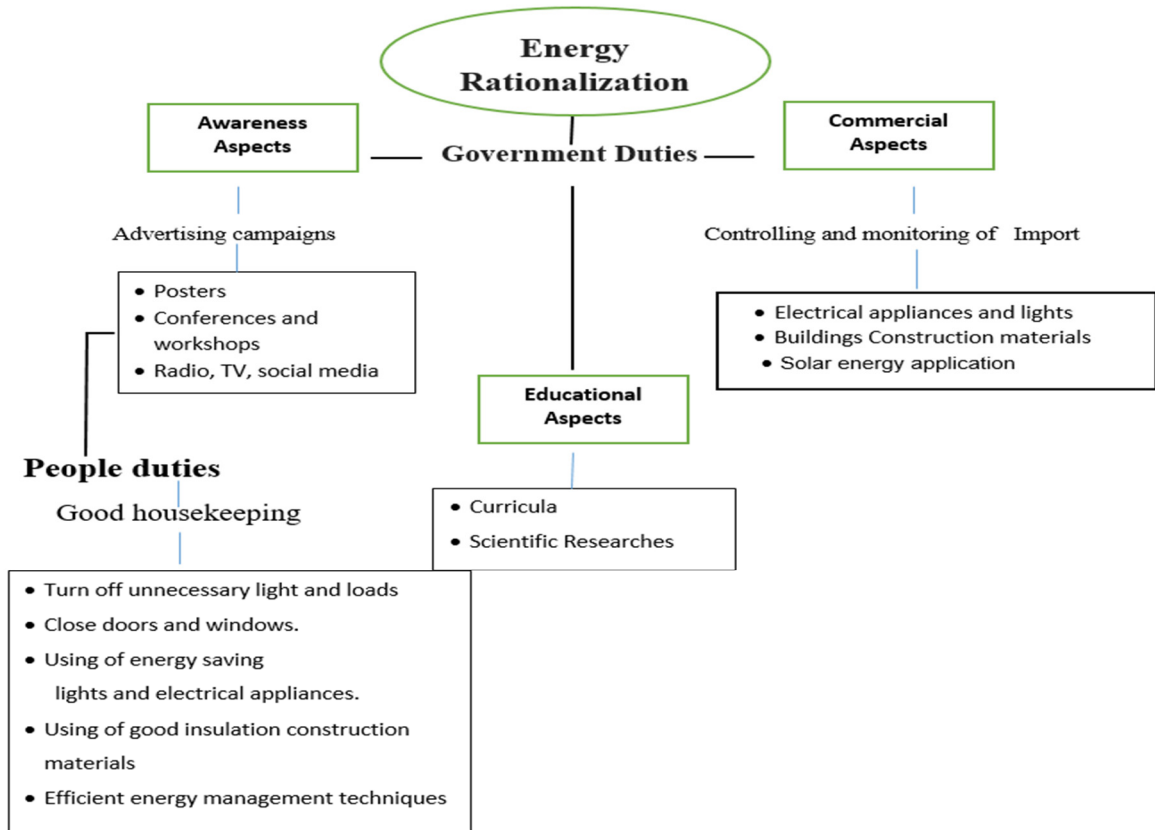


**FIGURE 2.** Global Horizontal SR in Iraq (kW/m<sup>2</sup>) by solar GIS map [4].

The main objective of this present study is to lay out solutions and overcome many obstacles to ensure that a large part of the losses in the domestic electrical energy of buildings are reduced.

## THE PROPOSED APPROACH

It's very important to stop energy dissipation and work seriously to overcome all challenges and difficulties which give the country successful control of energy to meet the green building conditions. The outline of the current study can be present briefly by the flowchart shown in the Fig.3.



**FIGURE 3.** Flowchart of The Current Study of Energy Rationalization Program

## Government Duties

The main important part of the study is presented by the government duties and nothing can be achieved without the real efforts, these duties are as follows:

### Awareness Aspects

It is considered under the short term scheme which has little or no capital expenditure and can be applied through advertising campaigns as follow [5] [6]:

#### Posters

A campaign organizer must print advertising posters containing enthusiastic expressions to encourage people to use energy wisely by eliminating unnecessary usage of it like shout down needless lights and other loads and hang them in public places, schools and universities.

#### Conferences and Workshops

It is very necessary to hold seminars, workshops and conferences that urge how to use energy rationally in the various ministries of the country, its departments, universities and institutes.

## **Radio, TV, and Social Media**

At the present time, most people are interested to communicate through social media sites on the Internet like Facebook and Tweeter, while others follow TV and radio programs, and this gives positive use of these means to share the idea of energy conservation in an easy and fast way to cover all categories of the people.

## **Educational Aspects**

In this aspect the need for low financial support has existed especially in a field of scientific research so included within the medium term scheme [5]. The educational aspects are as follows

### **Curricula of primary schools**

The new generation is considered the most targeted category of people, as the intellectual impact of them takes a wide range of consolidating the correct enlightenment from childhood until it remains anchored in all subsequent stages of life, so it is better to add some phrases and instructions in the curricula of primary schools that teach them about the importance of energy in the live and how to behave to ensure no dissipate it.

### **Scientific Researches and Energy Efficiency**

Measuring the progress of countries lies through their universities and solid scientific research. Research always has a role in solving problems, and from this point there should be support for research in general because it touches on many issues and it is possible to focus on solving the country's problems such as the problem of spending electrical energy, especially that Iraq have very hot weather, this requires more studies to develop and encourage scientific research that specializes of using modern technologies of high thermal insulation materials for buildings to minimize the thermal losses and the need to use solar energy applications to rationalize energy, as well as working to reduce electrical losses and increase the efficiency of appliances [6].

### **Commercial Aspects**

It is considered under the medium term scheme and can be applied through auditing and controlling the import by government and only allowing the electrical products which has lowest consumption of energy and this could be reached by employing a team of experts associated with the Ministry of Electricity act as a control gate at all entrances of the country to avoid entering any undesired products [6]. Here are some examples of energy saving and old products.

### **Electrical Appliances and Economic Lights**

First it's necessary to follow the (Energy Star) and other programs as regular programs of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping people to save money and reduce the environmental pollution effects through high energy efficiency electrical products.

After convention between the U.S. Government and the European Community (EU), the EU Energy Star program was born. Thus, those stringent energy efficiency standards should be followed in the EU as well. So when anyone wants to buy a home appliance or any product authorized with the energy star, this ensures that it is environmentally friendly and it will save energy and money too during the next coming years. Although the prices of these products are slightly more expensive than others, they will return to a financial gain in the future by reducing electricity bills [7].

Also, note that there are other brands of economic electrical products that differ from one country to another, and all of them indicate the same purpose, which is that the product has good efficiency and specifications that enable it to save energy. The Fig.4 shows examples of logos related to different countries.

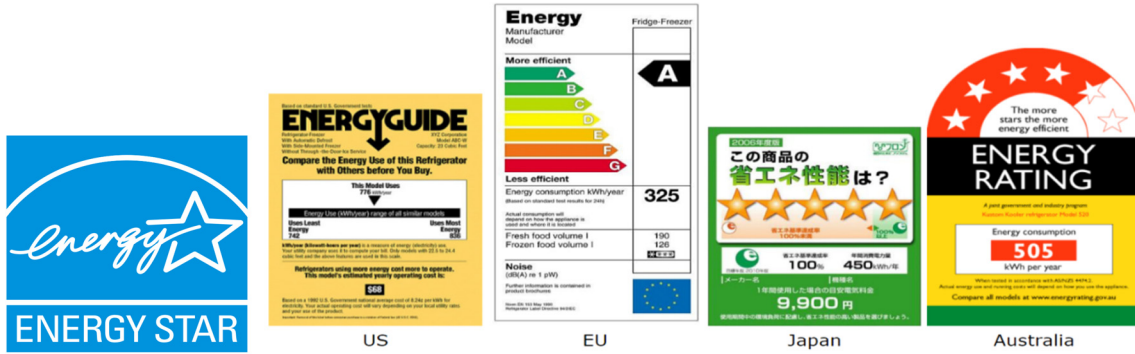


FIGURE 4. Energy saving labels of different countries

## Smart Inverter

In Iraq, the most daily consumption among the different devices in the summer is the air-conditioning(A/C) equipment (about 75% of a home total power consumption), and many government buildings and homes also use old devices such as window type cooling devices with an old reciprocating compressor that consumes high electrical capacity. In addition to that, the non-economic modern devices and that work without the inverter system. (A/C) maintain desired temperature by cooling when room temperature rises above the set temperature and heating when the room temperature falls below the set temperature.

The smart inverter is the latest evolution of technology which can be used in electro motors of electrical appliances for example in a compressor of air conditioner, its constantly controlling of a motor speed to maintain set temperature levels [8]. The speed of motor in conventional type air conditioners stay constant and temperature is adjusted by turning the motor ON and OFF, which consumes more energy while in inverter modern air conditioners, temperature is adjusted by changing motor speed without turning the motor OFF and ON [9].

## Energy Computational Analysis of A/C

The average requirement for a single home of the cooling load is about 6 tons of refrigeration(TR) equal to 3 units have 2 TR of each one, and in this analysis shows a comparison between conventional refrigeration devices that do not contain an inverter with devices supported by inverter, taking into account the work in a well-insulated space with good thermal insulation and other not insulated, considering the set point temperature is adjusted to 24 Co which is the human comfort temperature. For this analysis the following Mathematical Equation is used to find energy consumption for these cases in Kw.hr/day can be presented:

$$\text{Energy (E)} = \text{Power (P)} * \text{Time (T)}$$

Energy in Kilowatts-Hours (kWh)

Power in kilowatts (kW)

Time in Hours (h)

$$P = \text{Voltage (Volt)} * \text{Current (Amperes)}$$

$$\text{Total Energy} = \text{The power of unit} * \text{No. of units (kW)} * \text{Time (No. of working hours per a day)}$$

Applying total energy consumption equation of A/C units to four cases:

1. The a/c without inverter (3.15 kw of 2 TR) will work for 24 hours/day at full load when there is no good insulation and the energy needed can be calculated by

$$E1 \text{ total} = 3.15 * 3 * 24 = 226.8 \text{ kWh/day}$$

2. when the zone is insulated will work about 12 hours/day and stop for remaining time of a day, so the energy needed is

$$E2 \text{ total} = 3.15 * 3 * 12 = 113.4 \text{ kWh/day}$$

3. When using inverter (2.15 kw of 2 TR unit) in a bad insulated zone it will work at full load and consumed energy of:

$$E3 \text{ total} = 2.15 * 3 * 24 = 154.8 \text{ kWh/day}$$

4. In a case of using inverter ac at a good insulated region it will work for all time of 24 hours but at approximately half load and result will be

$$E4 \text{ total} = 2.15 * 3 * 12 = 77.4 \text{ kWh/day}$$

The results will be as in the following table:

**TABLE 1.** Energy Computational Analysis of A/C sample 2 TR and then converted to kW of 6 TR which is single home required of cooling load, in first row of the table showing the power consumption of using A/C with Inverter in tow Zones first one when the zone is well insulated and the other when the zone is uninsulated, the second row is showing the power consumption of A/C without inverter in same previous zones.

Type of A/C	Power Consumption for Same Cooling Capacity (2 TR) (kW)	Power Consumption for Same Cooling Capacity (6 TR) (kW)	kWh/day Well Insulated Zone	kWh/day Uninsulated Zone
A/C With Inverter	2.15	6.45	77.4	154.8
A/C Without Inverter	3.15	9.45	113.4	226.8

This analysis shows that air conditioners with inverters and good insulated zones eliminates wasted operation of the compressor and reserves about 65% of power needed to run A/C appliances and 50 % of the total power of a single house.

### Economic Analysis

The inverter conditioner units might be more expensive than the constant motor speed type, but this is balanced by less electricity bills. In table.2 below showing a comparison between the types of A/C with and without inverter considering power for same cooling capacity, A/C cost, bill cost over a period of time and total cost so it is worth noting that the most appropriate is to use A/C with inverter technique for power and money saving.

**TABLE 2.** Economic Analysis of A/C with and without inverter according to total expenditure, in this table its showing that when use A/C with inverter even its more expensive than A/C without inverter, the total expenditure (unit price plus electricity bill for 4 months) economically tends to A/C with inverter.

Type of A/C	Power Needed for Same Cooling Capacity (6 TR) (kW)	Cost of Single Unit A/C (Dollars)	Total Cost of A/C Units Per House (Dollars)	Electricity Bill Cost for 4 Months at Tariff of 0.1 Per kWh (Dollars)	Total Cost (Dollars)
A/C with Inverter	6.75	2100	6300	972	7272
A/C Without Inverter	9.75	1800	4500	1400	5900

### New-Generation Refrigerant

Although there are many different types of refrigerants, R-32 is a new refrigerant currently taking the most interest. Because R-32 efficiently transfers heat, it can reduce electricity consumption compared to that of air conditioners using refrigerant R-22 and R-410a [10].

### Economic Lights

Energy efficient or saving bulbs are a term to describe the light bulbs that need less energy than the old incandescent light bulbs (IL). The one of most efficient bulbs in the market are called compact fluorescent light

(CFL) bulbs. The difference between the two types is that the old one old incandescent and halogen bulb used a thin filament which was heating and producing light when electric current passed through it. On the other hand, in CLF technology, for producing light, use a phosphorous-coated gas filled tube.As electrical current passes through the gas in the tubeUV rays are emitted that excite the phosphorous coating and emit visible light.



The newest technology is light-emitting diodes (LEDs) the best energy save lighting technology are solid-state devices that convert electric energy directly into light of a single color. Because they employ “cold” light generation technology, in which most of the energy is delivered in the visible spectrum, LEDs don't waste energy in the form of non-light producing heat. In comparison, most of the energy in a CFL is in the infrared (or non-visible) portion of the spectrum. As a result, both CFL and incandescent lamps produce a more deal of heat [11].

The average requirement for a single house of the light bulbs is about 45 piece (4% of total consumption) which have total power of 0.36 kw for LEDs and 0.63 kw for CFL, that can be give a profit of 42% of energy used for lightning in a case of using only LEDs and 1.6 % of total power of domestic uses.

Here in table.3 below showing a comparison among the types of bulbs considering power, bulb cost, tariff price and total cost over a period of time so it is worth noting that the most appropriate is to use LEDs bulbs for power and money saving.

**TABLE 3.** Economic analysis of different light bulbs according to total expenditure

Type Of Bulb	Power for Same Brightness (Watts)	Cost of Single Bulb (Dollars)	Average Life of Bulb (hours)	No. Of Bulb Needed for 20000 Hours (5 Years)	Total Price Of Bulbs Over 5 Years (Dollars)	Electricity Bill Cost for (20000) Hours at Tariff of 0.1 /kwh (Dollars)	Total Cost Over 5 Years (Dollars)
Incandescent and Halogen	60	0.75	1,500	20	15	120	121.5
CFL	14	1.5	8,000	3	4.5	28	32.5
LEDs	8	2.25	20,000	1	2.25	16	18.25

## Construction Materials

The government’s role here presents by importing only materials with high thermal insulation to use it in building construction works that are not less value than economic electrical appliances as it has a large percentage of lowering energy consumption by maintaining the required temperatures in the air-conditioned space in summer and winter and this lead to minimize power consumption of A/C appliances.

The job of insulating materials with low thermal conductivity is reducing transmission of the heat between the conditioned zone and ambient by using good insulators like cork at outside of roofs and outer walls facing the sun [12]. Another technique is using of cool coating, on sunny day (solar reflection of 0.74) decreases peak roof temperature, temperature of the indoor air and everyday heat gain up to 14.1 C°, 2.4 C° and 0.66 kWh / m2 (or 54%) through the concrete roof [13].

Wood, plastic, and gypsum panels for the inner walls and secondary ceilings [14]. Plastic frames windows and doors fitted with doubled [15] or coated glass [16] and tightly closed (no infiltration) also an important thing that has an effect on reducing the impact of solar radiation and hot or cold outside air. Roof ventilation in hot weather is also



an efficient way may be used to exhaust the upper layer of air and force it outside to replace it by less temperature air in lower point of buildings. But during cold season the ventilation must be less [17].

## Solar Energy Application

It is known that solar panels are one of the most important means of providing alternative and sustainable energy in Iraq, which can be used in various buildings to be another source of energy support and reduce the energy need for buildings, but there are other applications that can also be used.

Among the most important examples of techniques for using solar energy in buildings is water solar heater which compensates for the use of the conventional electrical heater that consumes a large amount of electric energy in winter, it is better to be connected in a hybrid way of sources (because the climate in winter is not always sunny, but sometimes is semi or fully cloudy), this give opportunity to eliminate waste of energy about 24 percent of total power needed for one house in winter [18].

Other application is using bulbs outside of buildings with daylight with smart control sensor as energy management technique that ensure it blows out from sunset to dawn and shines at night automatically, also bulbs with the motion sensor can be used in some places like outdoor corridors, W.C. and others, this gives energy saving without the need to remember by people to turn it on and off.



FIGURE 6. Examples of solar energy applications

## ENERGY MANAGEMENT TECHNIQUES

Home energy management system is also a good solution for domestic which involves smart control systems to optimize the load and reduce the energy waste, these techniques will minimize electricity consumption in range of (20-40)% of total energy, in this study focused on the simple energy management methods presented of people duties as awareness aspects for examples as its mentioned before the adjustment of A/C unit set point temperature to 24 C° when cooling and water heater to 60 C° in winter also using smart light.

## CONCLUSIONS

Through the previous study there are several challenges and obstacles which the government and people must overcome in order to achieve the desired goal by successful planning, organizing programs and setting up committees of experts to follow up on the issue and implement all these duties easily and give a lot interest in controlling of import, marketing of appliances and construction materials and adherence to protocols established for the construction of homes and buildings. Financial support is important to activate proper planning and apply good conditions and terms for the actual implementation of prepared programs especially of awareness and educational aspects which need that financial support to succeed advertising campaigns and motivate scientific researches.

Using of A/C inverter appliances, good houses insulation, economic lights, energy management techniques and other housekeeping and awareness things like Turn off unnecessary light, loads, Close doors and windows can solve the sufficient of electricity providing and match the demand of 20-22 hours/day especially for peak months in hot and cold seasons.

The energy consumption depends not only on the appliance's energy efficiency and energy management, but it is really important that you make proper use of it (people rationing of electricity), for example a refrigerator will use large amounts of energy if it is left open for extended periods of time and a light bulb will use electricity while being bright. So that The people should cooperate with the government and follow the instructions and directions of electrical rationing to reach the best energy conservation. Depending on the base of the triple sequence between the three parameters represented, electricity cannot be provided sufficiently without people rationing of electricity, rationing cannot be obtained without tax, and tax cannot be applied without sufficient electricity so it is needed to balance among these parameters gradually to approach the optimal results.

## RECOMMENDATIONS

Regarding the object of constructing homes and other service buildings, we recommend that special laws be established by the government that require citizens to adhere to a specific protocol of building materials used to construct walls and roofs, and within this protocol the use of insulation materials, as well as auditing procedures by specialized committees.

As for the old electrical and cooling appliances that consume high energy especially A/C window type with reciprocating compressor, it is possible to impose fines on citizens who use them at home, as well as the merchants who trade in and confiscate them and allows only importing A/C with inverter system also importing led bulbs only.

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