# Effective and Efficient Method of Electricity Usage in any Institution to Reduce Electricity Tariff

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**ABSTRACT---** ***The demands for electrical energy in offices, industries, educational institutes and homes are heavily increasing now days due to the heavy use of electrically operated instruments. This increased consumption of electrical energy requires more production of electrical energy. The electrical energy production due to increased demand is not only possible to satisfy by the renewable hydro power generation in Srilanka but also need to use non-renewable thermal power generation now days. The increased thermal power generation increases the cost for electricity production due to increasing the cost of non-renewable energy sources such as fossil fuel, coal, etc. This will increase the electricity tariff drastically in the institutions and industries. The increase of the electricity tariff is not possible to manage in most of the institutions. Therefore the need arises to minimize the electricity tariff in possible ways. This paper presents the possible methods such as the use of low energy consumed electrically operated equipment with automatic control and power management capability and the reduction of electrical energy losses and wastages from the equipment and their surroundings to minimize the electrical energy consumption in any institution and further it introduces the renewable solar energy and wind energy uses by the institution effectively and efficiently in the way of hybrid grid tie system implementation. The use of renewable energy sources provide the advantages of reducing Green Effect in our living environment as well as protecting the non-renewable energy sources from exhausting.***

## 1. INTRODUCTION

Electrical energy is one of the most important needs in our lives today because most of the offices, industries, educational institutes and homes are using electrically operated instruments for their day to day usage. Due to increased demands for electrical energy, production of electrical energy has to be increased from different sources of energy in order to meet the demand. In Srilanka, even though renewable hydro power generation is available, it is limited because duration of rainy season has been reducing for last few years but the demand for electricity is increasing rapidly compared to the production of hydro power electricity. So until now, non-renewable energy sources such as fossil fuel, coal, etc. are taking lead in the production of thermal electrical energy to meet the increased demand. But the use of non-renewable energy sources to produce thermal electrical energy are polluting the spaces of our living environment severely. Further, these non-renewable energy sources are exhausting rapidly in the world due to heavy usage of them for various purposes including thermal electrical energy production. Because of diminishing nature of non-renewable energy sources, cost of these energy sources are increasing rapidly in the world from recent years of time which in lead increase the cost of electrical energy production. This rapidly increasing cost for electrical energy becomes huge headache to the management of industries, offices, educational institutes as well as in homes due to the difficulty in controlling the electricity consumption with the existing electrical equipments, lighting systems and air-conditioners.

To reduce the cost of electrical energy in any industries, offices, educational institutes and homes, effective and efficient use of electrical energy is very essential and also the generation of electrical energy from renewable energy sources is the most important need in now a day. To achieve these goals, we have to find the suitable ways for adopting effective and efficient use of electrical energy in any system and also the generation of electrical energy with renewable energy sources.

The purpose of this paper is to discuss the way and means of effective and efficient use of electrical energy in order to reduce electricity tariff as well as protecting the non-renewable energy sources and the environmental pollution. The following points are mainly considered in this article to achieve our goals.

- Identifying low energy consumed electrical equipments, air-conditioners and lighting methods

- Finding the ways for maximum effective use of electrical energy comfortably with minimum energy losses and wastages.

- Introducing grid connected hybrid solar and wind energy system.

## 2. METHODOLOGY

### *2.1 Low Energy consumed electrical Systems*

Office equipment is the fastest growing electrical load in the business and educational sectors. With the widespread use of computers, monitors, printers, fax machines, scanners, photocopiers and other electrically operating devices, an office will have hundreds of electrical energy units and then the energy costs will add up. Energy use by office equipment has surpassed lighting in many buildings where office equipment and miscellaneous loads can account for up to 2.5 Watts per square foot of floor space while lighting only makes up 1.5 Watts. In a recent study, office equipment and other miscellaneous uses accounted for over 40 percent of electricity consumption in large office buildings, in which most of that by office equipment. Since office equipment accounts for an increasingly large share of the electricity bill, it is important to consider energy use characteristics when new equipment are purchased for office usage. By shopping the most energy-efficient office equipment, the electricity bill will be reduced, adding to the bottom line. This energy-efficient equipment are automatically powers down when not in use for a period of time and they can be recognized by looking for the familiar ENERGY STAR label. With ENERGY STAR rated office equipment, energy use can be reduced by 50 percent or more. This helps to reduce the load on air conditioning equipment due to low power dissipation by those equipment and also to protect the environment from greenhouse gas emissions as well.

Further, while purchasing the devices it is always very important to look that they have power management capabilities which enable them to power down after a predetermined period of inactivity. For computers, it is better to purchase laptops instead of desktops because a typical laptop computer draws only 15 to 25 watts during the use compared to the 150 watts used by a conventional desktop computer and monitor and also the laptop sleep mode typically uses just a fraction of a watt. For printers and copiers, it is necessary to look that they have power management features and also to be considered that they do not use a heat fusing mechanism when applying ink to paper which require much energy. While purchasing TV or monitor, LCD or LED displays are better than conventional displays because these displays use much less energy than comparable plasma sets and cathode ray tubes (CRTs).

Power adapters are mostly used in low power products like camcorders, digital cameras, laptops, and cell phones in everyday use. So they have to be selected to save a substantial amount of energy by switching to an Energy Star power adapter which, on average, is 30% more efficient than conventional models. They are also often lighter and smaller in size, making it easier for consumers to travel with products such as their laptops.

Air conditioners are widely used in offices and laboratories in any institutions. They cost more money and use more energy to cool the places. Typically 30% to 40% of the utility bills pay for cooling the environment in our country. To reduce the energy consumption and cost of electricity bills for the use of air conditioners, Energy Star® with programmable thermostat air conditioners have to be installed in the laboratories and offices. In addition, solar air-conditioners can be used with electricity and solar energy as an auxiliary power in accordance with the principle of fluid dynamics. This solar air-conditioner combines the absorption working system to compression system by using environmental friendly media in cooling on the basic of traditional air-conditioner technology to achieve energy-saving up to 30% and environmental protection. It adopts vacuum tube solar collector which is with high performance of absorption and low reflection ratio. Further, air filters of air-conditioners must be kept clean or replace while damaged in order to reduce the energy consumption by around 5%. D.C powered solar air conditioners can also be used directly with solar system as shown in Figure-1 in order to reduce a.c. power consumption from the common power grid.

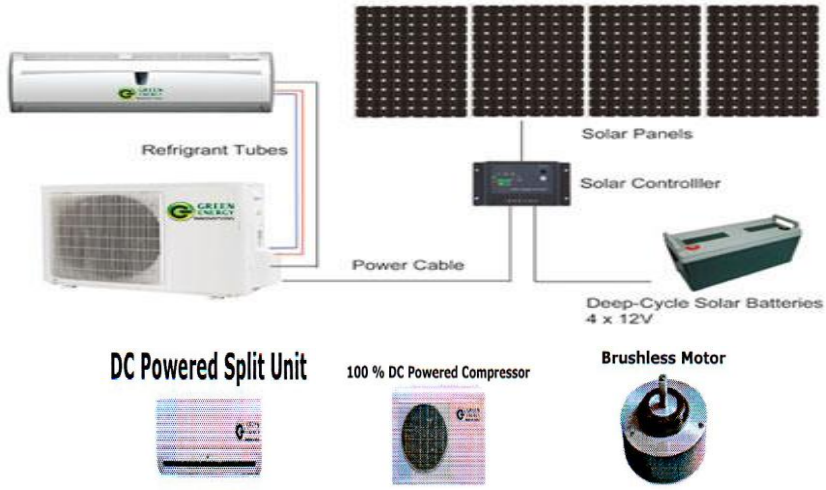


**Figure-1 : D.C. Powered Solar Air conditioner System**

In addition to air-conditioners, many offices and institutions are commonly using electric fans as their air cooling instrument which can be ceiling fans or wall fans or stand fans. These fans consume considerable energy for its continuous use in summer season. To reduce the energy consumption and the cost of electricity bills, Energy Star® fans with thermostat and intelligent regulator to control the speed of them according to the temperature and relative humidity can be used. Further, remote controlling of the fan operation can be incorporated with this system in order to avoid the waste of the energy unnecessarily. The high efficiency and low power consumed DC fans as shown in figure-2 are also considered with battery operated solar system in order to reduce the use of nonrenewable energy as well as to operate continuously even in the absence of electricity supply.


**Figure-2 : High Efficiency and Low Power Consumed D.C. Fans**

Electric lighting is another major energy consumer. Enormous energy savings are possible using energy efficient lighting products, effective controls and careful design for efficient operation of lighting, and daylighting of rooms with energy-efficient windows and skylights. Using less electric lighting, heat gain of the rooms can be reduced, thus saving air-conditioning energy and improving thermal comfort. Lighting controls as shown in figure-3 are critical for minimizing lighting energy use and maximizing space functionality and user satisfaction. Control techniques ranges from simple to extremely sophisticate. Electric lighting design also strongly affects visual performance and visual comfort by aiming to maintain adequate and appropriate illumination while controlling reflection and glare.

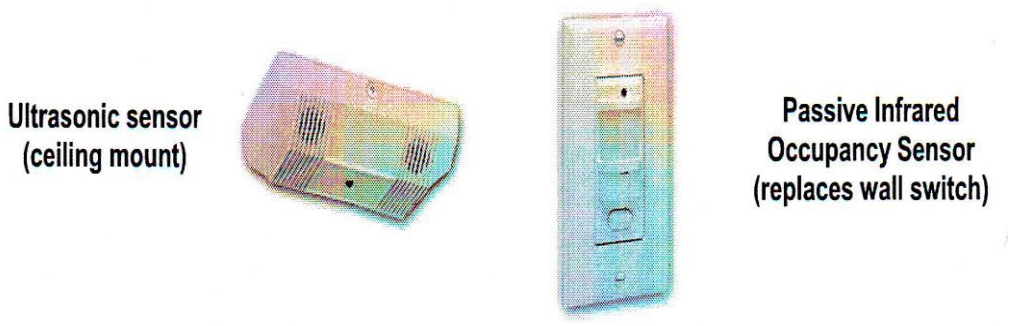


**Figure-3 : Occupancy/Motion Sensors to turn Lights ON and OFF where appropriate**

**Lighting Energy Savings Potential with Occupancy Sensors**

| Application | Potential Energy Cost Savings |
|---|---|
| Offices (private) | 25-50% |
| Offices (open areas) | 20-25% |
| Restrooms | 30-75% |
| Corridors | 30-40% |
| Storage areas | 45-65% |
| Meeting rooms | 45-65% |
| Conference rooms | 45-65% |
| Warehouses | 50-75% |

**Table-1**

There are several ways of energy efficient lighting according to the application as in Table-1 with affordable lighting technology. The following are a few examples of energy-saving opportunities with efficient lighting.

* Installation of compact Fluorescent Lamps (CFLS) in place of Incandescent Lamps.
* Installation of Energy-Efficient Fluorescent Lamps in place of "Conventional" Fluorescent Lamps.
* Installation of occupancy/motion sensors to Turn Lights ON and OFF where appropriate.
* Use an automated device, such as a Key Tag system, to regulate the electric power in a room.
* Offer nightlights to prevent the bathroom lights from being left ON all night.
* Use high efficiency (HID) exterior lighting.
* Add lighting controls such as photo sensors or time clocks.

Installing a low voltage lighting system is safe and easy and does not call for any technical expertise or special skills. Low voltage lights have twin benefits as that are both energy efficient and economical to operate. The brightness level of the lighting is determined by the bulb wattage that is selected. Available bulb wattages range right from 4 watts up to 50 watts (halogen).

### *2.2 Maximize effective electrical energy usage with minimum losses and wastages*

Electrical energy usage is possible to maximize with minimum losses by considering different techniques while constructing the buildings, setting up computer and other laboratories, arranging the office administration sections, etc.

In the construction of buildings, walls, windows and ceiling must be insulated for heat transfer from inside to outside or vice versa by constructing cavity wall insulation around the building; installing argon filled, double glassed windows or double glassed windows with wooden frames; installing 250 mm thickness of loft insulation between ceiling joists at the roof of the building and painting the building with light color in warm climate area or dark color in cold climate area. Orientation of buildings in construction is also important to reduce the heat effect in rooms of the building by sun light. Normally buildings are oriented in the direction of North-East to South-West or South-East to North-West to minimize the heat effect and optimize the lighting of building by sun light. Further, surroundings of the building, especially close to windows and doors, draught condition must be eliminated by planting shade trees and having garden in and around. Air conditioned rooms in the building must be sealed properly by using caulk and weather stripping to plug air leaks. Energy losses can be reduced from electrical equipment by switching off them when not in use instead of leaving them on standby and furniture and cloth curtain in the rooms or laboratories must be kept away from radiators. It is good to place aluminum foil behind radiator to reduce energy wastage. By reducing the water usage in the institutions and offices, number of times to pump water to the tank can be reduced and hence it will save electrical energy from wastage. By installing a plastic 'Hippo' in the toilet cistern, 35% of water used for flushing the toilet with normal cistern will be reduced to 12 – 15%. Further greater water wastage can be reduced by stopping drips of water from taps and overflows.

Watering the gardens can be done by collected runoff water from shed roofs while raining, into the water butts and drainage water.

In class rooms and Auditorium, the use of fan and its speed can be automatically controlled as shown in figure-4 according to the number of people inside the room and its relative humidity. If class room or auditorium is taken, the switching ON the number of fans and their speed monitoring can be done according to the number of people in the row of sheets and the relative humidity variation in those areas. Similarly, number of air conditioners to be operated and their setting of thermostat can be automatically controlled in relevant to the people sitting in the area and the relative humidity to be maintained in comfortable for the rooms and auditorium. By making above arrangements energy consumption can be optimized and the waste of electrical energy is reduced.

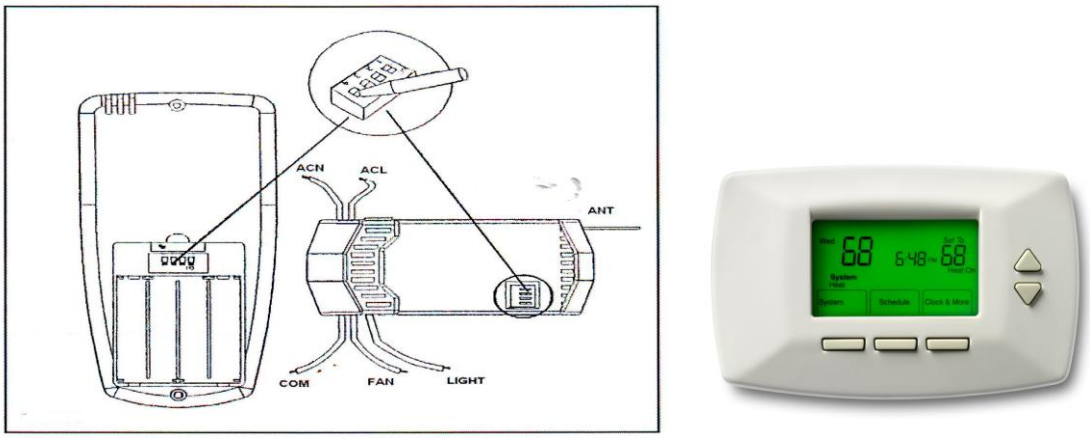


**Figure-4 : Thermostatic Ceiling Fan and Light Remote Control System**

From above methods, 10 to 20 percent of electrical energy bills can be saved from normal bills.

### *2.3 Grid connected Hybrid solar and wind energy system*

In parallel to Ceylon Electricity Board (CEB) supply to the institution, solar power generating system can be installed in the institution premises and it can be connected to the common grid of the CEB supply through net metering as shown in figure-5. Solar power generated by photo voltaic (PV) panel is a d.c. power which has to be converted to a.c. power before connecting to the main supply panel of the institution. To convert the d.c. power to a.c. power, efficient d.c. to a.c. inverter should be used in order to reduce the consumption of power by inverter while operating. This a.c. power from solar panel is connected to the common grid through main panel by net metering which is a result of regulations that obligate utilities to allow excess energy generated by solar PV systems to be sent to the grid, thus spinning the meter backward. This arrangement allows all electricity produced by PV solar power system to be used to offset the utility bills.

By this method of power generation, cost for electricity tariff can be reduced very much, say 60% to 80%, depending on the capacity of installed solar power system and the available strength of sun light in the area and its duration in day time. This saving of money from electricity tariff would cover the initial cost plus its interest for implementing the solar power system within the period of five to seven years.

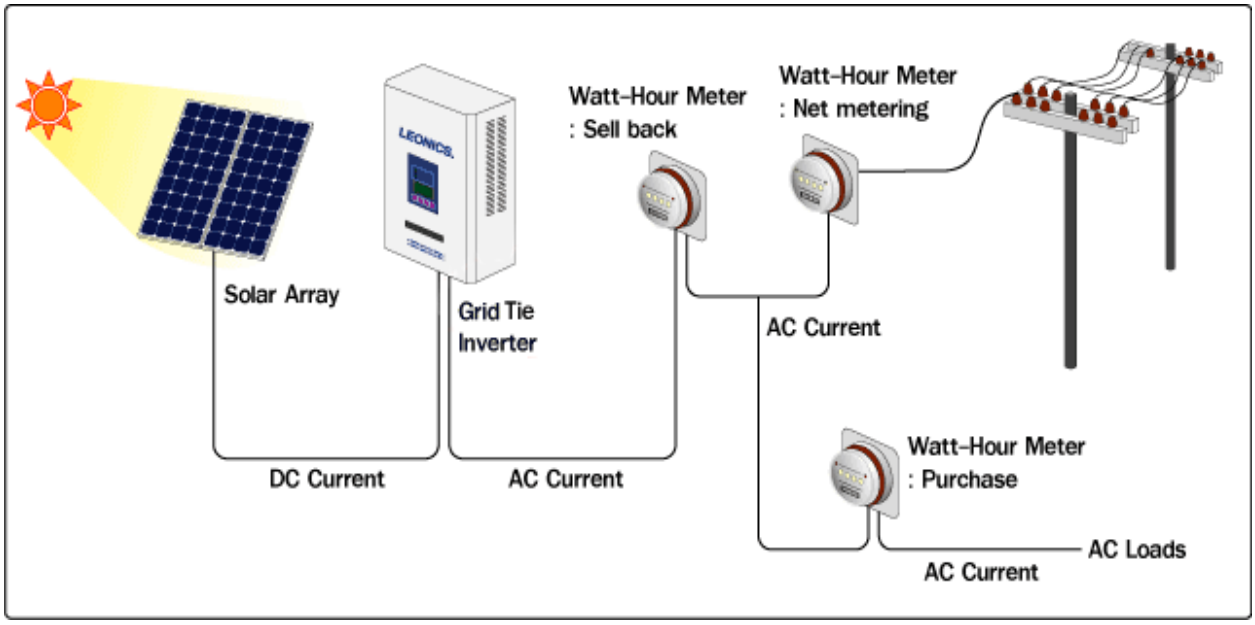


**Figure-5 : Grid Tie Solar Power System**

Further, if the capacity of solar power generation required to the institution is less than 4 kW of power in order to reduce the electricity tariff to 70%, then micro inverter can be used to convert the d.c power to a.c power instead of conventional inverter in order to reduce the initial cost for implementing grid connected solar power system by 20% with the increase of life time of inverter from seven to fifteen years and the increase of total safety to the system under any case of emergency. This micro inverter solar electrical power system can be installed by interconnecting number of micro inverters in integrating manner in order to obtain required electrical power to the use. This method of installation helps to provide the solar electrical power without interruption even if one or number of the micro inverters fail in operation under any circumstances such as fault of the micro inverter or sudden fire in the portion of the building or shutdown the power in any part of the building for maintenance purpose, etc. Further, this integrating manner of installation of micro inverters provide the easy way to expand the solar electrical power system in future according to the increasing needs. Due to these benefits of the use of micro inverter, many institutions, industries and even homes are willing to use grid connected solar electrical power system now a days.

In addition to solar power system, wind power is also possible to obtain in some regions where continuous wind is possible. By interconnecting solar and wind power as shown in figure-6, it is possible to generate renewable power continuously throughout the day and night. This arrangement may take large initial investment but any how these expenditure can be recovered within the short period of time as four to six years. By doing this, the cost of electricity tariff can be brought to 5 – 10% of the cost incurred currently.

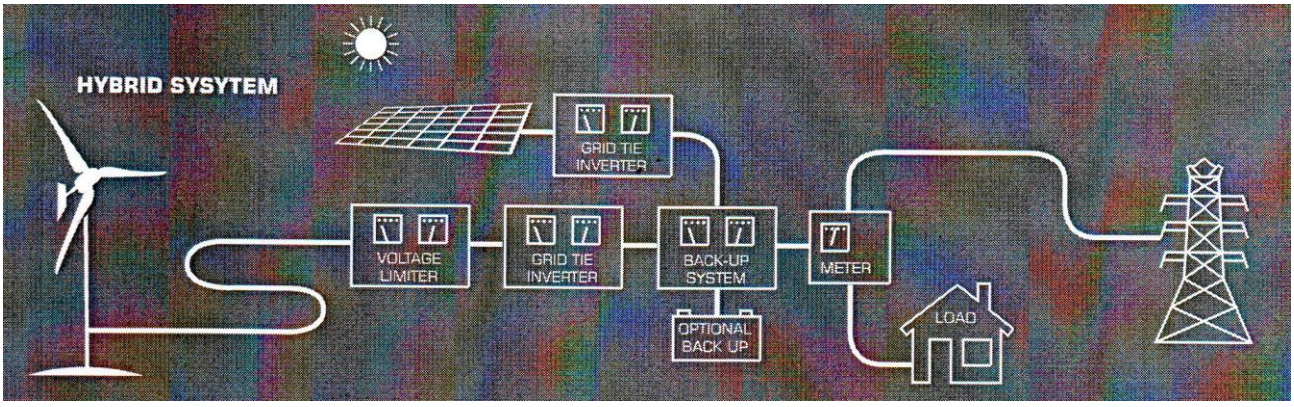


**Figure-6 : Hybrid Solar and Wind Power System**

Further, optimizing the capacity of solar and wind power system according to the current needs, initial cost for implementation of the interconnected solar and wind power system can be kept at the minimum level. After the recovery of the initial cost plus its interest within four to six years, the saving of electricity tariff is 90% which is totally profit to

the institution. This saving can be used for expansion of solar and wind power system in integrated manner for increased needs in future. In addition to this saving, the environmental pollution by $CO_2$ emission due to the use of non-renewable energy sources for electricity generation is reduced greatly and the economy of the country is improved by minimizing the expenditure of foreign exchange for fossil fuel and coal.

## 3. RESULTS

From above studies, it is noted that electrical energy consumption by office equipment, air conditioners, electric fans and lighting system can be reduced between 30% - 40% by adopting ENERGY STAR label equipment and low power consumed devices and system. By reducing the losses and wastages of electrical energy in the way of constructing the building with minimum heat energy transection between inside and outside of the building, setting up external environment to be suitable for low electrical energy consumption by the building for lighting and air conditioning and automatic control of electrical equipment under not in use state, the electrical energy consumption is further reduced to 10% - 20%. Then the total reduction in electrical energy consumption will be in the range of 40% - 60%. This will reduce the electricity tariff in considerable amount.

Further, the introduction of grid connected solar or hybrid solar and wind electrical power system will reduce the electricity tariff drastically to 80% - 90% with minimal initial cost for the implementation of low capacity solar or hybrid solar and wind electrical power system depending on the energy consumption level because of reduced energy consumption of electrical equipment and surroundings of the buildings by the means of using ENERGY STAR labeled power management devices and reduced energy losses and wastages in the equipment and buildings respectively. This solar and wind power system gives the additional advantages as the minimum use of non-renewable energy sources, the reduction of environmental pollution due to the reduced amount of $CO_2$ emission and the saving in the economy of the country.

## 4. DISCUSSION

The study of effective and efficient use of electrical energy helps to identify the ways of reducing the energy consumptions in existing system without much alteration. It also shows the methods of reducing energy losses and wastages in the system as well as around the surroundings. Further, this study indicates how the Grid Tie Solar system and Hybrid Solar and Wind system reduce the electricity tariff drastically in any institution as well as protect the non-renewable energy sources around the world. In addition to the protection of non-renewable energy sources, the above system helps to reduce Green Effect in the environment and save the economy of the country.

## 5. CONCLUSION

As discussed in this paper, each and every institution will be able to practice the above methods to reduce the electricity consumption as well as introduce the renewable energy sources for their power requirements by incorporating into CEB supply. This will help them to reduce their electricity tariff as well as protect their economy and the living environment. As a whole, the country will get the benefit. Further, it focuses on advanced studies and researches on implementing the energy efficient devices and system for future energy needs and avoid energy crises.

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