ADOPTION OF HOUSEHOLD EQUIPMENT FOR WATER AND ENERGY CONSERVATION

Abstract

The massive consumption of natural resources by a growing population has pushed global ecosystems to the brink of irreversible damage, threatening many interconnected natural areas. In energy and water consumption assessments, empirical feedback indicates that consumption is a rational and individual decision-making process. Authors in the social and environmental sciences believe that the analysis of sustainable productivity must be complemented by integrating questions about sustainable consumption and changes in lifestyle. There is increasing pressure on society to move towards more sustainable use of its resources in the current context. Sustainable development or resource use is mainly based on certain premise such as efficient use of resources, reduction of waste and pollution. In this article, an attempt has been made to compare different drivers of energy and water conservation using smart and controlled techniques, so that ways can be realized. sustainable to reduce energy and water without waste. This can help optimize the environmental, economic, and social benefits of infrastructure planning.

Keywords: Sustainable resources, water consumption, Energy Reduction, smart technologies, electricity consumption**.**

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I. INTRODUCTION

In much of the developing world, limited energy and water resources are facing growing pressure because of developing and unpredictable household consumption. Since the industrial revolution, anthropogenic forces have become the main driver of global environmental change [1]. This changes also increase the consumption of valuable resources which have led to a number of economic and environmental problems such as peak electricity demand, climate change and widespread water shortages [2]. Faced with these challenges, utilities and governments have begun to deviate from the 'build and supply' model traditionally dominating the energy and water sectors, wherein useful resource engineers offer extra pipes, wires, and infrastructures to fulfill escalating consumption. Here comes the sustainable consumption which helps the government and the environment by changing to new smart and sustainable technology to reduce wastage and conserve energy and water simultaneously.

1. **Sustainable consumption:** It is the use of tangible products, energy and intangible services in such a way that the impact on the environment is minimized to meet human needs for the present and future generations [4]. Consumption involves not only individuals and households, but also governments, businesses and other organizations. Sustainable consumption is associated with sustainable production and sustainable lifestyles. A sustainable lifestyle minimizes ecological impacts while enabling a flourishing existence for individuals, households, communities and more [5]. It is the product of individual and collective choice of aspirations and needs and the adoption of practices that can be conditioned, facilitated, and constrained by the use of social, physical, and cultural norms. Political institutions, public policy, infrastructure, markets and culture [6]. Thus, sustainable consumption can also include analytics on efficiency, infrastructure and waste, as well as access to essential services, green and respectable jobs and the good life. Better for everyone. It has some common features and is closely related to sustainable production and development [7]. Sustainable consumption within the framework of sustainable development is a prerequisite for the global fight against sustainable development challenges such as climate change, resource depletion, hunger and environmental pollution. Sustainable development and sustainable consumption are based on certain assumptions such as [8]

    - Effective use of resources, and minimization of waste and pollution
    - Use of renewable resources within their capacity for renewal
    - Fuller product lifecycles
    - Intergenerational and intergenerational equity

2. **Electricity generation and demand in India:** Electricity generation in India is mainly done by coal- fired power plants. Despite efforts to diversify options, especially in the case of renewable energy, coal remains the country's main source of electricity. Since 2000, the share of electricity generation from coal has increased slowly; it was 68% at the turn of the millennium and increased to 73% in 2013 [9]. The perceived share of all other energy sources, with the exception of renewable, decreased during this period. In 2015, India generated a total of 1078. The from coal, natural gas, petroleum, nuclear and hydroelectric sources [10]. Renewable and alternative electricity in the form of solar, wind, biomass, and small hydroelectric.

plants (under 25 MW) are also making great strides. It is estimated that these types ofpower sources produced about 70 TWh of electricity in 2015 [11].

Total electricity consumption is expected to increase from 1,000 TWh in 2015 to 3,000 TWh in 2030. In 2030, commercial demand increases to 1,700 TWh; demand for housing increased to 490 TWh; agricultural demand will increase to 350 TWh; economic demand increased to 340 TWh; transmission demand increased to 30 TWh; and a boom in the replacement sector at 140 TWh [12].

3. **Demand and use of water in India:** According to data collected by the Central Electricity Authority (CEA) from distribution companies, all states have shown a significant increase in total residential electricity consumption in recent years. Between 2004 and 2015, states such as Assam, Bihar, Chhattisgarh, and Jharkhand with low initial household electrification showed high residential electricity consumption growth rates (about 11% to 16%). The states with greater domestic electrification such as Delhi, Punjab, Haryana, and Tamil Nadu have grown at a slowerbut still significant rate (6% to 8%), by high absolute numbers [13], with a high. Monsoon rains are India's lifeline in agriculture as well as water regeneration. India receives about 4,000 bcm (billion cubic meters) of average annual rainfall as well as snowfall, including 3,000 bcm during the monsoon season (June to September) [14].

   India's total annual usable water resources are 1123 billion m3 (690 bcm of surface water + 433 billion m3 of groundwater) [14] [15]. As an agricultural country, irrigation is by far India's largest source of water use with a continuous use rate of 78% of the total water supply, followed by the inland sector (6%) and the industrial sector (5%) [15]. Groundwater is an important source for irrigation, domestic use and industry. It is likewise a prime supply of ingesting water in the city and rural India [16] [17]. 45% of the total irrigation water and 80% of the hygienic water comes from underground water reserves [18].

   India has an abundant groundwater reserve that are replenished every year, mainly due to monsoon rains [15]. However, in some states. The over-exploitation of groundwater resources in Delhi, Punjab, Haryana, and Uttar Pradesh has resulted in water scarcity. In states like Rajasthan and Gujarat, arid climates lead to water- stressed conditions, while in Tamil Nadu, Karnataka and Andhra Pradesh, poor aquifer properties are to blame for the scarcity. water [19]. With increasing population pressures, unprecedented industrial development and urbanization rates, groundwater is being extracted from lower levels faster than precipitation can even be replenished. While groundwater supplies a substantial amount of water, a long-term analysis of water intake during pre- monsoon and post- monsoon seasons shows a decrease in groundwater levels due to limited water replenishment [20]. If this continues, India will face a big water deficit withinside the future, particularly withinside the irrigation sector. While per capita water availability is projected to decrease or stay the same, per capita water consumption is projected to increase from 99 l/day (2009) to 167 l/day (2050) [21]. Average home water call for may also boom from 85 litres according to man or woman according today (lpcd) in 2000 to 125 lpcd and 170 lpcd in 2025 and 2050 respectively. Total industrial water demand is also expected to increase to 92 bcm and 161 bcm by 2025 and 2050, respectively [22]. Total industrial water demand is also supposed to increase to 92bcm and 161 bcm by 2025 and 2050 respectively [21].

According to the Code of Basic Requirements for Water Supply, Drainage and Sanitation in IS 1172: 1993, it is recommended to use 200 lphd (litres per person per day) of water at a rate of at least 135 lphd. When used properly, on average at least 90 units per month (kWh) to power a medium- sized family with 4 ceiling fans, 4 tube lights, TVs, small refrigerators and small kitchen appliances.) Is supplied [13] Country, its minimum average is 150 units per month. Even if the recommended value in use is given, the public is unaware of it and uses the resources. According to the Central Power Authority (CEA), household electricity consumption has increased from 55% in 2004 to 80% in 2015.

II. SUSTAINABLE PLAN

We have divided the type of family according to their annual income concerning the survey taken by The Hindu, 2015. Lower (below Rs 36,000/year), Lower- Middle (Rs 36-96,000/year), Middle (Rs 96-180,000/year), Upper-Middle (Rs 180- 720,000/year) and Upper (above Rs 720,000/year). As per the statistic on "the Indian population by income bracket". In 2005, 54% of the population fall under Lower- class families, 41% fell in the Lower-Middle class, 4% in the Middle class and 1% for both Upper-Middle and Upper-class families. The statistic also predicts the income bracket in 2025 to be 22% of the Lower class, 36% in Lower-Middle class,32% in the Middle class, 9% in an Upper - Middle and 1% of the upper class (McKinsey 2007). As the above report predicts that when lower to lower-middle families upgrade and lower-middle to middle families there will be a minimal change in upper or upper-middle-class families. So, this shows lower and lower-middle families will not be able to pay higher electricity and water bills as their income is just below Rs 96,000/year, (contributes 58% of the population that can be neglected) and the rest 42% of the population can be taken in account.

Even after half of the population is neglected energy and water resources are being exploited limitlessly. So here are some possible solutions which can minimize the electricity and water wastage, which helps effective use and conserving it for future generations. The below table shows the electricity power consumption for each appliance collected for each family type using the survey forms before implementation of this recommended application.

Table I. Power Consumption for Each Household Appliance

SL	*Name of appliances*	*Power consumption*	*Unit consumption*	*Unit for water pump*
1	Ceiling fan	75W	1.2 kWh	0.125 kWh
2	CFL tube	40W	0.24 kWh	
3	CRT TV (less 22")	120W	0.94 kWh	
4	CRT TV (22-24")	145W	1.16 kWh	
5	LCD TV (24-32")	86W	0.688 kWh	
6	LCD TV (32-42")	134W	1.072 kWh	
7	LCD TV (42-50")	135W	1.08 kWh	
8	Refrigerator (0-1)	-	270 kWh	
9	Refrigerator (1-2)	-	217 kWh	
10	Refrigerator (2-3)	-	205 kWh	
11	Refrigerator (3-4)	-	178 kWh	
12	Refrigerator (4-5)	-	148 kWh	
13	A/c rate 5	-	509 kWh	

The below table represents the nominal usage of different Indian families. For this, we have taken an average of five members in each family type, water filling twice a day, there for low-class family having 2 ceiling fans, 3 fluorescent tube lights, single door refrigerator (star no rating- 1) and cathode- ray tube (CRT) television mostly of less 22 inches. Lower-middle class family having 2-3 ceiling fans, 3 fluorescent tube lights, single door refrigerator (star rating 1-2) and CRT television 22-24inch. Medium-class family having 4 ceiling fans, 4 fluorescent tube lights, double door refrigerator (star rating 2-3) not more than 2 air conditioners (AC star rating 5) and liquid crystal display (LCD) television 24-32inch. Upper-middle-class family having 4 ceiling fans, 6 fluorescent tube lights, double door refrigerator (star rating 3-4) more than 2 air conditioners (AC) and LCD television of 32-42inch. Upper-class family with more than 4 ceiling fans, 6 fluorescent tube lights, double door refrigerator (star rating 4-5) more than 2 air conditioners (AC) and multiple LCD televisions of 42-50inchs.

The usage of ceiling fan is taken as 16 hours/day, light about 6 hours/day and television about 8 hours/day. Water pump uses 250 watts which runs for 30 minutes twice a day. The calculated value of the above data was collected by doing an interview based survey with questionary to about 25 families and an average of each class where taken which is tabulated in table 2.

Table 2: Electricity and Water Usage With Cost Per Household

SL	Family type	Electricity usage per 2 months (kWh)	Water usage per day (ltr)	Cost for electricity (Rs)	Cost for water (Rs/30 days))
1	Low class	303	600 liters	1,500	515
2	Lower- middle class	405	675 liters	2,201	565
3	Middle class	504	800 liters	3,500	655
4	Upper-middle class	790	1000 liters	6,250	1,280
5	Upper class	1,173	1500 liters	10,508	1,880

- The cost electricity was calculated using the bill calculator of Kerala state electricity board (KSEB).
- The cost of water was taken from Chennai metropolitan water supply & sewerage board.
- Survey was manually taken and the average of 5 family classes are produced.

1. **Solutions for optimized usage of electricity and water:** Electricity and water can be reduced in a most efficient way by changing the human lifestyle and mindset in the water wastage and electricity usage than any technology. But as we are ourselves an example of not changing to a sustainable lifestyle will force us to implement some technologies to reduce it minimally as the initial change.

1. **Solutions for electricity reduction:** Electricity can be reduced by some less electricity-consuming appliances. Such as

- **BLDC ceiling fan***:* BLDC motor stands for Brushless Direct Current Motor which works on direct current (DC). BLDC motor makes use of everlasting magnets, rather than electromagnets which are used in traditional motors. The permanent magnets of BLDC motors have much less power and warmth losses as compared to electromagnets. This motor converts the entry of alternate current into direct current, and subsequently, this generation works easily even at low voltage or power fluctuations. Alongside, it brings you an extremely good deal because it reduces your power intake by up to 50%. BLDC motor fans consume about 1/2 of the power of a conventional motor. Ceiling fans use BLDC generation which operates on an extensive voltage variety from 90V-300V. It is found that a traditional fan's power invoice comes as much a □ 2850 yearly according to a fan while fanatics with the BLDC technology have an electric powered bill of simply □ 1350,accordingly saving □ 1500.

- **LED light fixtures:** These lights and tubes use diodes instead of gas or heated filaments to produce light, making them the most energy-efficient lighting option available. They produce 40-80 Lumens per watt. LED lights are usually the brightest and come in the greatest number of colors [22] [23].

  Fluorescent Operation: Annual Energy Consumption: 75,336 kWh Annual Operating Costs: $8,286.96
  LED Operation: Annual Energy Consumption: 28,032 kWh Annual Operating Costs: $3,083.52
  Savings: Annual Energy Savings: 47, 304 kWh Annual Operating Savings: $5,203.44

- **Appropriate type of refrigerator for each family condition:** A refrigerator is a heavy appliance that runs almost every day for considerable hours to preserve food items. The factors that contributed to electricity consumption for a fridge [24].

  Size: It is a well-known fact that the larger the fridge, the higher the energy consumption. The size and volume of a refrigerator are determined in liters. This means that a large refrigerator should not be purchased unnecessarily. Instead, you need to select the size which can perfectly suit your needs.
  Technology: The technology that drives the compressor in a refrigerator has a greater impact on energy efficiency. The latest refrigerators feature inverter technology, which significantly reduces power consumption. In fact, a reversing refrigerator can reduce electricity consumption by 20 to 30% compared to a conventional refrigerator that is not powered.
  Energy rating: Modern fridges feature stars that determine energy performance. In India, the Bureau of Energy Efficiency set a star rating standard for household appliances. The higher the star count, the more energy-efficient the refrigerator is. This means that energy consumption will be lower.
  Load: The more filled your refrigerator is, the less electricity it consumes. This is because a less filled fridge has more air that the refrigerator should cool to bring down the temperature. On the other hand, the filled items will take less time to cool down the interior temperature. Therefore, try to keep your refrigerator full for a lower

energy consumption.

Door count: The more you open the door of the fridge, the greater may be the electricity intake. This is due to the fact on every occasion you open the door, the outdoor heat air goes in. This will increase the temperature of the interior. The compressor should work at a better place to settle down the temperature again. Hence, the electricity intake will be consumed to be high. Therefore, it's far smart to shop for a multi-door refrigerator, in order that hot air is going in the best in a specific section.

Temperature control: The temperature of the interior of the refrigerator and freezer. Refrigerators are usually delivered with some temperature adjustment, and you should check if they are moderate. Adjusting the temperature too low will result in higher energy consumption. Moreover, it could lead to frosting in certain refrigerators that can damage the food.

- **Natural cooling of rooms:** However, ACs aren't cheap, and everyone knows that.It is not unusual for electricity bills in summer to touch multiples of thousands for just a month. These methods are some of the best ways to cool a home without the help of air conditioning [25].

  Close the blinds: Approximately 76% of the daylight getting into your house via the windows will become warm, so it is a great idea to keep your blinds or curtains closed. The Department of Energy shows medium-colored drapes with white- plastic backing to lessen warmth inside, and a few humans even choose blackout curtains to preserve the windows protected and block the daylight out completely.

  Don't use the oven: Nothing heats up a room like a 400-degree oven. Burners additionally emit a little heat, so be strategic approximately which kitchen home equipment you're using. choose outside grilling instead, or any seasonal summertime season recipe that doesn't require heat.

- **Swap to LED lights:** Light bulbs are another culprit, albeit a much less apparent one. Incandescent mild bulbs deliver the maximum warmth by losing 90% of the power they use, so making the transfer to CFL (compact fluorescent lamps) or LED bulbs could make a distinction in maintaining your house cool. An introduced bonus is power-efficient bulbs like those that can even help decrease your electric-powered bill.

  Use of ceiling fans: Creating a cross breeze with fans is a great manner to flow into cooler air and push warm air out. Find the best part of your house (either the coolest room or outdoor air from a window withinside the shade) and perspective the fan in the direction of the most up-to-date part of your residence. This needs to help draw in cooler air from one side of the residence and push the warmer air out.

  Manage the humidity: The humidity could make the summertime warmth, sense even worse. While a dehumidifier won't lessen room temperature, it's going to assist manage the sticky, thick air that makes warm days even extra uncomfortable. Since humidity decreases the price at which our sweat evaporates, we frequently experience a lot warmer and sweatier in humid weather, so making an investment in a dehumidifier can maintain your house greater cushy throughout the humid months.

Let the night air in: The temperature drops at night-time open the windows earlier than the bed. Working with the outside temperatures can prevent money and help maintain your home cool. Just make certain you shut up the windows and returned up withinside the morning to maintain the cool air earlier than it receives too warm outside.

Plant shades: This plan could take in advance making plans to work. A tree can block around 70% of the sun's radiation a good way to become into your home. These shade-supplying trees, when located close to the windows, can take withinside the warmness from the solar at some point in the afternoons and cool the residence down, additionally offering you a higher landscape.

- **Selecting appropriate televisions**: An LCD is just a liquid crystal display with a fluorescent backlight, an LED is just a light emitting diode that emits all of today's currents, and a CRT is just a cathode ray tube (CRT). The vacuum next to the electron gun. 19- inch LED TVs use 32 watts per hour, LCD TVs use 45 watts per hour, and CRT TVs use 90 watts per hour [28]. In particular, LEDs consume 50% less power than LCD TVs and 300% less than CRT TVs.

The other kind of technics to reduce electricity from grid is by implementing solar cell (photovoltaic cell) and use it for These are the techniques to reduce the electricity bill by half of its rate from now.

2. **Solution for water reduction:** Water conservation involves controlling our water resources carefully and responsibly. As every individual depends on water for livelihood, we must learn how to keep our limited supply of water pure and awayfrom pollution [26]. Keeping our water system secure and clean will safeguard it for future generations. It is critical that we do not contaminate our water, as many people have no idea of how valuable and rare water is [29]. Conserving water involves refraining from water pollution [27]. his requires the use of strategies that includes reducing wastage, preventing damaging water quality, and improving water management [31]. The population must save the water it has today and provide a sufficient supply for the next coming years [28].

- **Quamist tap water savers:** it is a twin mode tap, water savers or additionally referred to as Quamist with distinct modes, particularly the mist mode, which could keep as much as 95% water by producing the water into minute droplets or mist- like consistency, and the shower mode which induces extra bulbous float of water and simultaneously saves up to 85% water. Switching between the 2 modes can take place with only an easy twist of the tap aerator. Quamist tap water saver is available in a nation-of-the-art layout to include an eco-friendly, elegant, and green utilization of water in houses and kitchens. Water-saving aerators provide a reputable quantity of water-saving (i.e 95%) as they lessen water float from 10 LPM (Litres Per Minute) to much less than 0.5 LPM.

- **Low flow faucets:** Switching to a low-flow faucet that uses 5.6 litres per minute can reduce your sink's water flow by about 30% or more [29]. There is an enormous number of types featuring:

- Metered-Valve Faucet
- Self-Closing Faucet
- Ultrasonic or Infrared-Sensor Faucet
- Foot Control Faucet

- **Low flow toilets:** standard toilets use 6 litres per flush, compared to the 4.8 litresused by low-flow toilet fixtures.

  High-Efficiency Toilet: High-Efficiency Toilets (HETs) consume 20% less water than most low- flow toilets, about 5 liter per flush. Often called Dual-Flush Toilets, these models feature two buttons, one for flushing liquids and another for flushing solids [30].
  Low flow shower heads: standard showerheads use 9.5 liter of water per minute, while low-flow showerheads use no more than 6 liter per minute.
  Aerator showerheads: These blend air with water to create a satisfactory spray. Quality aerating heads offer equal coverage as much fewer green fixtures at the same time as the usage of less water. The nice spray does create extra moisture.
  Laminar flow showerheads: These are formed to create individual streams of water that aren't combined with air. This is the fixture of preference for those whoneed to decrease the moisture and humidity as a result of the shower. Refer to the figure 1

Figure 1: Aerating and laminar flow [31]

These are the way to reduce through taps and toilets using municipal water supplies. But some households will have their own natural well to draw water from it. So here are some techniques to refill and reuse the natural aquifers.

- **Rainwater harvesting (RWH):** It is the collection and storage of rain, rather than allowing it to run off. Rainwater is collected from the rooftop of some houses and redirected it into the tank, cistern, deep pit (wells or borehole), aquifer or to reservoir by percolation. We can consider an 80% of water collected with a 20% of the loss. This water can be sent into the ground to recharge it for the coming years. Also, the water collected can be filtered and used for drinking called "drinking water harvesting (DWH)".

- **Grey water reusing:** The water used in our bathroom sinks, showers, tubs and washing machines. It's not the water that comes out from toilets. Grey water may contain traces of dirt, food, grease, hair, and cleaning products. 60% of the water we use for cleaning household is wasted as grey water. The easiest way to reuse grey water is by the good gravity earth filter and use it for irrigation, maintaining green around the compound and can also use it for car wash purposes. It is also able to convert grey

water into drinkable water by just adding a UV filter in the above system. Refer to the figure 2.

Figure 2: Grey water purification [32]

Table 3. Power Consumption for Each Household Appliances

SL	*Name of appliances*	*Power consumption*	*Unit consumption*
1	BLDC ceiling fan	28W	0.448 kWh
2	LED tube	16W	0.096 kWh
3	LED TV 20”	34W	0.272 kWh
4	LED TV 42”	70W	0.56 kWh
5	Refrigerator (SD 3-4)	-	175 kWh
6	Refrigerator (SD 4-5)	-	140 kWh
7	Refrigerator (DD 3-4)	-	185 kWh
8	Refrigerator (DD 4-5)	-	148 kWh

SD= Single Door and DD= Double Door

The table 3 shows the data that is used to calculate the after solutions recommended. Implementation of these bathroom fixtures can reduce the quantity of water used and wasted. Calculating the values of these 2 solutions the amount of water and electricity can evaluated and tabulated in table 4.

Table 4: Electricity and water reduced as per the above methods

SL	**Family type**	**Electricity usageper 2 months (kWh)**	**Water usage per day (ltr)**	**Cost for electricity(Rs)**	**Cost for water (Rs/30 days)**
1	Low class	200	455 liters	730	290
2	Lower- middle class	220	530 liters	845	330
3	Middle class	260	655 liters	1.195	550
4	Upper-middle class	280	855 liters	1,300	1.100
5	Upper class	320	1,355 liters	1,580	1,500

III. RESULT AND DISCUSSION

As the above tables illustrate the amount water and electricity reduced with the above-mentioned methods and technology. As the values in table 1 and 2, for water almost 145 litres have been reduced which bought the cost to 20 to 50%. In terms of electricity, almost 2 to 10 times less for lower and upper-class family respectively. The calculation for water reduction after implementation is done with the help of a simple equation (1).

$$(x-l) \quad (1)$$

Where, *x* is value form table 2 and L is reduced litres (145 litres)

This is how we have reached the 145 litres by adding all the reduced litres from each solution. In table 3 have not calculated air conditioner because it cools the room and heat the environment quite faster than the rate of cooling the room. The best refrigerator for middle, upper-middle and upper family type is double door with a star rating of 3 and above. For families of low and lower middle is single door with 3 or above star rating. In terms of Televisions, for low and lower middle family its best to use 20inch LED TV which only consume 34W and for middle, upper-middle and upper family the best option is 42inch LED TV which is about 70W of power consumption.

IV. CONCLUSION

By implementing above mentioned methods and technology which will help in reducing a major amount of energy in electricity and water production and treatment. Even though the initial cost is high which will end up effectively reducing the electricity bill. Finally, it all about changing the lifestyle and adapting sustainable behavior which will be best way to reduce more amount of water and electricity and implement self-energy generation and water treatment plants within each household.

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