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Model of Electricity Consumption and Conservation: The Determinants from Household Perspective

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Abstract: Pakistan is an energy-deficient country. Since 2000, residential sector electricity consumption has continuously increased, indicating households as a central and influential research target. This study develops the concept of electricity consumption and conservation in a household context based on the literature. This paper aims to assess and review the household's cognitive, personal, and external factors directly, indirectly, or interactively minimizing electricity consumption and maximizing its conservation, addressing the multifaceted challenge of energy-wasting and saving consumer's behavior, massive variation in scale, and energy usage pattern. Further, the study offers a research model that describes the role played by the socio-demographic, psychological factors, and efficacy behavior for electricity consumption and conservation. 150 electricity consumers tested this model. The theoretical and empirical debate reveals three broad variables (socio-demographic, psychological, and efficiency behavior) that contribute to consumers' consumption and conservation activities. Furthermore, massive, cost-effective, and generalizable solutions regarding energy-efficient technology and low emission electricity sources are required. Long-term behavioral change is the crux of curtailing electricity consumption and rising conservation.

Keywords: electricity consumption, electricity conservation, electricity efficiency, household behavior.

電力消費與節約模型：家庭視角的決定因素

摘要：巴基斯坦是一個能源匱乏的國家。二千年以來，居民用電量持續增加，表明家庭成為中心和有影響力的研究對象。本研究在文獻的基礎上發展了家庭環境中電力消耗和節約的概念。本文旨在直接、間接或交互地評估和審查家庭的認知、個人和外部因素，以最大限度地減少用電量和最大限度地節約用電，解決能源浪費和節約消費者行為、規模巨大變化和能源的多方面挑戰。使用模式。此外，該研究提供了一個研究模型，該模型描述了社會人口、心理因素和功效行為對電力消耗和節約所起的作用。一百五十名電力消費者測試了該模型。理論和實證辯論揭示了有助於消費者消費和保護活動的三個廣泛變量（社會人口、心理和效率行為）。此外，還需要關於節能技術和低排放電源的大規模、具有成本效益和可推廣的解決方案。長期的行為改變是減少電力消耗和提高節能的關鍵。

关键词：用電量, 節電, 電力效率, 家庭行為。

1. Introduction

Electricity is a key component in sustainable development that acts as a backbone in modern economies. The electricity demand outstrips because of rapid urbanization and industrialization. Electricity also acts as a critical functional indicator in socio-economic development because the hunger for electricity increases

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as economies grow. Pakistan faces a severe energy crisis due to the failure of energy policy and poor institutional governance resulting in supply and demand mismatch. The recent shortfall of 5000MW-700MW was observed in 2017 due to inefficient fuel mix choices [1]. The problems mentioned above in Pakistan are mainly due to line losses, poor infrastructure, unexplored renewable energy resources, and circular debt on electricity generation units.

Mounting residential electricity consumption and decline in the industrial sector were observed since 2001, although several energy efficiency policies were implemented [2]. The household is the main target group and should be the focus of future efforts for electricity conservation. Factors affecting household electricity consumption and conservation for sketching effective energy policies are crucial for investigation [3]. Previous researches have discerned and classified numerous individual factors like socio-economic aspects for electricity consumption. The studies have greatly contributed and fleshed out in industrial sectors to design policies for reducing energy consumption globally and ignore the residential sector [4].

Household energy conservation is an important research issue due to energy insufficiency and adverse consequences of fossil energy usage in the environment [5]. Investigating the efficiency of involvements targets to motivate households to reduce electricity consumption, build capacities and tactics as a guide for effectively designing policies. The possible causes of variance in residential sector electricity efficacy consumption have been inspected. There is no conceptual framework or model universally accepted and provides most of the factors that can explain electricity utilization and conservation. Any single approach does not predict correspondingly individual behavioral differences. Furthermore, some variables stipulated by empirical evidence may better predict energy consumption, but these findings are not satisfactory from consistent time, context, respondent, and studies.

Variability may be partially an object because electricity behavior can be defined operationally and conceptually in different ways. Consequently, few studies use appropriate scientific methodology to define causal relationships. Numerous studies are non-experimental and determine the correlation among variables but unable to draw strong conclusions. Furthermore, a thorough literature review reveals no research scientifically discovered relationships between numerous variables impacting residential sector electricity consumption.

2. Research Question and Objectives

The main theme of the study is to explore those striking factors to build an effective policies structure for residential sector electricity saving. Our research goal is to build a comprehensive framework and explore the various factors affecting consumption and conservation. The focus of our study is socio-cultural, economic, psychographic, socio-demographics, and situational factors affecting household electricity consumption and conservation. Moreover, the study also addresses the multifaceted challenge of "energy-wasting" and "energy-saving" consumers' behavior. The report further added massive variation in scale and pattern of energy use. The issue of what differentiates above and below-average electricity users are addressed in the present literature. This study is differentiated from previous literature by including the micro and macro factors to dig down and reach the main causes that will determine the most influential factors affecting consumer consumption and conservation behavior. The study reports the following problems.

What are the major consumer interpreters, consumer electricity efficiency behavioral factors, and electricity conservation factors? What are the most influential demographic, psychographic, and situational factors affecting electricity saving behavior?

Our study contributed to the following objectives.

Objective 1: Key objective of the study is to explain major consumer interpreters. We will explain these interpreters and find out the most influential factors to know how and why consumers utilize energy.

Objective 2: The core of this objective is electricity conservation factors and the most important activities of consumers. We will investigate what motivates households to consume and conserve electricity.

Objective 3: Investigation of significant socio-demographic factors to determine the amount of energy utilized. What are those factors, how and why do they affect electricity consumption and conservation?

Objective 4: Elaborating the significant psychographic factors and explaining household cognitive behavior. We will investigate and find out the most important cognitive factor which drives households' electricity consumption.

Objective 5: We will determine consumer electricity efficiency behavioral factors such as situational or macro-level factors. We will also examine efficiency decisions taken by the consumers.

Influential, and most important, 97 articles were reviewed for the construction of this research paper. Organization of paper as, Section 1 discusses the pertinent literature to highlight the paper contributions. Section 2 presented the pertinent literature, and Section 3 advocated the different significant and dominant theories regarding consumption, conservation, and household behavior. Section 4 gives the discussion and overview of key findings. This section is alienated into subsections; section 4.1 explains consumer electricity conservation to identify different activities performed by consumers at different periods or as per requirements to save energy. Section 4.2

scrutinizes consumer interpreters in detail to understand the factors responsible for electricity consumption. Consumer's psychological factors are elaborated to comprehend individual-specific factors in section 4.3. Situational factors are explained in section 4.4, presenting the current scenario and role of macro factors. In section 5 the summary is presented for quick understanding, and future implications are discussed.

3. Literature Review

Demographic factors like age, gender, occupation, and income; personal characteristics like education and knowledge of residents are considered. The composition and family size influences electricity consumption and conservation. Electricity usage rises with age [6], [7], [8]. An increase in the age of the family head increases electricity consumption by approximately 3% and vice versa [9]. However, opposite results are found in [10]. Some studies found marital status, gender, and education are worthless factors regarding electricity consumption and conservation [6]. Families with high education levels and higher classes use more electricity than middle or lower classes with lower education levels. However, [11] found that households with greater knowledge exhibit reduced energy consumption behavior and used energy-efficient equipment, such as radiators, thermostats, and low energy light bulbs. The family size increases electricity consumption by approximately 8% [12]. Individuals who live alone or with another adult consume less electricity than those living with children [13].

Socio-economic factors such as income per month, electricity price, and expenditure shares influence electricity consumption and conservation. Higher-income groups tend to consume more electricity [6]. Researchers cannot observe any statistically significant correlation between electricity consumption and income. The resident's income and electricity consumption statistically correlate [9] and explain changing conservational behavior. The wealthy resident has electricity-efficient appliances and lives in novel buildings [14]. A 10% increase in electricity price led to a decrease in demand by 4.5% [15]. Research showed that a general increase in electricity consumption by 5-15% is due to the rebound effect. The use of more electrical appliances increases electricity consumption [16]. Today young people use more appliances as compared to older people. Few studies scrutinize that home appliance contribute over three-quarters of total household electricity consumption. However, the use of electricity-efficient appliances leads to lower power consumption and vice versa [9].

Various household behavior patterns can save electricity without further investment in infrastructure that has been observed since the 1970s with oil crises by Hayes and Cone [14]. 46% variation in consumption caused by household behavioral factors like knowledge, epistemic values, consumer's values, functional values (quality of life), and other factors such as geographic area, weather, and household locality.

Significant relationships are between weather, temperature, and electricity [17]. Furthermore, an increase in electricity consumption is accounted for by a 0.8°C change in temperature [15]. The study is compared with earlier reviews and shown in Table 1.

Table 1 Comparative table of related studies and factors of electricity consumption and conservation

Ref	SDF	HAS	G	IO	EK	FSS	GA	CA	CV	PVN	EV	SVN	EDIT	SCF	EF	W	TC	LR	EEA	CA
[1]	✔	✔	✔	✔	×	✔	✔	×	×	×	×	×	×	×	✔	×	×	×	✔	×
[3]	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	×	✔	✔	×	✔	✔	✔	✔	✔	×
[5]	×	×	×	✔	✔	×	×	×	×	×	×	✔	×	×	✔	×	×	×	×	✔
[6]	×	×	×	×	×	×	×	×	×	×	×	×	✔	×	×	×	×	×	×	✔
[7]	✔	✔	✔	✔	✔	✔	✔	×	×	×	×	×	✔	✔	✔	✔	×	×	✔	×
[9]	×	×	×	✔	×	✔	×	×	×	×	×	×	✔	×	✔	✔	×	×	✔	×
[10]	×	×	×	✔	✔	×	✔	✔	✔	×	×	×	✔	×	✔	✔	×	×	×	×
[11]	×	×	×	✔	×	×	×	×	×	×	×	✔	×	×	✔	×	×	×	×	×
[13]	✔	✔	✔	×	✔	✔	×	×	×	×	×	✔	✔	×	×	✔	×	×	✔	×
[14]	✔	✔	✔	✔	✔	✔	×	✔	✔	×	×	×	✔	×	✔	×	×	×	×	✔
[17]	✔	✔	✔	✔	✔	✔	✔	✔	×	×	×	×	✔	×	✔	✔	×	×	✔	×
[38]	×	×	×	×	×	×	×	×	×	×	×	×	✔	×	×	×	×	×	×	✔
[42]	✔	✔	✔	✔	✔	✔	×	✔	×	×	×	×	✔	×	✔	✔	×	×	✔	×
Continuation of Table 1																				
[43]	✔	✔	✔	×	×	✔	×	✔	✔	✔	×	✔	×	×	×	×	×	×	×	×
[46]	✔	✔	✔	×	×	✔	×	✔	×	×	×	×	✔	✔	×	×	×	×	×	×
[50]	✔	×	✔	✔	✔	×	✔	✔	×	×	✔	×	✔	×	✔	×	×	✔	✔	✔
[51]	✔	×	×	✔	×	×	×	×	✔	×	×	×	✔	×	✔	×	×	×	×	✔
[53]	✔	×	✔	×	×	✔	×	×	×	×	×	✔	✔	✔	×	×	×	✔	×	✔
[54]	✔	✔	✔	×	×	✔	✔	✔	✔	✔	×	✔	×	×	×	✔	×	×	×	×
[55]	✔	✔	✔	×	✔	✔	×	×	×	✔	×	×	×	×	×	×	×	×	×	✔
[56]	×	×	×	✔	✔	×	×	×	×	✔	×	×	✔	×	×	×	×	×	×	✔
[57]	×	×	×	×	×	×	✔	×	×	×	×	×	×	×	×	✔	✔	×	×	×
[59]	✔	✔	✔	✔	✔	✔	×	×	×	×	×	×	✔	×	✔	✔	×	×	✔	✔
[63]	✔	✔	✔	✔	✔	✔	×	✔	×	×	×	✔	✔	×	✔	✔	×	×	✔	✔
[64]	✔	✔	✔	✔	✔	✔	×	×	×	✔	×	×	✔	×	✔	✔	×	✔	✔	✔
OW	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Abbreviations: Socio-Demographic Factors (SDF), Householder's Age Structure (HAS), Gender (G), Income and Occupation (IO), Education and Knowledge (EK) , Family Size & Structure (FSS), Geographical Area or Level of Urbanization (GA) , Consumer Attitude (CA), Consumer Value (CV), Personal Values & Norms (PVN), Epistemic Values (EV), Social Values and Norms (SVN) , Electricity Efficient Technology (EET), Socio-Cultural Factors (SCF) , Economic Factors (EF), Weather (W), Laws & Regulations (LR) , Traditions & Customs (TC), Electricity Efficiency Activities (EEA), Curtailment Activities (CA),Our Work (OW)

4. Theoretical Background and Conceptual Framework

This section of the article discusses the most influential theories concerning electricity consumption and conservation. The behavioral model of residential energy usage is described by [18]. This model determines the personal, environmental, and behavioral factors for electricity use at home, offering some energy-saving campaigns. The socio-psychological model of energy conservation behavior advocates the factors involving decision making and information processing in conjunction constrain and facilitator factors to consumer actions [19]. The causal model of resource use [20] examined the multivariate association between environmental attitude and pro-environmental behavior.

The work [21] practices theory applied by many researchers to test unconscious habits and technological structure. Visualizing energy consumption activities [22] demonstrates the importance of household activity patterns and energy consumption analysis and understanding for policy development. Understanding the behavior of household energy consumption, lifestyle, and practices encourages consumers to lower energy consumption [23]. Diffusion of innovation theory regarding decision making and household consumption behavior [24], [25] demonstrates how, why and at what rate new ideas, innovations, and technology are communicated in the social system. Theory of planned behavior [26], [27] bridges the beliefs that human behavioral intentions are based on three basic components as attitude, subjective norms, and behavioral control. According to the attitude-behavior external condition ABC model [28], human behavior is influenced by attitudinal factors and external conditions. Value belief norm theory [29] provides an outline for interrogating normative factors to encourage sustainable human attitudes and behaviors. The study [30] proposes the external, internal, and demographic factors of consumer behavior. There are several attitude formation theories, among which three are the most influential. A cognitive dissonance theory [31] posits the discrepancy between beliefs and behavior roots as uncomfortable psychological tension that leads people to restore their comfort. Elaboration likelihood model [32], [33], discussing the stimuli processing, use, and results in the change of attitude. In the social learning theory [34], [35], [36], Pavlov demonstrates that two stimuli associated together to produce a new learned response in following are the proposed conceptual framework based on the thorough scrutiny of pertinent literature. The selected factors portray in a sequential manner and their relationship with each other. The model is tested empirically to find out their actual relationships in Pakistan's electricity consumption and conservation.

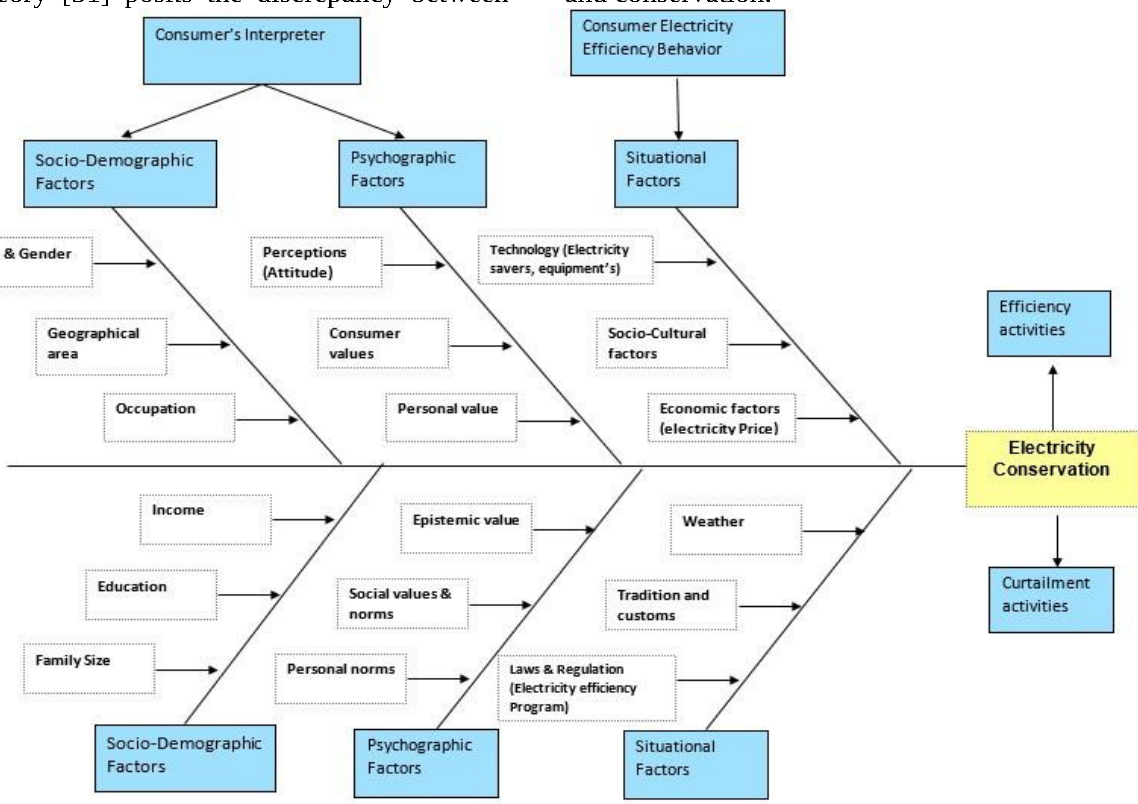

Fig. 1 Conceptual framework

5. Debate and Recapitulation Key Findings Paradigms

5.1. Consumers Interpreters

Electricity consumption serves as socioeconomic development and production function indicator. Numerous individual factors responsible for increasing household electricity consumption were identified and classified by earlier studies. Thus, consumer interpreters include all the factors related to consumers that affect electricity consumption directly or indirectly.

5.1.1. Socio-Demographic Factors

Socio-demographic characteristics are classified in literature for electricity consumption, such as (a) family size, (b) home covered area/size, (c) household age, (d) time spent at home, (e) home age and characteristics, and (f) level of development [38], [1]. Many studies indicated factors influencing

– Electricity curtailment behavior that significantly determines household consumption includes age, gender, income, level of education, and occupation [39].

– Electricity consumption is positively related to age [13].

– Females show more electricity saving and caring behaviors compared to males in daily life [38].

– High-income household uses more electricity as compared to lower-income household [10].

– Highly educated people tend to show more electricity saving behavior than less educated people [40].

These results may be controversial because the influence of socio-demographics varies according to cultural frameworks [10].

5.1.2. Income and Occupation

Income of a household is threshold based on the energy demand of that household and quantity of energy consumed, including the variation in the use of energy based on price and income increase or decrease of the same household. Comfort degree and other related intensity factors amongst households could be assessed by income and occupation [39]. As income increases, the household prefers less intense appliances and unwanted to compromise their comfort in the price-increasing context [41]. Electricity consumption may be indirectly affected by household employment status by impacting income and socioeconomic status, which seriatim restrict consumers' economic and purchasing power in efficiency measures. Some studies examined the link between occupational level and energy conservation strategies and found limited and varying results.

Moreover, household income has a strong positive relationship with electricity consumption and conservation. Income also affects household capacity and purchasing power regarding the electricity efficiency strategies such as advance equipment purchasing [42], [43]. Electricity use for some electronic products is independent of age and income, like refrigerators and washing machines [16].

5.1.3. Gender

Gender refers to socially defined roles, responsibilities, opportunities, expectations of men and women. Gender affects electricity consumption and conservation inconsistently or minimal. Additionally, the association among electricity consumption, conservation, and gender is statistically insignificant [38], [44]. As stated, earlier studies, females exhibit more electricity-saving behavior than males, while others found no statistically significant relationship. Furthermore, females have spent more time at home and are responsible for taking care of the house, considered as an influential variable. Females exhibit a caring attitude concerning switching on and off extra lights and appliances usage compared to males. Some studies found no difference in misuse of electricity among males or females [45].

5.1.4. Family Structure

Family structure is also an influential factor. Kids and older people consume electricity as well. Thus, a household with kids and older people consumes more electricity in their daily lives and shows less saving behavior, increasing electricity bills [46] while finding an opposite outcome. Moreover, electricity-saving behavior is also affected by marital status [39]. Different studies found variation in findings on the impact of socio-demographic factors. Though, there is very little evidence regarding the comparison of these variables. Therefore, this study considers the influence of these variables on both types of direct and indirect electricity curtailment behavior.

5.1.5. Family Size

Family size refers to the total number of members in a household. A typical household family size is an average of 6-7 persons in Pakistan, and different families have different electricity consumption patterns. Family size significantly affects the household's direct and indirect electricity [38], [45]. Various studies argue that the strongest impact is exerted by possession on electricity consumption [47]. A negative correlation between electricity consumption per capita and family size because household members share consumer items. A strong correlation between family size and energy consumption has been found [41]. Another important influence is time tenure, and the household members spent at home affect electricity consumption and conservation.

5.1.6. Householders' Age Structure

The age group has a different level of willingness to consume and save energy. Retired people have more willingness to save energy than the average individual. Household age structure exerts a significant influence on residential electricity requirements [38], [46]. Moreover, a statistical study conducted by earlier researchers specifies that electricity requirement per capita is about 7% higher where the head of household age is 25 -29 years compared to those who are less than 25 years. This percent will increase to 13% when the head of the family is above 50 because much of the electricity is used for health and comfort. Other reasons include lack of knowledge about usage patterns, electricity conservation, momentum to change, the value of well-being for increased per capita electricity consumption with age. Moreover, health and comfort controlled these reasons [48].

5.1.7. Geographical Area or Level of Urbanization

The geographical area serves as the factor that contributes to the indirect consumption of energy for urban and rural areas. In hot areas, households consume more electricity to have better cooling equipment for maintaining comfort level than the cold area [41]. The same pattern exists in Pakistan. The United States defines urbanization as population growth people when moving from rural to urban domains correspond to urban migration. This fast phenomenon causes increased electricity utilization per capita [14]. Advancement in lifestyle causes the electricity used for cooking to decrease and leisure and ease increases. Location plays a significant role along with other variables discussed and explained the energy expenses at a different level across households [64].

5.1.8. Knowledge, Epistemic Values and Education

Education level influences the opinion and behaviors about electricity consumption and conservation. It is commonly stated that the higher the education level, the lower the electricity consumption; rather, education has an indirect effect on electricity consumption and conservation [49]. Epistemic values lead to cognitive achievements of true, justified belief, understanding, and knowledge. Across many human behavior domains, a knowledge action gap is found in both pro-environmental and energy consumption and conservation [38]. Some other studies were also described that formal education factors significantly affect electricity conservation and engage people in conservation measures for electricity efficiency. Education gives awareness and knowledge about the cost of electricity, energy use, electricity-saving behavior, and the significance of these behaviors [43], [50].

5.2. Psychographic Factors

The psychographic factors with the adaption of energy-efficient technology influence the behavior of individuals to salve electricity-related problems. These factors are at the core of the solution to reduce increased electricity consumption. The psychological factors include all the individuals' specific factors that affect electricity consumption directly or indirectly [8]. These include the following factors.

5.2.1. Consumer Attitude

Attitude can be a significant behavioral predictor as it signifies positive and negative evaluations of an individual's specific behavior. The psychological point of view states attitude as a predictor of behavior and explains how and why attitudes vary [11]. Additionally, behavior attitude is more predictive as compared to general behavior [4]. The positive attitudes, values, and beliefs encourage saving behavior but do not leading actual reduction in electricity consumption inherently and are termed as attitude action gap or value action gap. Previous researches identified efficiency and curtailment attitude as the people's positive or negative perception and verdict to electricity efficiency and curtailment behaviors. Moreover, it establishes a positive relationship with both the direct and indirect efficiency and curtailment behavior.

5.2.2. Consumer Value

Consumer values are an overall viewpoint and significant verdict about objects consumed consumption behavior, and tendencies. Values and attitudes lead to positive intentions to save electricity and are affected by many intervening variables like lack of knowledge and social norms [51]. Consumer values as consumption behavior exert an impact on electricity use. These values are divided into materialism and non- materialism as mutual measurements. Earlier studies indicated that the propensity of materialistic electricity consumers did not affect their quality of life while obtaining benefit of saving electricity cost. Therefore, in making electricity-saving choices in daily actions, they are not sacrificing the quality of living. Direct curtailment behavior is a more usual one. More conscious efforts are required for indirect curtailment behavior and efficiency due to psychological variables such as attitude, perceptions, consumer vales, and social values and norms. These psychological variables are significantly related to indirect curtailment behavior as compared to direct curtailment behavior.

5.2.3. Personal Values

Personal values are the belief that leads to actions according to personal preferences [52]. Behavior is the central significance of values. The term values are values that facilitate understanding opinions, actions, behavior, and attitude and justify why one prefers behavior over another [52]. Defining personal values as prudent goals, variation in importance, serve as leading philosophy in the people's lives. Personal values explain how and why individuals prefer and adopt some behavior. According to [40], consumption values are the instinctive belief of the popular way or behavior to acquire personal values. These researchers also designate the kind of values household derived from the goods and services consumption there for consumption values, and personal values are interrelated. Thus, electricity usage and conservation are referred to and directed by the consumer's values.

5.2.4. Personal Norms

One's feeling of moral obligations to behave in a certain way is referred to as personal norms. These personal norms motivate consumption and conservation behavior. This association depends upon awareness and a sense of responsibility regarding behavioral significances [7]. The theory of planned behavior (TPB) is also based upon personal values and motives. It states that people make rational choices and behave optimally, minimizing costs and maximizing the benefits [53]. Perceived obligation for electricity deficiency issues and other problems are strongly correlated with consumer behavior. All those who have strong feelings and obligations regarding electricity problems tend to minimize or solve these issues, showing their norms for energy consumption and conservation. Similarly, the internal locus of control leads to rational consumer behavior towards electricity consumption and conservation than those with an external locus of control [54].

5.2.5. Social Values and Norms

Group associations and social influences affect electricity consumption and conservation. Previous studies indicate that most people behave like others due to social values and norms such as rules and values of common, desirable behavior in a group or society. The system of social norms and values serves as a guideline and influences human actions. The social psychology model for energy conservation painted significance and effect of social values, norms, influences, dispersal, and reference groups in maintaining and promoting energy conservation [55], [56]. Thus, descriptive norms and values at both the micro and macro levels strongly correlate with consumption behavior [42].

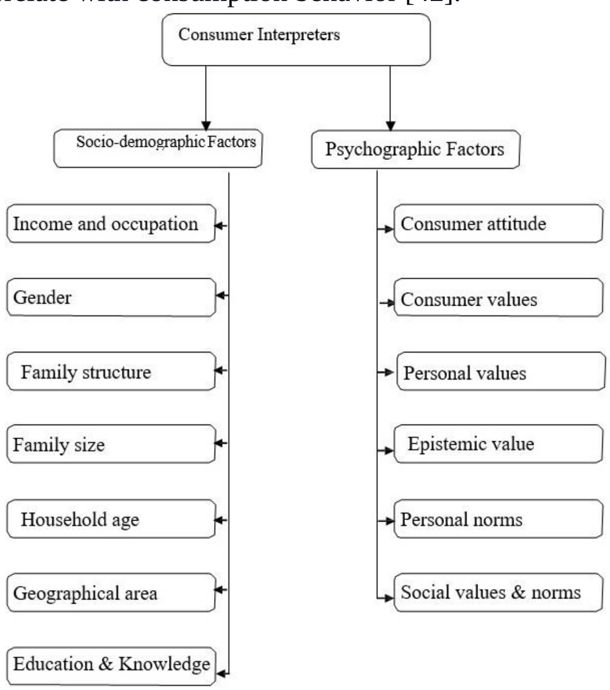

Fig. 2 Consumer interpreter for electricity

5.3. Situational Factors

These are the macro-level factors that affect not only micro-level factors but also facilitate or restraint energy consumption and conservation. These macro-level factors have made a dynamic contribution in determining the effect of other related micro-level factors, depending upon the problem under consideration.

5.3.1. Economic Situation

Electricity consumption is strongly affected by the economic growth of a country. Economic growth guarantees the efficient distribution of resources and fulfilling public needs. The growing contribution of technology in the economic system and people's lives impacts electricity consumption and other resources. The economic condition of the state and individuals are both considered important for electricity consumption and conservation. It includes the cost that households incur to consume electricity. The financial cost incurred by the efficiency measures may restrain consumers from purchasing those [57]. Correspondingly cost of energy also motivates consumers to take the efficiency measure for energy conservation. These steps depend on the economic conditions of consumers. Previous studies have found economic variables like total household income, electricity prices, and electricity efficiency equipment prices [43].

5.3.2. Electricity Price

Electricity charges significantly affect long-term and short-term electricity consumption; as prices increase, the residential electricity consumption decreases [55]. Proposed by [53], residential electricity use is not always affected by small electricity price differences. The observable electricity demand will reduce with an increase in price from a certain threshold. High electricity prices encourage the consumers to search and invest in some efficiency measures for energy conservation. Similarly, attitudes and behavior have changed too to take part in saving electricity activities. People use only enough information to make a good decision rather than processing all the available information to choose an optimal or best decision regarding energy conservation measures [53]. That will lead them to more effort, cost, time, and resources later. This propensity to settle good enough rather than the best solution to the problem may incur more price - people make poorer choices and worse decisions when overloaded with information.

5.3.3. Socio-Cultural Factors

Socio-cultural factors are large-scale cultural and societal forces that affect behaviors, feelings, thoughts, and attitudes. Many people prefer their positive image, which motivates them to follow the group norms they belong to. The social learning theory states that individual learns from others' behaviors and outcomes [43]. These social norms have a considerable impact on household behavior for electricity consumption. The socio-cultural theory belongs to psychology, studies societal groups contribute to individual development. This theory suggests that human learns from the social process and explains the interaction between people and culture. As a result, the factors necessary for energy consumption behavior adaption are cognition, creation, and safeguarding of individual and social identities [41]. Thus, the pattern of energy consumption is determined by the social system and available energy resources. Emphasize that household choices are restricted by the available technology, individual education, government policies, and marketing strategies (non-conservational messages overload the consumers with information).

5.3.4. Customs and Traditions

Customs and traditions stem from social and cultural factors. A common way of doing things is customs; these can be a belief or practice that an individual or group has practiced for a long time. Customs become a tradition when transferred from one generation to other. Thus, customs are handed down from the past. Tradition can be described as the pattern of thought, actions, and behavior that is inherited, established, and customary. Customs and traditions have a significant influence on electricity consumption and conservation. Information communicated through the social customs and tradition is more likely to influence behavior as easily perceived, favorably evaluated, understood, and evoked than the information conveyed through established means of education, advertising, and marketing [58]. Such relational, informational sources are more influential in provoking and reducing electricity consumption than media appeal. Many other researchers [49] have suggested that opinions from friends and relatives affect household energy choices and consumption than expert opinion, although later one is better and more professional.

5.3.5. Electricity Efficient Technology

Energy-efficient technology aims to reduce the quantity of energy obligatory for providing products and services [46]. Maintaining a comfortable home temperature, insulating a home are energy efficient. Six major domestic uses of electricity are cooking, water heating, cooling, lighting, and electrical appliances. Appliances can also be categorized into washing machines, dryers, AC, refrigerator, dishwasher, TV, etc. However, the extent of this end-use varies from country to country, such as considering air conditioning as an additional main end-use. According to society’s income level, appliance affordability is a major reason for domestic electricity demand, which refers to new and advanced appliances [39]. Reducing electricity use reduces costs, which in turn results in financial cost-saving, is the main motivation of energy efficiency. That will lead long term benefits by implementing different electricity conservation measures [5]. Mainly electricity conservation measures are acceptable next to the relationship among different preferable conservation measures, numerous socio-demographic factors, and respondents’ environmental concerns [59], [63].

5.3.6. Weather

Besides the number of human factors influencing electricity consumption, some important external factors are described by many studies. The weather has an impact on residential electricity consumption and demand, particularly [43]. Weather effects on heating and cooling degree days served as indices. Energy analyst uses quantitative indices to calculate the effect of outdoor temperature on electricity consumption in building [60]. There is a minimum temperature for electricity use and a balance point when a building is neither cooled nor heated. Deviation leads to either heating or cooling the building, which is mostly due to atmospheric temperature. Moisture, wind flow, number of sunny days, home microclimate, and atmospheric temperature are other weather-related factors. A microclimate is the residence’s local temperature considered in designing a building for lowering electricity use [43], [63]. Microclimate includes topography, plantation, wet area, urban forms, and these have an impact on small climate patterns. People living in the same area share the same level of technology, climate, and socio-economic but different level of electricity consumption due to the buildings micro climate that has an additional impact on electricity consumption and demand [51], [64]

5.3.7. Laws and Regulations

The use and taxation of energy are governed by energy laws and regulations. These laws and regulations refer to the primary authority, political rules and regulations, public policies, socio-cultural, economic, public infrastructure, pressure groups, electricity prices, financial markets, media, advertisements, and others that strongly influence consumption and conservation patterns of consumers. These factors are free from the impact of individual influences. These influences of macro-level also restrict policymakers within societal and institutional boundaries regarding policies for industry and household consumers [3], [50], [61]. The government should base energy-related laws and regulations on energy efficiency and make cost-effective strategies for erecting an economy without unavoidably increasing energy consumption a strong influence on consumption and conservation patterns of consumers. These factors are free from the impact of individual influences. These influences of macro-level also restrict policymakers within societal and institutional boundaries regarding policies for industry and household consumers [3], [50], [61]. The government should base energy-related laws and regulations on energy efficiency and make cost-effective strategies for erecting an economy without unavoidably increasing energy consumption.

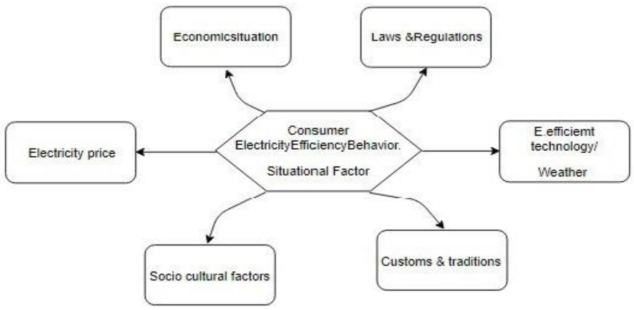

Fig. 3 Consumer electricity efficiency behaviors

5.3.8. Electricity Efficiency Activities

Electricity efficiency refers to minimizing energy usage for the achievement of a given level of output. People have become aware of the efficient use of energy from the oil crises since 1973 [61]. Alternate electricity resources are abundantly available, renewable, and more environmentally benevolent than fossil fuels like solar energy. Excellent planning and policies are required to exploit these resources. Previous researchers describe the concept of electricity efficiency as perpetuating and maximizing delivered output and minimizing electricity consumption. Energy efficiency is reducing electricity consumption by individual households through better insulation strategies and energy-efficient equipment. At the micro-level energy, efficacy is invisible, but at the macro level, it is possible when a horde of households starts efficient consumption of electricity [2]. Activities based on increases in fuel prices like driving less, adjusting thermostats, or reducing fuel usage by varying their daily activities are not considered efficient activities because they may be restored any time with price reduction. [62] reveals that energy efficiency reflects the logic of consumers, a matter of behavioral facts and attitude towards suitable technology usages, such as regulating temperature or automatic standby mode of products. Hence, comprehend all related factors affecting residential electricity consumption for the achievement of electricity efficiency. Previous studies have investigated potential causes of residential electricity consumption and represent respective investigators' points of view, showing their concern for certain issues. A methodical survey of potential variables of dwelling electricity utilization has never been accomplished. This paper describes almost a complete list of efficiency factors of residential electricity consumption and conservation.

5.3.9. Curtailment Activities

The behavior of energy curtailment can be performed either directly or indirectly. Daily domestic energy consumption is referred to as direct energy use like water, gas, and electricity. Indirect energy use is embedded energy consumed by the residence that is built-in goods and services [10]. Goods and services chosen and purchased are involved in indirect energy consumption and are considered part of residential electricity consumption [1]. Consequently, the direct electricity curtailment behavior calls for optimal or reduced gas, water, electricity usage at home, accomplished through caring attitude such as turning off light, fan, AC in an unused area of home [42]. Indirect electricity usage is reduced by consuming less electricity-intensive products by switching expenses to lower electricity-intensive goods or switching from electricity-intensive goods to extensive electricity services [5]. Therefore, indirect energy curtailment behavior calls for goods and services that consume lower electricity, e.g., efficient equipment [17]. These types of electricity savings happen in our daily life. Indirect electricity use is estimated at half of the average household electricity [15]. Though, compared to residential direct electricity curtailment behavior, indirect curtailment behavior is not investigated in Pakistan.

5.3.10. Electricity Saving Consumer Behavior and Energy Efficient Equipment

Implementing different measures to reduce household electricity consumption, two main aspects, behavioral effort and technical improvements, have different properties [5]. Energy efficiency technology development weakened due to the rebound effect and led to increased electricity usage in the residential sector of the world [58]. Because of this effect, the importance of household behavioral change in electricity use has been highlighted. Household curtailment behavior is performed repeatedly and modified in everyday life to save electricity and greatly influences total domestic electricity consumption [58]. Effective communication strategies and marketing tools are required to understand the curtailment behavior and cautious determination of the main factors influencing that behavior. Previous researches identified consumption choices and focused more on consumers' simple actions like turning off lights and ignoring the people's indirect electricity consumption. Guiding consumption behavior to the maintainable direction and excessive industrial production can be controlled because consumption behavior influences production and transportation behavior [4].

Furthermore, hurdles or opportunities for electricity consumption affect how households save electricity since income affects electricity expense and purchase decisions. Correspondingly, electricity-saving decisions need conscious efforts related to psychological factors that impact saving behavior. Thus, we inspect attitudinal, behavioral, important external factors of Pakistan residence and examine the experiential influence on electricity consumption and conservation. Furthermore, intricate adapted saving policies and strategies that motivate others who are careless about electricity saving.

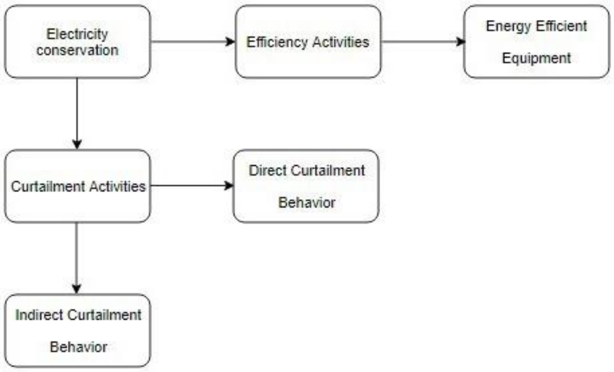

Fig. 4 Electricity conservation factors

6. Case Study of Electricity Consumption and Conservation

The study gathered data through both primary and secondary data collection methods. Articles, major journals, newsletters, and economic surveys are concerned for secondary data collection. A 5-point liker scale was used for primary data collection, which includes questions related to factors. These questionnaires are distributed among a sample of 200 people. A total of 150 questionnaires were included in the study because these were filled completely and accurately. Principle Factor Analysis has been applied to collected data to extract the most important factors. Regression analysis on overall factors and the extracted factors is applied to find relationships among variables and model fitness.

6.1. Sampling

The convenience sampling techniques were used for primary data gathering, and a sample of 200 people was used to collect data. The sample includes only a fully and correctly filled questionnaire based on a 5-point Likert scale. Table 2 shows the consumption of electricity in different sectors. As shown, household consumption has been increasing for the last 16 years, which indicates a shortfall of electricity, increasing load shedding. However, in other sectors, an increase decrease pattern is noticed in small proportion. These results demand efficient government policies and programs to increase production and motivate the public to save electricity.

Table 2 Electricity consumption patterns by different sectors

Fiscal year	Traction	Household	Commercial	Industrial	Agriculture	Street lights	Other Govt	Total
2000-01	13	22,765	2,774	14,349	4,924	213	3,547	48,583
2001-02	11	23,210	2,951	15,141	5,607	212	3,490	50,622
2002-03	10	23,624	3,218	16,181	6,016	244	3,363	52,656
2003-04	9	25,846	3,689	17,366	6,669	262	3,650	57,491
2004-05	12	27, 601	4,080	18,591	6,988	305	3,750	61,327
2005-06	13	30,720	4,730	19, 803	7,949	353	4,035	61,603
2006-07	12	33,335	5,363	21, 066	8,176	387	4,373	72,712
2007-08	8	33,704	5,572	20,729	8,472	415	4,500	73,400
2008-09	5	32,282	5,252	19,330	8,795	430	4,277	70,371
2009-10	2	34,272	5,605	19,823	9,689	458	4,499	74,348
2010-11	1	35,885	5,782	21,207	8,971	456	4,797	77,099
2011-12	1	35,589	5,754	22,801	8,548	478	4,590	76,761
2012-13		-36,116	6,007	22,313	7,697	457	4,199	76,789
2013-14		-39,549	6, 374	24,356	8,290	458	4,381	83,409
2014-15 (p)		-41,450	6,512	24,979	8,033	441	4,403	85,818
2014-15(e)		-30,040	4755	18,445	5,985	331	3,290	62,846
2015-16*		-31,655	5134	18,955	6,164	306	7,331	69,545
P: Provisional -: Not available								
E: Consumption of coal and electricity is estimated								
*: Consumption of coal of the period July-15 to March-16 is estimated								

6.2. Demographics

Age, family size or members, income, and education influence the characteristics of the household and expound the electricity consumption and conservation. Younger households adopt new technology and electricity-efficient appliances more readily. Moreover, youngsters are more aware of electricity conservation measures than elders [1]. Family size influences the amount of electricity used, and large families show careless behavior in saving electricity. House insulation, the home composition, is considered a less relatively effective factor in Pakistan. Information: energy-saving behavior is encouraged by energy bills or energy labels. Awareness information campaigns about energy-efficient technologies are frequently communicated by international, national, regional, local management and institutes, energy organizations, different consumer links, technology suppliers, and their links [39].

Moreover, it is not confirmatory that knowledge quality and information level improve outcomes in sustaining electricity conservation – economic factor: electricity price exercise a strong influence on reducing electricity use. Furthermore, higher electricity charges motivate consumers for electricity saving and purchase energy-efficient equipment. Norms, beliefs, and attitudes are important determinants of electricity consumption, but no author statistically proves them. Whereas for this research, mixed results are provided by literature [49].

The descriptive include perception-related questions and the caring attitude of a consumer concerning energy conservation. Using a programmable electronic device to set temperature automatically, 28 respondents said yes, 108 said no, and the remaining gave “nil” answers. All the respondents use LED lights and energy savers to save electricity and lightning for about 10-15 hours daily. All respondents have 2-3 kids and older people on average, indicating more electricity usage. 70 respondents use another standby source of electricity, and 40 have no such source, whereas the remaining have no idea about it or no response was given. About load shedding effect, 60 people respond as highly affected, 32 moderately, and the remaining are unaffected. 60 respondent practices turning off lights and force family members as well, 30 occasionally/rarely turn off lights, whereas others are careless about it. Behavioral change for other reasons like incentives offered by government to save electricity or equipment manufacturers, 28 say yes, 40 say no, and others do not consider it. Approximately 90 respondents have high billing as the main motive for saving electricity, and the remaining respondents show no concern. When buying a new electronic, 30 respondents consider the product’s energy efficiency, 20 consider the price, and the remaining respondents consider both factors.

6.3. Principle Component Analysis (PCA)

Extraction method PCA was used to extract uncorrelated variables of linear combinations. From these factors given in Table 3, first has a maximum variance. This variance is gradually minimized as proceeding and explained by second and following factors, which are uncorrelated with each other. This process is like Canonical Correlation Analysis. The orthogonal rotational method Varimax (which gives independent variables = no multicollinearity) was used to reduce variable numbers based on factor loadings and simplify factors interpretation. Variables should have at least 5-10 observations for factor analysis. The normal ratio of suspects to variables is 10:1. The EFA works better, and data error can be reduced by using a larger sample smaller sample size can be enough (n>150) with several factors loading scores (> 0.80). In this case study, the sample of 150 and 12 observations for each variable encounter the conditions for better results.

Table 3 Total variance explained of selected variables (components)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %
1	5.911	42.224	42.224	5.911	42.224	42.224	5.12	36.579	36.579
2	1.454	10.384	52.608	1.454	10.384	52.608	2.24	16.029	52.608
3	0.944	6.745	59.353	-	-	-	-	-	-
4	0.835	5.967	65.32	-	-	-	-	-	-
5	0.744	5.317	70.637	-	-	-	-	-	-
6	0.657	4.696	75.333	-	-	-	-	-	-
7	0.604	4.312	79.644	-	-	-	-	-	-
8	0.572	4.083	83.727	-	-	-	-	-	-
9	0.561	4.006	87.733	-	-	-	-	-	-
10	0.502	3.589	91.322	-	-	-	-	-	-
11	0.36	2.57	93.892	-	-	-	-	-	-
12	0.322	2.302	96.194	-	-	-	-	-	-
13	0.303	2.164	98.359	-	-	-	-	-	-
14	0.23	1.641	100	-	-	-	-	-	-
Extraction Method: Principal Component Analysis.									

In Table 4, correlation matrix shows mostly strong and significant positive relationship among variables. The 0.30 or greater correlation must be in variables because lower will consider as weak relationship [12]. The Squared Multiple Correlation (SMC) check was used for nonexistence of multicollinearity in dataset [12]. According to the rule of thumb, variables with singularity issue should be removed (SMC close to 0) and multicollinearity (SMC close to 1.0). So, no such problem arises in this study. W (weather) has positive and significant correlation with other variables. Furthermore, CT (customs and tradition), LR (laws and regulations), EA (efficiency activities) and CA (curtailment activities) than CA (consumer's values) and EA (efficiency activities) show significance to most variables.

Table 4 Observed correlations among selected variables

		PA	CV	PV	EV	SVN	PN	T	SC	EF	W	CT	LR	EA	C A
PA	Pearson Correlation	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CV	Pearson Correlation	.608**	1	-	-	-	-	-	-	-	-	-	-	-	-
PV	Pearson Correlation	.500**	.354**	1	-	-	-	-	-	-	-	-	-	-	-
EV	Pearson Correlation	.474**	.480**	.378**	1	-	-	-	-	-	-	-	-	-	-
SVN	Pearson Correlation	.187*	.177*	.237**	.216**	1	-	-	-	-	-	-	-	-	-
PN	Pearson Correlation	.436**	.381**	.346**	.387**	0.005	1	-	-	-	-	-	-	-	-
T	Pearson Correlation	.322**	.279**	.351**	.366**	.186*	.320**	1	-	-	-	-	-	-	-
SC	Pearson Correlation	0.033	0.155	.217**	.197*	.478**	0.147	.284**	1	-	-	-	-	-	-
EF	Pearson Correlation	.354**	.365**	.424**	.321**	.287**	.346**	.348**	.312**	1	-	-	-	-	-
W	Pearson Correlation	.464**	.538**	.435**	.523**	0.145	.443**	.347**	.303**	.502**	1	-	-	-	-
CT	Pearson Correlation	.424**	.512**	.408**	.470**	0.132	.436**	.251**	.310**	.450**	.726**	1	-	-	-
LR	Pearson Correlation	.300**	.352**	.342**	.362**	.348**	.296**	.310**	.305**	.331**	.492**	.407**	1	-	-
EA	Pearson Correlation	.469**	.533**	.424**	.445**	.214**	.401**	.287**	.269**	.468**	.674**	.586**	0.48**	1	-
CA	Pearson Correlation	.421**	.427**	.416**	.375**	0.138	.369**	.242**	.172*	.381**	.585**	.440**	0.33**	0.622**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

As shown in Table 5, this test gives the technique for dimension reduction. We obtained the set of factors that summarize the information available in data (without loss of information). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.843, which is considered perfect and has acceptable extraction values (kmo > 0.5 is considered acceptable and kmo > than 0.6 is perfect). As for Bartlett's test of sphericity is concerned, we check the p-value that must be less than 0.001; thus, in this case, it is 0.000, which is significant.

Table 5 KMO and Bartlett's test, measure of sampling adequacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.843
Approx. Chi-Square	1716.86
Bartlett's Test of Sphericity Df Sig.	378
	0

Table 6 commonalities mean the extent to which a variable is correlated with all other variables. The table shows extraction values. These extraction values demonstrate the amount of variation of each variable explicated by the factors. These values are equal to or high than 0.5 are considered as good extractions. All the values are greater than 0.5 except T (technology), PN (personal norms).

Table 6 Commonalities of selected items

SR #	Initial	Extraction
Q # 1	1	0.651
Q # 2	1	0.666
Q # 3	1	0.715
Q # 4	1	0.532
Q # 5	1	0.688
Q # 6	1	0.73
Q # 7	1	0.755
Q # 8	1	0.673
Q # 9	1	0.607
Q # 10	1	0.649
Q # 11	1	0.681
Q # 12	1	0.597
Q # 13	1	0.657
Q # 14	1	0.708
Q # 15	1	0.628
Q # 16	1	0.543
Q # 17	1	0.62
Q # 18	1	0.588
Q # 19	1	0.759
Q # 20	1	0.637
Q # 21	1	0.53
Q # 22	1	0.733
Q # 23	1	0.541
Q # 24	1	0.479
Q # 25	1	0.654
Q # 26	1	0.71
Q # 27	1	0.692
Q # 28	1	0.736
Extraction Method: Principal Component Analysis		

According to Table 7, factor analysis extracted 28 components or factors. These factors explain 65% of the variance and are supported by a theoretical explanation, whereas the minimum requirement is 50 %. This extraction is based on an eigenvalue that must be greater than 1 (rule of thumb). Homogeneous samples lower the variance and factor loadings, so we use heterogeneous samples [1].

Table 7 Total variance explained within defined data set

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %
1	8.576	30.63	30.63	8.58	30.63	30.63	4.22	15.075	15.075
2	2.188	7.816	38.446	2.19	7.816	38.446	2.57	9.191	24.266
3	1.568	5.602	44.047	1.57	5.602	44.047	2.39	8.525	32.791
4	1.423	5.081	49.128	1.42	5.081	49.128	2.25	8.042	40.834
5	1.183	4.226	53.354	1.18	4.226	53.354	2.12	7.556	48.39
6	1.148	4.099	57.452	1.15	4.099	57.452	1.66	5.921	54.311
7	1.068	3.816	61.268	1.07	3.816	61.268	1.63	5.834	60.146
8	1.003	3.582	64.85	1	3.582	64.85	1.32	4.705	64.85
9	0.925	3.302	68.153	-	-	-	-	-	-
10	0.867	3.095	71.247	-	-	-	-	-	-
11	0.784	2.798	74.046	-	-	-	-	-	-
12	0.744	2.658	76.704	-	-	-	-	-	-
13	0.72	2.57	79.274	-	-	-	-	-	-
14	0.646	2.307	81.581	-	-	-	-	-	-
15	0.635	2.268	83.849	-	-	-	-	-	-
16	0.53	1.892	85.741	-	-	-	-	-	-
17	0.469	1.673	87.414	-	-	-	-	-	-
18	0.461	1.645	89.06	-	-	-	-	-	-
19	0.454	1.623	90.682	-	-	-	-	-	-
20	0.432	1.544	92.227	-	-	-	-	-	-
21	0.387	1.381	93.608	-	-	-	-	-	-
22	0.352	1.257	94.866	-	-	-	-	-	-
23	0.319	1.141	96.006	-	-	-	-	-	-
24	0.313	1.118	97.124	-	-	-	-	-	-
25	0.241	0.862	97.987	-	-	-	-	-	-
26	0.227	0.811	98.797	-	-	-	-	-	-
27	0.195	0.697	99.494	-	-	-	-	-	-
28	0.142	0.506	100	-	-	-	-	-	-
Extraction Method: Principal Component Analysis									

Graphical representation of eigenvalue is shown in the following screen plot. Reporting extracted factors above the eigenvalue of 1 and all other prospective factors below 01 are not extracted.

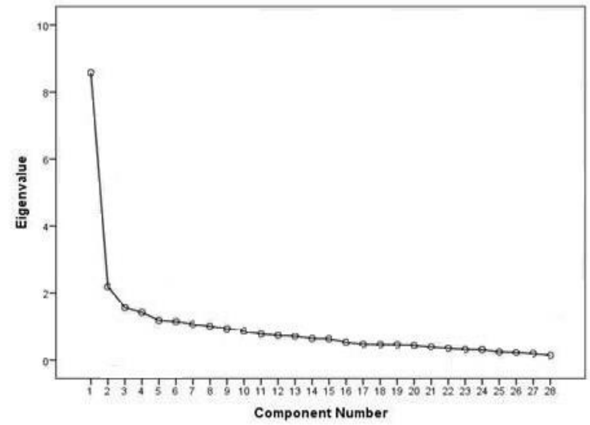

Fig. 5 Screen plot depicting eigenvalues and extracted factors

According to Table 8, the rotated component matrix contains estimates of correlation among the set of variables and estimated components. Matrix reveals variables were extracted under 2 factors. In this case, factor loading is greater than 0.50, considered practically significant (using 0.50 as the threshold for factor loading). Cross-loaded factors are dropped (T, technology). The first factor includes extracted variables weather, epistemic values (knowledge), customs and tradition, efficiency and curtailment activities, and consumer's values. The second group comprises socio-cultural, social values and norms and laws and regulations.

Table 8 Rotated component matrix of selected items

	Component							
	1	2	3	4	5	6	7	8
Q # 22	0.805							
Q # 19	0.728							
Q # 8	0.633							
Q # 20	0.631							
Q # 21	0.569							
Q # 4	0.557							
Q # 26								
Q # 23								
Q # 28								
Q # 27		0.769						
Q # 25								
Q # 15								
Q # 10			0.718					
Q # 16			0.589					
Q # 24								
Q # 18								
Q # 3	0.54							
Q # 1				0.619				
Q # 9		0.508		0.533				
Q # 12								
Q # 5			0.584					
Q # 6					0.661			
Q # 2								
Q # 14				0.506				
Q # 17					0.52			
Q # 11						0.617		
Q # 13							0.737	
Q # 7								

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

6.4. Linear Regression Analysis

In Table 9, internal consistency is measured through the Cronbach Alpha reliability test, how a set of items are closely related as a group and measure the same construct and idea. It is a reliability coefficient, not a statistical technique. The Cronbach Alpha reliability test indicates higher reliability as .889 against the threshold of 0.5.

Table 9 Reliability statistics of study

Cronbach's Alpha	No of Items
.886	14

Table 10 gives the means and standard deviation of all items. CA (curtailment activities) has the highest mean value of 4.07, and CV (consumer's values) reveals the second highest mean value of 3.92.

Table 10 Variable's descriptive statistics

	Mean	Std. Deviation	N
EA	3.9	0.749	150
CA	4.07	0.884	150
PA	3.77	1.041	150
CV	3.92	0.896	150
EV	3.55	0.906	150
SVN	3	1.029	150
PN	3.87	0.789	150
T	3.55	0.808	150
SC	3.12	0.928	150
EF	3.66	0.834	150
W	3.87	0.891	150
CT	3.84	0.805	150
LR	3.36	0.83	150

Table 11 gives a regression analysis of the study. When there is no change in the independent variables, there is still 0.577 units of electricity saving. One-unit change in independent variables gives rise to a one-unit change in the dependent variable (efficiency activities) electricity saving. Table 11 shows that CV (consumers values), W (weather), and LR (laws and regulations) significantly affect electricity saving. Other related studies also gave similar results. F-value shows the good model fit, implying that independent variables jointly affected the dependent variables.

$$Y = \beta + \beta 1 + \beta 2 + \beta 3 + \beta 4 + \beta 5 + \beta 6 + \beta 7 + \beta 8 + \beta 9 + \beta 10 + \beta\ 11 + \beta\ 12 + \mu$$

$$Y = \beta + \beta(PV) + \beta(CV) + \beta(EV) + \beta(SVN) + \beta(PN) + \beta(T) + \beta(SC) + \beta(EF) + \beta(W) + \beta(CT) + \beta(LR) + \mu$$

The empirical results are theoretically, technically sound, and statistically acceptable as R2 and adj. R2 values are according to the rule of thumb. No Serial correlation problem is checked by the Breusch Godfrey Serial Correlation LM test ($p > 0.05$). Moreover, the theory supports coefficient signs and hypotheses of the study.

Table 11 Regression analysis of selected variables

Variables	Unstandardized coefficient	T value	P-value
Constant	0.572	1.799	0.074
PV	0.054	0.845	0.4
CV	0.125	1.761	0.08
EV	0.011	0.163	0.871
SVN	0.016	0.286	0.775
PN	0.038	0.535	0.594
T	-0.035	-0.53	0.595
SC	0.2	0.316	0.753
EF	0.88	1.279	0.203
W	0.302	3.511	0.001
CT	0.095	1.078	0.283
LR	0.13	1.897	0.06
R2	0.545	-	-
Adjusted R2	0.505	-	-
F (p value)	0	-	-
a. Predictors: (Constant), LR, PN, SC, T,			
b. Dependent variable: EA.			
c. Significant at 5% level			

The histogram in Fig. 6 is a kind of bar graph, represents the distribution of numerical data accurately. Stretch the probability distribution of quantitative variables. Before investigating the coefficient of determination, the check of normality of data is necessary. The following visual of histogram reveals normality of data as all residuals lie under the normal curve and give a bell shape. Some residuals lie outside, either on the right or left, exhibiting positive and negative skewness and a few on the top instigating kurtosis.

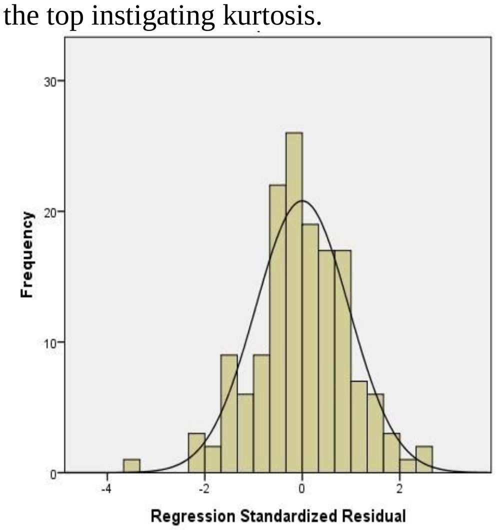

Fig. 6 Histogram depicting graphical summarization of distribution of univariate data set depending variables: EA. Mean = 1.01E-15. Std. Dev = 0. 959. N = 150

Table 12 gives the results of 2nd regression in which the dependent variable is Curtailment Activities (CAs). When there is no change in the independent variables then there is still 1.113 units of electricity saving. The empirical results reveal that Weather (W), Perception and Attitude (PA) and Consumer Values (CVs) are significantly affected electricity conservation. Other related studies also gave the similar results. F-value show the good model fit R2 and adj. R2 also meet the threshold values of cross-sectional studies. Serial correlational problem is not exists as checked by Breusch Godfrey Serial Correlation LM test. Thus, independent variables mutually influence the dependent variable.

$$Y = \beta + \beta 1 + \beta 2 + \beta 3 + \beta 4 + \beta 5 + \beta 6 + \beta 7 + \beta 8 + \beta 9 + \beta 10 + \beta\ 11 + \beta\ 12 + \mu$$

$$Y = \beta + \beta(PV) + \beta(CV) + \beta(EV) + \beta(SVN) + \beta(PN) + \beta(T) + \beta(SC) + \beta(EF) + \beta(W) + \beta(CT) + \beta(LR)$$

Table 12 Regression analysis of selected variables

Variables	Unstandardized	T value	P-value
Constant	1.113	2.735	0.007
PA	0.061	0.747	0.456
CV	0.81	1.716	0.376
EV	0.012	0.169	0.885
SVN	0.012	0.991	0.866
PN	0.09	-0.502	0.323
T	-0.043	-0.188	0.617
SC	-0.015	3.879	0.551
EF	0.058	0.592	0.517
W	0.427	0.128	0
CT	-0.067	1.078	0.555
LR	0.011	1.897	0.899
R2	0.398		
Adjusted R2	0.346		
F (p value)	0		
a. Dependent Variable: CA			
b. Predictors: (constant), LR, PN, SC, T, CV, SVN, EF, EV, CT, PA, W.			

The following histogram shows data normality as it gives a bell shape and reveals that residual lie under the normal curve, which indicates the normality of data with dependent variable curtailment activities.

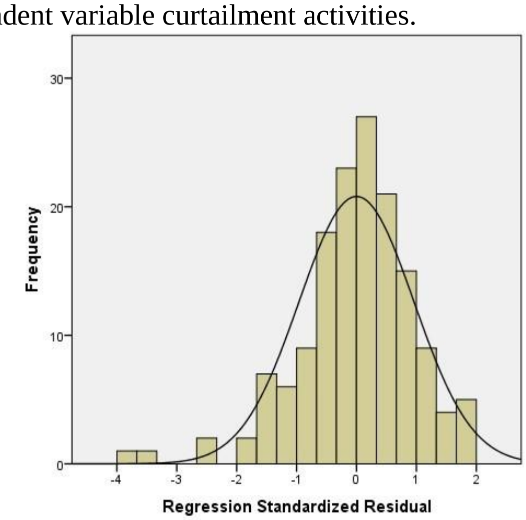

Fig. 7 Histogram depicting graphical summarization of distribution of univariate data set depending variables: CA (Mean = -2.08E-15, Std. Dev. = 0.959, N = 150)

The above analysis proves that consumer psychology, cognitive structure, quality of life, environment, laws, and regulations regarding government policies, electricity efficient equipment, and products are the main motivators for electricity conservation. At the same time, global warming affects whether due to excessive use of natural resources, in turn, affect climate, consequence cumulative use of electricity by household. Furthermore, lack of knowledge, social values, and norms cause high electricity usage and low conservation. Woosley identified that energy consumption is mostly economic reasoning and presumes a rational and independent entity uninfluenced by others. The impact of social relations, non-individual elements, and the role played by the community is ignored by this assumption. The “social” or “non-technical” barriers are hindrances for electricity efficiency knowledge into practice. Now people are getting awareness about electricity saving concept over time.

7. Conclusion

As a developing country, Pakistan faces the problem of increasing population and industrialization, causing drastic energy consumption. Fossil fuel is primary as well as a secondary source of energy in Pakistan. Poor infrastructure and lack of institutional governance indicate that current energy sources cannot meet increasing demand. The solution to this problem lies in energy conservation, efficiency, and utilization of renewable energy sources. Besides this, any enduring solution to restricting rising electricity usage depends on considering the main determinants of consumer behavior. This determinant (including demographic, psychographic, and other situational factors and the adaption of energy-efficient technology) influences the behavior of individuals to solve electricity-related problems. These factors are at the core of the solution to reducing the increasing electricity consumption.

On theoretical implications, this study offers a more comprehensive research model that covers almost all the factors related to the household. To the best of our knowledge, no other study gives the model and empirical results to conclude the most influential factors and determinants of the household. Very limited studies offer the cognitive, epistemic, and consumers values factors at the household level to demonstrate impact on consumer behaviors. These factors’ implications to households explain the consumers’ behavior, switching towards using efficient equipment for energy conservation. On the practical implication side, the study investigates practice–performance links on consumers that provide the perceptions to motivation and psychological drivers to behaviors. On the other hand, the study offers policy-making implementation on the government side to better understand the consumers’ values and psychology to improve energy conservation.

This methodical study analyzes determining factors to residential electricity consumption and conservation, a comprehensive view of human behavioral factors, non-human factors, and their effect on electricity consumption. Weather, consumer values, quality of life, price of electricity, laws, and regulation by the government regarding electricity efficient policies and equipment are the most influential factors affecting residential electricity consumption and conservation. Furthermore, Pakistani people show both direct and indirect curtailment behavior towards saving electricity. Motivation, changing behavior, and effective strategies have potential in the long term.

8. Limitations and Future Work

The research was conducted in two cities -Abbottabad and Mansehra of Pakistan with small sample size. These results provide the consumption and conservation patterns of these cities only and may not represent entire Pakistan. The convenient sampling can be biased in distributing some socio-demographics like age, income, and education. There is a gap between actual consumption and conservation behavior and behavioral consumption and conservation, as actual consumption and conservation are very complicated and depend upon an unlimited factor. Thus, suggesting investigating micro-level and macro-level factors with different sampling techniques followed by measuring the electricity bills to measure actual consumption behavior. Furthermore, this research mainly emphasizes some of the most important socio-demographic, psychographic and situational factors. Further research can be conducted by considering the indicators like perceived behavioral control, political, environmental, cultural, and others.

There is a need to conduct in-depth theoretical and qualitative research for factors quantification. This research will significantly affect electricity efficiency and consumption in all sectors of Pakistan to meet the increasing energy demand and fill the gap between supply and demand. Policymakers must precisely consider the numerous strategies to increase electricity efficiency and evolve steady development in household electricity consumption. Strategies range from addressing the varying factors leading consumer behavior providing basic knowledge, education, social values, and norms to varying outcomes of such behavior like feedback, performance, offering rewards and incentives. This research has addressed some of the factors and strategies affecting behavior; there is much variation in different behaviors with different underlying predictors and needs more empirical research. Furthermore, before designing and implementing programs and strategies, the government and policymakers should conduct comprehensive studies of different areas and situations, as different population segments behave differently at different times. They should also follow up on the effects of applied strategies on consumer behavior.

It is critically significant for the government and policymakers to compare related strategies for cost-effectiveness and efficiency. The political, environmental, socio-economic, cultural economic factors should be considered in-depth in the future. There are many other underlying socio-demographic, psychographic, and situational factors integrated into consumer segmentation. These factors can be productively and practically used to identify consumers with different electricity use patterns.

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