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CHAPTER 1

INTRODUCTION

This chapter introduces the research problem. The introduction is outlined in section 1.1, including the conceptualization of green social work in the context of environmental sustainability. Section 1.2 presents the well-structured background of the study, whereas section 1.3 explains the concept of Solar Home Lighting Systems (SHS). Sections 1.4 to 1.6 provide an overview of the current scenario of SHS adoption in India at a glance and in Punjab, in particular. The problem statement, along with the objectives and significance of the study, has been presented in sections 1.7 and 1.8. The organization of the thesis is given in section 1.9.

1.1 Introduction

Scientists and social activists have long warned the world about the climate crisis. Yet climate commitments fall short of the actions needed to avoid disastrous consequences. Annual climate events such as the Conference of the Parties (COP) or the environment-related days designated in a calendar year, such as World Ozone Day, remind us of the challenges we face due to climate change, but that effort on climate justice is too little and late.

Recently, the ecosocial approach and environmental issues have emerged on the social work agenda due to the need to respond to and mitigate the climate crisis and global environmental problems and their effects on human wellbeing (Nöjd et al., 2023). According to Mason and his associates, as social work increases its action to address climate change, an ecosocial worldview can provide a holistic framework for social work engagement with not just social systems, but also the ecological systems in which all humans are embedded, and an awareness of the intersecting needs of the environmental and human world (Mason et al., 2022).

Social work scholars have devised many variants of key concepts focusing on environmental issues and climate justice in this context.

- **Ecological social work** places both humanity and nature at the center of its education and practice to ensure the sustainability of natural resources for the long term (McKinnon & Alston, 2016).
- **Environmental social work** (ESW) is an approach and a perspective in social work focusing on ecological and environmental sustainability and justice within the context of sustainable development (Rambaree, 2020). It recognizes the inter-twinned connection between human nature and well-being and sets the goals to help create sustainable conditions for the flourishing of both human and natural worlds (Gray et al., 2013; Ramsay & Boddy, 2017).
- **Green social work** considers how social work practice can be transformed by encompassing a holistic 'green' agenda rooted in the interdependency of all peoples and their socio-cultural, economic, and physical environments. It requires social workers to address the politics of identity and redistribution and not treat the environment as a means to be exploited for people's ends (Dominelli, 2012).
- **Ecosocial work** relies on ecological arguments and justifications to make demands for social justice and advocate respecting human rights and participatory approaches through social work interventions in communities (Matthies et al., 2001). It implies integrating social and ecological sustainability on all levels of social work practice (Boetto, 2017).

From the formulation of above concepts, green social work emphasizes green development and green transformation at the macro level; environmental social work emphasizes advocacy from environmental protection to environmental justice; and eco-social work emphasizes the transformative significance of Indigenous cultural and natural ecological diversity on traditional social work paradigms, which helps to advance social work interventions. These concepts' commonalities include (1) transformation and intersubjectivity and (2) welfare integration and sustainability. (Wang and Altanbulag, 2022)

As depicted from Figure 1.1, sustainability comprises intertwined economic, social, and ecological dimensions, and the relationship between them must be addressed for sustainability to be tangible (UNGA, 2013). While social work research and practice for environmental sustainability has grown, much initial literature focused on calls-to-action rather than concrete intervention. In

response to the research gap on social work, climate change, sustainable development, and concrete intervention, this study, therefore, brings an important and well-needed layer of empirical evidence in considering the implications for catalyzing environmentalism within the field of social work. The unique perspectives and skills and competencies of the social work profession are essential in tackling the climate change crisis. These encompass focusing on social justice and empowerment, the person-in-environment perspective, and the use of a systems framework (Powers et al., 2021).

1.2 Background of the study

The Sustainable Development Goals (SDG) serve as a blueprint for attaining a healthier and more sustainable future for everyone. They tackle the global difficulties we encounter, encompassing issues of poverty, inequality, climate change, environmental degradation, peace, and justice. The 17 Goals are interrelated, and to ensure inclusivity, we must accomplish all of them by 2030. Nonetheless, as the environmental and socio-economic impacts of global warming and climate change become more pronounced, achieving the various UN SDGs by 2030 is becoming increasingly difficult. Not only this, but some of the goals are moving in the wrong direction, especially SDG 13: Climate Action, with the average worldwide warming increasing by 1.3° Celsius from 1.2° a year ago and the current temperature being 1.54° Celsius, up from 1.45° Celsius in 2023 (World Meteorological Organization, 2024). While this emphasizes the dire necessity for emission cuts and transition away from fossil fuels by all countries, it supports UN SDG 7 – access to clean and affordable energy, which is a key to developing agriculture, industries, healthcare, education, communications, and transportation.

Thus, a clean energy source is a necessary element of socio-economic development. The increasing economic growth of developing nations in the last decades has caused an accelerated increase in energy consumption (Kumar & Majid, 2020). In this line, the IREDA, in its Annual Report 2020-21, has projected that as the economy grows, the electricity consumption will reach 15,280 TWh in 2040 from 4,926 TWh in 2012. In this context, newtrends in energy policy and sustainability analysis are now facilitating increased attention to energy, environment, and developmental relationships. In recent years, solar technology as a source of renewable energy has achieved unprecedented results on several arduous tasks. For instance, its use in lighting applications, such

as solar lamps, solar cookers, solar geysers, and solar home lighting systems (SHSs), has made consumers more aware of their energy consumption. Scholars, policymakers, and practitioners contend that SHSs are vital in meeting the UN's Sustainable Goal 7 (SDG7), i.e., establishing affordable, reliable, and modern energy services for all by 2030.

1.3 Concept of Solar Home Lighting System (SHS):

A solar home lighting system (SHS) is a system powered by solar energy that uses solar cells from rooftop solar panels that convert solar energy (sunlight) directly into electricity for lighting the home as well as powering electronic appliances (Mitscher & Ruther, 2012). SHS is a photovoltaic array module comprising silicon-based solar panels, a charge controller, a stand-alone inverter, a battery, and electronic appliances using the system that converts direct solar energy into electricity for lighting up the home and powering the DC and/or AC electronic appliances. The solar module setup is mounted on the house's rooftop, where it gets unhindered exposure to direct sunlight, and the charge controller and battery are kept in a protected place.The operational time of SHS depends upon the system's capacity, which generally ranges from 3 KW to 10 KW for households. There are two types of SHS

i. Off-grid SHS
ii. On-grid SHS

The Off-grid SHS operates independently from the primary power supply of the electricity board and is mainly used to supply the energy requirements of rural/distant areas where the grid access is unreliable. The captured solar energy is stored in the battery bank, and the inverter transforms the direct current (DC) into an alternating current (AC) to run the various electrical appliances.

On the other hand, the On-grid system is connected to the main power grid supply. They operate using a net metering policy (NEM) framework. The NEM is a metering and billing method that enables solar power consumers to gain credits for the electricity they contribute to the grid. This strategy monitors and records the interaction between solar panels and the governmental electricity grid. Solar panel users can transmit the surplus energy produced by the panels to the grid when they create excess power. The users can then retract this additional power at their own discretion.

For instance, during night time or a power outage, when solar panels are inoperative, etc. The bi-directional power meter as displayed in figure 1.2 will function in reverse when solar energy units are recorded. Owners of solar energy systems are billed solely for their 'net' electricity consumption. The On-grid SHS is the most cost-effective option, as customers do not need to utilize expensive solar batteries for surplus energy storage. Homeowners can optimize the metering billing system by obtaining power credits for solar electricity they contribute to the grid. These credits may be utilized when solar power generation falls short of energy requirements.

The On-grid SHS is mainly installed in urban areas and has various advantages. The net metering system rewards users with credits for the units produced. This is reflected with a substantial reduction in their electricity bills which helps them offset the initial investment made in purchasing the SHS. On-grid solar systems have garnered considerable interest in recent years owing to their beneficial environmental effects. These systems utilize solar energy to diminish reliance on fossil fuels, which release detrimental greenhouse gases. Decreased carbon emissions is essential in addressing climate change and its harmful impacts on the Earth. The primary benefit of on-grid solar systems is their capacity to diminish the carbon footprint linked to electricity production. Their maintenance is easy, convenient, and not too expensive on the pocket, making it user-friendly. Thus, they are reliable and efficient systems contributing to the resilience of the electricity grid.

1.4 Adoption of SHS and transition away from fossil fuels:

PM Narendra Modi's pledge to elevate India to the "third largest economy" will increase expectations for India to assume a larger role in reducing greenhouse gas emissions. This may entail accelerating its zero-emission targets from 2070 to 2050 and achieving the production of electricity without fossil fuels by 2040 (Kumar, 2023). With the increasing climate change concerns, renewable energy systems have become the primary means of achieving the net-zero transition. The widespread adoption of renewable energy is gaining momentum worldwide in the commercial, transportation, and industrial sectors (Alipour et al., 2020). As per the India Energy Outlook Report 2021, solar power will be the new king of electricity in the coming years and will

be the primary catalyst for the global increase in the use of renewable energy across all scenarios analysed (Schulte et al., 2022). Where other renewable energy systems fail to enter the market, residential rooftop Solar Photovoltaic (SPV) symbolizes end-user's desire to take a practical initiative to fulfil the socio-environmental demands of society. The promotion of distributed SPV technology characterizes the energy-consuming residential sector as a small-scale electricity producer and a new stakeholder in the electricity network (Alipour et al., 2020). Therefore, the present study has been carried out with a focus on residential energy consumption, where the adoption of solar home lighting systems is key to the decarbonization of the residential sector. Even though governments worldwide have made extensive financing options, additional benefits, and attractive subsidies available, private household involvement in solar roofing remains largely inaccessible amidst the multipurpose benefits of solar energy and its widespread adoption (Masini & Menichetti, 2012). Hence, it is vital to examine households' attitudes towards adopting solar home lighting systems.

1.4 India's domestic solar industry:

As the world strives towards a carbon-neutral energy system, the widespread domestic adoption of energy-efficient appliances, such as solar home lighting systems (SHS), will increasingly play a pivotal role. Govt. of India has set a target for establishing 500 GW, 50% cumulative electric power, from renewable energy installed capacity by 2030 (MNRE, 2021). This means at least 40 GW of solar power should be added annually up to that year, although this has barely crossed 13 GW in the last five years. Therefore, to meet this ambitious target, India's domestic solar industry has to supply many more solar panels and component cells. According to Bloomberg NEF, since the start of 2021, around two-thirds of India's consumption of cells and 100% of wafers came from China, which controls 80% of global supply (*Bloomberg - Are You a Robot?,* 2023). To curb these imports, the government has implemented a policy under The Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019. This discourages the domestic solar industry as manufacturers have to pay the government to get a certificate from the National Institute of Solar Energy while at the same time losing out on orders to the cheaper Chinese panels. Thus, it is a road with no easy shortcuts if India's solar industry wants to grow without compromising on quality.

1.6 Current scenario of adoption of SHS by urban households in Punjab:

Urbanization has been linked with higher economic growth, increasing manufacturing industries, and enhanced development. However, urbanization also gives rise to various developmental challenges, such as escalating poverty, housing scarcity, heightened energy use, mounting pressure on resources, and the expansion of metropolitan areas. (Kaur and Luthra, 2018).

Punjab ranks fifth among India's most urbanized states, right behind Tamil Nadu, Maharashtra, Gujarat, and Karnataka. According to the 2011 census, Figure 1.3 demonstrates that the urban population in the state is 37.48%, which is significantly higher than the national average of 31.16%. The proportion of people living in urban areas has risen from 21.72% in 1951 to 37.48% in 2011. The urban population rose by 26.11% from 2001 to 2011, somewhat lower than the national average of 27.60%. However, the State's overall population grew by 14.22% over the same period, which was also slightly lower than the national average of 17.64%. The total number of urban areas/towns has also experienced an increased tendency, mirroring the growth of the urban population. The number of towns has increased from 110 in 1951 to 217 in 2011, almost doubling (ESO, 2022). It is quite evident that the growth rate of the urban population has been high in Punjab, which implies that the electricity demand would increase significantly as electricity consumption and human development have a direct correlation (Kaur and Luthra, 2018); however, as society transitions towards carbon neutrality, this increased demand for electricity needs to be met by deploying more energy-efficient technologies.

The Punjab State Power Corporation Limited (PSPCL) is making continuous efforts to increase the share of Renewable Energy in the total energy mix to achieve the sustainable development goals set at the national level for clean and affordable energy by 2030. Punjab has one of the highest per capita power consumption rates, approaching 1744KWH+KVAh as of 2021-22. Furthermore, Punjab is among the states that achieved complete electrification well in advance. Figure 1.4 presents statistics on the distribution of electricity consumption in different categories in the urban areas of Punjab. It brings out that in urban centers, domestic electricity consumption is the second largest consumer after industrial consumption. Hence, it is crucial to study the role of domestic energy consumers in developing sustainable electricity generation to achieve net zero

within multi-year time constraints. In this context, the adoption of solar home lighting systems is seen as an essential part of the sustainable energy transition.

Although it is encouraging to observe the maximum number of solar rooftop installations in the domestic sector, i.e., 5486 households (Figure 1.5), this share becomes negligible when it is seen in the context of a total number of urban households in Punjab, which is 50,32,199 households (MRD, 2011). Despite the rich solar energy potential of Punjab, 2.81 GWp with approximately 330 days of sunshine, the growth of the residential rooftop sector in Punjab is substandard (MNRE, 2021). Previous research suggests that behavioral change strategies could accelerate householders' adoption of energy-efficient technologies. This empirical study aims to understand the attitudes of urban households toward adopting SHS.

1.7 Problem statement and research objectives

Despite this enormous potential, why are fewer Industries and Households adopting SHS? This question gives stimulus to the researcher, who has the background of being a chemical engineer-cum- social worker and wants to establish a linkage between socioeconomic determinants and the adoption behavior of solar home lighting systems amongst the urban households of Punjab. The proposed intersected research work will be an endeavor to analyze the opportunities for the production of rooftop solar, adoption behavior, dissemination policies, and the challenges being faced by different stakeholders with regard to rooftop Solar. The researcher has always been interested in working towards sustainability and the achievement of SDG goals, particularly SDG 7 (Ensuring access to affordable, reliable, sustainable, and modern energy for all) and SDG 11 (Sustainable Cities and Communities), and this research would help her focus on both. Within the context of Sustainable Development (SD), there is a global call for social work professionals to confront the climate crisis—especially one of its most significant drivers, societal dependence on fossil fuels as an energy source and a major contributor of Greenhouse Gas (GHG) emissions. Therefore, this study asks: What is the extent and nature of specific practices to transition away from fossil fuels that are documented in the social work literature?

Despite the great potential, there is a lag in the social acceptance of solar technology by the residents of Punjab (Pathania et al., 2017). Identifying the demands of the users and, subsequently,

new technology acceptance is the initial step towards the success or failure of any new technology. Despite being aware of the advantages of new technologies, copious researchers have confirmed that individuals are resistant to adopting them (Sharma et al., 2023). Therefore, it is imperative to ask what are the driving factors and inhibitors that impact a householder's behavioral intention for the adoption of SHS. Additionally, there is a gap in the literature caused by the shortage of publications that specifically address environmental issues from a social work perspective, advocating for and strengthening, the voice of social workers who support people during disasters at policy making and practice levels, however and whatever these take place (Dominelli, 2014).

In the context of this problem statement, this research aims to meet the following objectives:

O1: To examine the drivers and inhibitors for the adoption of the solar home lighting system amongst urban households of the State of Punjab.

O2: To examine the existing policies and challenges with respect to the dissemination of the solar home lighting system.

O3: To explore the frequency of ecosocial work practices among Indian social workers.

O4: To design a model for imbibing the drivers and tackling the barriers to the adoption of the solar home lighting system.

1.8 Significance of the study

The conventional model of energy production and consumption is unsustainable and inequitable. Concerns related to the adverse effects of climate change and increased energy needs have underscored a need to increase the share of renewable generation in energy systems. Solar energy – a key pillar of renewable generation - has the potential to be used at commercial as well as household levels. This research explores the question of what inspires households to adopt a solar home lighting system (SHS) in Punjab, one of the wealthiest states of India with adequate solar potential. Consequently, the study may help policymakers understand the determinant factors for SHS adoption and thus design more user-friendly policies, provide incentives, and organize knowledge-sharing programs to improve the dissemination status of SHS in urban communities

where abundant resources are available. A push of change is required to encourage households to transition to an eco-friendly lifestyle, accelerating the household energy transition.

1.9 Organization of thesis:

Chapter 1: Introduction- This chapter introduces the research study. It discusses the current energy scenario of India and Punjab discussing the renewable energy potential of the same. It describes the working of solar home lighting system and their advantages. Understanding the adoption drivers and inhibitors is a crucial process to study the behavioral intention to adopt SHS by the urban communities. The rest of the chapter covers the research objectives and motivation of the study.

Chapter 2: Review of Literature and Hypotheses Development - This chapter provides a detailed literature review of the existing studies based on identifying the adoption drivers and inhibitors towards SHS dissemination in India as well as Punjab in both rural as well as urban communities. The technology adoption models and adoption of this new technology i.e. SHS by the urban communities are deliberated. A modified version of the extended UTAUT2 model has been used as the conceptual model which is further discussed in the chapter.

Chapter 3: Research Design and Methodology- This chapter gives a description of the study area, i.e., the state of Punjab, and the sample size used in the study after thorough calculations. The method of questionnaire survey was collected from 500 urban households from all over the state of Punjab, covering an equal representation from its three regions of Majha, Malwa, and Doaba. The semi-structured interview method has been used to gain a better perspective on the technical glitches and policy improvements that can be made related to SHS.

Chapter 4: Data Analysis and Interpretation- This chapter discusses a detailed analysis of all the results analyzed using PLS-SEM with the help of SMART PLS-4. It gives us the significant adoption drivers and inhibitors for a positive behavioral intention towards the adoption of SHS by the urban community of Punjab. It discusses the use of moderators such as age and gender and the use of income and education as control variables to behavioral intention. A model has been eventually proposed to encourage the drivers and tackle the barriers for a better dissipation of SHS.

Chapter 5: Discussion, Implications and Future scope - The main findings of the study are deliberated upon in this chapter. The theoretical and practical implications of the study are highlighted in this chapter. The chapter concludes with a discussion of the limitations and scope for future research in this arena.

CHAPTER 2

REVIEW OF LITERATURE AND HYPOTHESES DEVELOPMENT

The literature review is an integral part of the entire research process. It helps to establish the theoretical roots of the study and clarifies the idea behind the study. It also helps to develop methodology and enhances and consolidates the knowledge base. It is also important to contextualize the study's findings and compare them with those of other researchers (Kumar, 2005).

The following sections have been developed to provide an in-depth review of the research work carried out in this chapter:

2.1 Solar Energy Potential in India
2.2 Urban and rural gap in India concerning SHS adoption
2.3 Drivers of SHS adoption
2.4 Barriers of SHS adoption
2.5 Distinction in the attitude of adopters and non-adopters towards SHS adoption
2.6 Green Social Work in India

Section 2.1 covers the review of the solar energy potential in India. It gives a global and Indian scenario of the installed solar energy capacity and the estimated solar energy potential. Section 2.2 reviews the urban and rural gap related to solar energy usage in India. Section 2.3 consists of an overview of the motivators i.e. the driving force for SHS adoption amongst the adopters while section 2.4 gives a scenario of the various technical and other inhibitors that pose a barrier to the adoption of SHS. Section 2.5 analyzes the comparison between the attitudes of adopters and non-adopters based on the likert scale responses on the items of drivers and inhibitors. Lastly, section 2.6 reviews the studies on green social work, its conceptual understanding, and its relevance in today's time and for our study. This chapter also focuses on hypothesis development based on the extensive review of the above-mentioned sections. The developed hypotheses were then tested using various statistical tests in various phases discussed in subsequent chapters.

2.1 Solar Energy Potential in India

Energy has taken center stage in the development of modern economies. The advances we see today would not have been possible without ample energy supplies. Historically, hydrocarbons have provided the bulk of energy supplies; however, these conventional sources of energy production and consumption models are unsustainable and inequitable. Rising energy needs, concerns regarding greenhouse gas emissions and climate change, the depletion of conventional energy sources, the unequal distribution of natural resources, and concerns regarding energy security have made it impossible to follow similar production and consumption patterns (Yergin, 2006; Nel and Cooper, 2009; IPCC, 2018).

Countries across the globe are seeking to adopt ways to align their technological, economic, and institutional structures to maximize synergies between sustainability, climate change mitigation, and development-related outcomes. One of these ways is a shift to renewable energy utilization that can significantly contribute to decreasing CO_2 emissions and fostering sustainable growth within a nation (Adebayo et al., 2022).

Globally, solar is beginning to be considered as a sustainable renewable energy alternative to the conventional fossil fuels. It is a natural resource that can be converted into electricity using a photovoltaic (PV) system. According to the World Solar Report 2024, released by the International Solar Alliance (ISA), the world's solar capacity has surged from 1.22 GW in 2000 to 1,419 GW in 2023, charting a CAGR of about 36%. Today, solar capacity represents three-quarters of all renewable capacity additions worldwide.

The renewable energy sector in India has emerged as a significant player in the grid-connected power generation capacity. Today, India stands 5th in solar power electricity generation with an installed capacity of 72,766.8 MW (IRENA, 2024). As of October 2024, there was a record surge in solar energy capacity in India, with a rise from 72.02 GW in October 2023 to 92.12 GW in October 2024 (Ministry of New and Renewable Energy, 2024). Given the multilevel governance of energy production and use, states have become significant stakeholders in India's energy transformation. The household energy transition is substantially determined by the diversity of

India's states. A state-level framework to understand plans, actions and governance processes is required to achieve energy transition. While India achieved a significant proportion of its renewable energy target of 175 GW, only Karnataka, Gujarat and Rajasthan met their individual targets among the states. According to the latest annual report of 2021-22 released by the Ministry of New and Renewable Energy (MNRE, 2021), the estimated solar potential of Punjab in the country is 2.81 GWp with approximately 330 days of sunshine, whereas the cumulative installed capacity for solar power for Punjab is the 10th largest in the country at 1190.58 MW (NSEFI, 2023), as shown in Figure 2.1. Despite this great potential, there is a lag in the social acceptance of solar technology by the residents of Punjab (Pathania et al., 2017).

2.2 Urban and rural gap in India concerning SHS adoption

The impetus to address climate change and ensure the future availability of non-renewable resources demands a shift in consumer behaviour and enhancements in energy efficiency within the urban and rural communities, the major onus of the same lying on households. The present study aimed to identify factors influencing the adoption of SHS focused on urban households belonging to Punjab, a prosperous state of India. Therefore, studies conducted in the Indian context have been reviewed for examining urban and rural gap in India in relation to SHS adoption. Additionally, studies pertaining to residential solar rooftops and no other forms of solar photovoltaic technology, such as solar cookers, solar heaters, solar geysers, solar lanterns, solar street lamps, and solar farms, were examined. The analysis of these studies is presented in table 2.2.1. Importantly, studies based on secondary data were not considered for the literature review.

It is very evident from table 2.2.1 that out of a total of 11 primary studies, 5 involved rural areas, 3 involved urban areas, and 3 involved rural + urban areas. The disparity between rural and urban areas in terms of demographics has a significant impact on energy consumption and usage because of a variety of factors, including income, way of life, and awareness of energy usage (Pachauri & Jiang, 2008). Thus, we wish to study the urban context because few studies have been conducted in urban areas, especially in relation to SHS adoption. Most of these studies have identified the factors that influence adoption with the help of descriptive analysis. Very few studies have attempted to develop a detailed research model that describes adoption drivers and their interactive

contextual relationships with the help of appropriate statistical tools such as analysis of moment structures (AMOS), structural equation modeling (SEM), interpretive structural modeling (ISM) and Matrice d'Impacts Croises-Multiplication Applique a Classement (MICMAC) method analysis. Most of these studies have explored both microeconomic and macroeconomic factors that have imperative influences on the adoption of solar energy; however, relatively few studies have explored adopter-level adoption drivers that focus only on urban households.

2.3 Drivers of SHS adoption

According to the International Energy Agency (2021), there is a significant need for a substantial shift in the attitudes toward energy efficiency and consumer purchases among hundreds of millions of households globally. Unlike conventional energy sources like coal, oil, gas, nuclear, and hydropower that necessitate elaborate infrastructure and intermediary transmission lines, solar energy may now be directly utilized at the point of consumption—within households, turning it into a home product (Mangotra, 2024). Hence, researchers across the countries have conducted studies to understand the factors influencing the adoption of rooftop solar energy by households. Liu et al., (2013) focused on renewable energy (electricity) deployment in rural households in Shandong province. They found that 84 percent of households' choices would be influenced by their neighbor's energy choices and behaviour patterns. Parsad et al., (2020) conducted a study in the Indian southern state of Kerala using a survey-based questionnaire. Based on two waves of data collection, their findings revealed that households considering the adoption of solar panels were likely influenced by six distinct factors, three motivators (financial motivators, energy, and environmental motivators) and three inhibitors (lack of knowledge and institutional barrier, technical and financial barriers).

The literature review has identified factors that motivate households to adopt solar home lighting system. Venkatesh et al., (2003) proposed the unified theory of acceptance and use of technology (UTAUT) theory after merging and testing variables of all the earlier eight adoption models (Figure 2.2), i.e., Diffusion of Innovation Theory (DOI), Theory of Reasoned Actions (TRA), Theory of Planned Behaviour (TPB), Social Cognitive Theory (SCT), Technology Adoption Model (TAM), the PC Utilization Model, The Motivation Model and the combined TAM-TPB

model. The UTAUT model consists of four major variables, namely, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Venkatesh et al. (2012) modified his UTAUT model and expanded it further with the addition of constructs such as price value, hedonic motivation, and habits. This extension of UTAUT2 produced better results with a substantial increase in behavioural intention, i.e., from 56% to 74%. The effect of these variables on behavioural intentions was moderated by age, gender, and experience. The UTAUT2 model was modified for our study. The price value construct was modified to include Financial Motivation. The SHS habit is new to India and is not a relevant variable; hence, it was adapted as Environmental Motivation for checking adopters and non-adopters' adoption of green habits.

Facilitating Conditions were revised to Knowledge and Awareness, as they are important determinants of the adoption of any new technology. A new construct of Energy Motivation was added to the model based on an additional review of the literature (Parsad et al., 2020). We examined the behavioural factors to understand society's concerns about global warming and saving the environment and whether they are ready to make this switch to being an adopter and contributing a sustained energy system. All eight factors influence our adoption of SHSs. We studied the relationship between adoption drivers and behavioural intentions to adopt SHSs. Behaviour Intention is the process through which people create deliberate projects to carry out or refrain from performing behaviours in the future. It is a function of attitudinal and social or subjective norms (Fishbein & Ajzen, 1975). In our study, Behavioural Intention refers to adopters and non-adopters' intentions toward using solar home lighting systems in their household. The identified drivers have been summarized in Table 2.4.1 below.

Considering the above findings, the hypotheses proposed are as follows:

- ***H1:*** **Performance Expectancy, Effort Expectancy, Hedonic Motivation and Financial Motivation are the Adoption drivers of solar home lighting systems.**
- ***H2:*** **Environmental Motivation, Energy Motivation, Social Influence and, Knowledge and Awareness are drivers of solar home lighting systems.**
- ***H3:*** **There is a significant positive association between Adoption drivers for solar home lighting systems and Behavioural Intention.**

2.4 Barriers of SHS adoption

In contrast to the adoption drivers' certain other factors could act as barriers to the adoption. According to Zhang et al., (2012), critical barriers to the diffusion of solar in Hong Kong include "high initial and repair cost," "long payback period," "inadequate installation space and service infrastructure," "lack of participation of stakeholders/ community in energy policy" and "lack of incentives by legislation and regulation." From survey conducted in major cities of China, Sun (2015) found that there are two major barriers of slow adoption of Solar Photovoltaic System (SPS): high initial cost of SPS and lack of knowledge of SPS. Rathore et al. (2019) have discussed various bottlenecks faced by the solar rooftop PV sector in India, i.e., lack of awareness among end consumers, lack of clarity in rooftop policies and financial institutes, and poor technical or commercial skills. To examine acceptance and willingness to pay for solar home systems, a survey questionnaire was distributed among the local inhabitants in the northern part of Pakistan in schools, colleges, shopping plazas, supermarkets, and factories. The survey results reveal that roughly 81 percent of the respondents are more interested in SHS. However, many respondents claim that hindrances obstruct them from using SHS, including the exorbitant pricing of solar panels, lack of proper information, and trust in solar panel providers/vendors (Khan et al., 2017). These factors have been summarized in Table 2.4.2.

The literature review has identified factors that motivate households to adopt solar home lighting systems. In contrast, certain other factors could act as barriers to the adoption. These deliberations guide the construction of the hypothesis H4 and H5 as stated below:

- ***H4:*** **Adoption Inhibitors is a multidimensional construct and is significantly defined by Technical Barriers, Policy and Regulatory Barriers, Socio-economic Barriers and Knowledge and Institutional Barriers.**
- ***H5:*** **There is a negative relationship between Adoption Inhibitors and Behavioural Intention to adopt SHS by urban households.**

Socio-demographic factors are frequently used as determinants for adopting solar photovoltaic (PV) technology (Alipour et al., 2020). In their study, Yuan et al., (2011) studied the social

acceptance of solar energy technologies in Shandong province, China, especially from end-users' perspective. Additionally, they concluded that families' age, income, and education levels significantly affect households' recognition and implementation of sustainable energy technology. Brown et al., (2023), in their analysis of domestic consumer attitudes and behaviour towards energy in Ireland, revealed a positive association between individuals in younger age groups and a higher level of concern over carbon emissions and the impact of climate change.

Liu et al., (2013) reported that the probability of occurrence of positive intention is found to increase with an increase in household income. Schulte et al., (2022), in their metanalysis study, found that the associations between adoption and sociodemographic variables such as gender and education are minimal, and there exists a weak correlation between income and intention, hence making it statistically insignificant. Consequently, age and gender have been used to assess their influence as moderators on the correlation between adoption drivers and behavioural intention. Nevertheless, it was concluded from literature review that age and gender have not served as moderators in former studies. Aggarwal (2019) did referenced the moderators in UTAUT2 but did not examine their effects on the UTAUT2 model. Furthermore review of studies also suggested that monthly family income and education level have not been observed as control variables regarding behavioural intention.

In light of the above findings, the hypotheses proposed are as follows:

- ***H6:*** **Monthly family income and education level of household head are the control variables and have no confounding effect on the model.**
- ***H7*****: The influence of Adoption drivers on the Behavioural Intention of urban households to adopt SHS will be moderated by age and gender of the household head.**

2.5 Distinction in the attitude of adopters and non-adopters towards SHS adoption

An attitude to any given topic is a product of the individual's beliefs, feelings, and behaviour (Hicks, 2004). Its measurement can provide valuable insights for understanding customer perceptions and preferences toward a particular product, service, or brand. The adoption rate of

any technology or innovation is impacted by the foundation pillars of a positive attitude and the right perception towards it (Yadav et al., 2009). Therefore, attitudes can be analyzed to assess the adoption rate and time preferences for various products and innovative technologies (Sultan & Winer, 1993).

Previously, many researchers have examined households' attitudes and behaviours toward using solar home lighting systems. In central England, Faiers & Neame (2006) undertook a study on households' attitudes toward the features of solar systems. They highlighted the challenges to their implementation, which included particularly the payback period, the level of grant support, and the visual appeal of the systems, which are perceived negatively and are thus restraining the adoption of solar energy. Sun and Spicer (2015) studied Chinese residents' attitudes towards solar PV systems and found two significant barriers to slow adoption: high initial cost and lack of knowledge of solar power systems. In Taiwan, Tsaur and Lin (2018) conducted a study to examine customers' attitudes toward the use of building-connected solar PV equipment and concluded that consumers lack an awareness of perceived ease of use.

Thus, previous research linking the adoption of SHS to urban households has focused on drivers and inhibitors, however, studies offering a nuanced understanding of the distinction in the attitude of adopters and non-adopters, are not widely reported. which is different in its conceptualization of the adoption of solar energy within the domestic market. In this context, following hypothesis has been constructed.

H8: Adopters and non-adopters differ based on their perceptions of solar home lighting systems. As compared to non-adopters, adopters rate this system as greater in Performance Expectancy ***(H8a),*** greater in Effort Expectancy ***(H8b),*** greater in Hedonic motivation ***(H8c),*** greater in Financial Motivation ***(H8d),*** greater focus towards Environmental Concern ***(H8e),*** greater in Energy Motivation ***(H8f),*** stronger in Social Influence ***(H8g),*** greater Knowledge and Awareness about SHS ***(H8h),*** lower in technical barriers ***(H8i),*** lower in policy and regulatory barriers ***(H8j),*** lower in socio-economic barriers ***(H8k),*** lower in knowledge and institutional barriers ***(H8l)***

2.6 Green social work in India

The discussions about nature, ecology, environment, sustainable development, and indigenous eco-social knowledge gradually became a new direction for social work localization (Wang & Altanbulag, 2022).

Dominelli (2014) explored the implications of environmental degradation and its reinforcement of structural inequalities in Sri Lanka, following the 2004 Indian Ocean Tsunami by drawing upon a three-year research project, funded by the Economic and Social Sciences Research Council in the UK. She concluded that social work organizations pursuing the Global Agenda can actively promote more sustainable forms of socio-economic development in environmentally devastated low-income areas by mobilizing people and resources to create new forms of employment that give them greater resilience in withstanding future environmental shocks. The development of wind, wave and solar energies can provide a way of providing employment for people while protecting the environment and further developing the sustainable socio-economic and environmental approach, as identified in her book entitled "Green Social Work".

Keevers (2022) analyzed the working model of 'Lampu Diak' - the solar lighting project, for Indigenous people living in remote communities in the Remexio district in Timor-Leste, Asia's youngest nation and the second most oil-dependent nation on the planet (Scheiner, 2016). This survey study of 133 households revealed direct social and economic development benefits include increased access to study and educational opportunities with the provision of light for study and learning; increased sense of sexual safety, especially for women; health improvements with the provision of smoke- and pollution-free light; lower energy costs; and local training and employment opportunities for solar installers and maintenance technicians. The Lampu Diak project is an example of developmental social work in action in which community and social workers are directly involved in economic development that contributes to poverty alleviation (Midgley & Conley, 2010).

The scoping review, examining practices to transition away from fossil fuels in the social work literature, by mason and his associates, indicated that the most frequent practice types were "organizing or advocacy" and "energy at home." Common targets of change were

individuals/households and private industry. The most organizing against private industry was led by Indigenous or Tribal nations. More social work engagement in the transition away from fossil fuels is needed, including engagement that embraces an ecosocial approach. Local organizing, advocacy, and program development are an area of strength and an intervention scale at which social workers can influence multi-prong efforts to transition away from fossil fuels (Mason et.al., 2022).

Using an environmental justice perspective consistent with a green social work approach, a study conducted by Downey and his associates examined the cultural, recreational, and environmental meanings of water for the rural river community of Mildura, Australa. Results from an online mixed-methods questionnaire showed that people privileged cultural meanings of water as fundamental to life, were concerned for river health, and felt marginalized in water debates. Social work can contribute to such environmental issues by working collaboratively to enable communities to exercise their voices and to advocate to decision makers to include consideration of environmental, social, and cultural impact (Downey et. al., 2023).

An electronic survey study carried out by Nöjd and his associates among 12,000 Finnish Talentia Union of Professional Social Workers, found that ecosocial work practices are quite rarely applied in Finnish social work. It indicates that personal interest in and knowledge of the ecosocial approach, organizational practices, and client attitudes play an important role (Nöjd et. al., 2024).

Despite the growing number of publications focusing on eco-social work, there remains a lack of green social work approaches in the domain of social work related to Sustainable Development Goal 7 (SDG7) - establishing affordable, and clean energy services for all by 2030. This study has explored the frequency of ecosocial work practices among Indian social workers, their perceptions of green social work, the extent to which they feel prepared to respond to environmental issues, their desire to learn more about green social work. This research contributes to a growing body of literature by arguing that to adequately prepare social workers to practice in a world increasingly impacted by environmental changes, green social work must be embedded in the conventional social work practices.

2.7 Summing up

Solar home system is a promising energy option for households living in off-grid areas of developing countries. However, household inclination towards consuming such clean energy is hampered by numerous factors. This study is motivated by the absence of more in-depth empirical studies on factors determining households' attitudes towards using SHS, particularly in urban communities of on-grid areas. By filling this gap, this study intends to generate informed policy recommendations, especially, from a lens of green social worker. Additionally, the study has developed a sustainable model for the enhancement of the SHS adoption.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Methodology is basically the blueprint of the study that comprises the elements that are as broad as questions related to paradigm and as specific as questions dealing with the nuts and bolts of who, where, when, how, and what (O'Leary, 2010).

This chapter comprises all the phases of the present study and the overall procedure followed to accomplish the objectives of the research. It describes the process of establishing the study's objectives, research design and methodology, selecting samples, tools and techniques, and employing data collection procedures. Finally, statistical methods utilized to derive the study's results, have been displayed in a tabulated form.

3.1 Phases of the study

To find an answer to the research problems addressed and to meet the objectives, the current study was conducted in four phases. The four phases along with the major objectives are described as follows in Figure 3.1.

Phase I

As India is on an original quest to fulfill its rising electricity demand while decarbonizing its sources of production, the deployment of renewable energy sources, in a sustainable and environmentally friendly manner, becomes exceedingly important. To that end, solar energy is particularly thought-provoking as it has the potential to be used at commercial as well as household level. This study has explored factors influencing the adoption of solar home lighting system at the household level and proposed measures to raise its adoption rate. The 1st phase of the study was aimed at achieving objective 1 wherein the extended UTAUT2 model was used to identify the drivers and inhibitors of SHS adoption amongst the urban households of Punjab.

Phase II

In accordance with objective 2, the 2nd phase of study focused on the existing policies while examining SHS usage experience of adopters. Analysis was carried out to compare the attitude of adopters and non-adopters towards the drivers and inhibitors that were identified in the 1st

phase of the study. The findings of this phase of the study led the researchers to understand the challenges related to SHS dissemination in urban areas of Punjab, India.

Phase III

An ecosocial approach endeavours to assimilate environmental aspects with social aspects in social work practice. A third objective was established to address issues related to the ecosocial approach and environmental sustainability. The data was collected via an electronic survey sent to social workers practicing in different parts of India. Accordingly, this study phase has explored the prevalence of green social work practices in India.

Phase IV

To attain objective 4, this study proposed a sustainable model that has been designed based on adoption inhibitors and challenges, highlighted in phases I and II, respectively. The model incorporated the various adoption strategies and retrofitting interventions for enhancing domestic solar rooftop technology adoption in the state of Punjab. The adoption strategies included unambiguous government policies, innovative finance mechanisms, green social work and building competence.

3.2 Research Design

Research design is a plan that ensures that the research question is addressed effectively and the objectives, established in a research study, are met perfectly. It involves the methods of collection, measurement and analysis of the data. Phase I of present study followed a descriptive research design to identify the factors that influence the Behavioural Intention of the urban households to adopt solar home lighting system wherein the quantitative data was collected. Nonetheless, qualitative as well as quantitative data was collected in phase II to understand the SHS usage experience of the urban households of Punjab. Both phases of the study used the same sample for cross-sectional questionnaire-based survey method (Figure 3.2). A cross-sectional study is a type of research design in which the data is collected across a sample population at a single point in time. Third phase of study also embraced a descriptive research design to develop a conceptual framework for the fulfilment of third objective.

3.3 Research setting

The research was carried out in the PhD Research Scholar Workstation at School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology, Patiala, Punjab, India

3.4 Informed consent and ethical approval

Ethical approval was taken from the Institutional Ethical Committee (IEC) of Thapar Institute of Engineering and Technology, Patiala dated 10-05-2022 (Annexure II). The respondents were informed about the purpose of the study and that the information provided by them would be kept confidential, and their identity would remain anonymous. Written consent for the same was taken from the respondents before starting the survey (Annexure III).

3.5 Duration of the study

The study was carried out from September 2021 to September 2024. A review of the literature was carried out, and the research proposal was accepted by the Institutional Research Board (IRB) on 16th September 2022. Questionnaire was developed simultaneously with the literature review and was validated by professors and academicians of various Universities and was finalized by January 2023. Data collection was carried out from February 2023 to January 2024. Data analysis and research paper writing were done thereafter.

3.6 Study Population and Sample

As researchers set up hypotheses, they should consider the population and the entire group of observations they are interested in studying. According to Malhotra and Dash (2010), a population is defined as all elements (individuals, objects, and events) that meet the sample criteria for inclusion in a study. The present study's population consisted of all households from urban and semi-urban areas of Punjab (India). Because of the many practical reasons that preclude the possibility of measuring the entire population, most social science involves studying samples and subsections of the population. Thus, a sample is a group of elements selected from a larger population. For the present research study, the following considerations were taken into account for the selection of a sample:

3.6.1 Sample size determination

The sample size was estimated using G*power 3.1 software. The minimum sample size was determined using a priori statistical power analysis (Faul et al., 2007) assuming a mean effect size (f2) of 0.05 and a level of significance (α) of 0.05, with a power of 0.95, which was 262 for a maximum of twelve predictors. Hence, the present research considered a sample size of 500 respondents, i.e., 250 SHS Adopters and 250 SHS Non-Adopters. Thus, for testing the theoretical framework, the sample collected fulfills all the prerequisite requirements for using structural equation modeling (SEM). An aggregate of 545 questionnaires was shared among the respondents, of which 500 were examined for the final analysis, and 45 were removed due to incomplete or missing responses.

3.6.2 Sampling Technique

A multistage purposive sampling technique was used for the primary data collection. The following criteria were used for the selection of sample households in the present study:

a) Districts that represent all three regions of Punjab, namely, Majha, Malwa and Doaba;
b) Malwa was the largest region (Figure 3.3), and the maximum number of districts were selected from the same region;
c) Six districts from Malwa, 2 from Majha and 2 from Doaba were short-listed on a random basis;
d) Finally, 25 adopters and 25 non-adopters were randomly selected from the urban areas of these shortlisted districts through snowball sampling technique.

3.6.3 Sampling criteria

The sampling criteria used are mentioned in Table 3.1 as follows:

Table 3.1 Sampling criteria

Inclusion criteria	• The household should belong to urban/semi-urban areas. • The householder who had the roof rights to his/her house was the respondent. • The head of the family was the respondent. However, in the absence of the head of the family, another family member who is active in the decision-making process became the respondent. • The head of the family should be more than 18 years of age.

	• The on-grid users of SHS were only included.
Exclusion criteria	• The rural households were excluded. • The apartment owners of urban areas were excluded as they do not have roof rights. • The off-grid/hybrid users of SHS were excluded.

3.7 Data collection methods

The data collection method included both primary and secondary sources. They have been enlisted as follows:

3.7.1 Primary sources

Primary data was obtained from a questionnaire-based cross-sectional survey and semi-structured interviews with people from all profiles (adopters, non-adopters, vendors, and PSPCL officers). The interviews revolved around Technical Barriers related to SHS adoption, government policies and schemes and their implementation, usage experience as SHS adopters, inhibitions of the non-adopters, freebies provided by state government and their impact, etc.

3.7.1.1 Survey instrument

A questionnaire was developed to be used as a survey instrument for the data collection. Section A covered the socio-demographic details and the main characteristics of the respondents and their households whereas section B measured the dependent constructs. Updated Modified Kuppuswamy Scale was used to determine the respondents' socioeconomic status. This most commonly and widely used scale for urban settings in India is based on three parameters: education, occupation and income (Sood & Bindra, 2022). Section B covered the two main constructs of the model, i.e., adoption drivers and adoption inhibitors, to measure the main dependent construct, i.e., behavioural intention. Section B measured adoption drivers by measuring its main eight reflective exogenous constructs including Performance Expectancy (PE), Effort Expectancy (EE), Hedonic Motivation (HM), Financial Motivation (FM), Environmental Concern (ENVM), Energy Motivation (EM), Social Influence (SI), Knowledge and Awareness (KA). Adoption Inhibitors were measured using Technical Barriers (TB), Policy and Regulatory Barriers (PRB), Socio-economic Barriers (SEB), and Knowledge and Institutional Barriers (KIB) The constructs were measured using a five-point ordinal scale, known as the Likert scale, anchored by strongly disagree (1) and strongly agree (5). Respondents were asked to indicate the degree to which they agreed or disagreed with each

statement. High scores on the statements related to product traits, whereas low scores on the statements related to barriers on the Likert scale indicated a positive attitude of urban households towards adopting SHS. Appendix 1 depicts all the measurement constructs and their corresponding measurement items. Most of the scales were adopted from the literature, and some of the constructs were self-structured (Appendix A). The major scale for adoption drivers was adapted from Venkatesh et al., (2012). The major adoption inhibitors were adapted from Pathania et al., (2017) and Parsad et al., (2020). The questionnaire for measuring behavioural intentions was modified from previous empirical studies by Uddin and Khan (2016), Walters et al., (2018), Aggarwal et al., (2019), Kumar et al., (2019), Parsad et al., (2020) and Atulkar et al., (2022). The multivariate normality of the data was checked by calculating Mardia's skewness and kurtosis values (Wulandari et al., 2021), as reported in Table 3.2. As the p values were less than 0.05, the absence of multivariate normality was confirmed; hence, the use of partial least squares equation (PLS-SEM) with Smart PLS (Ringle et al., 2015) became the natural choice.

3.7.2 Secondary sources

Secondary data was extracted from Punjab State Power Corporation Ltd (PSPCL) reports and online research from journals, research papers, and books. Previous studies on technology adoption models, ministry reports on the implementation of rooftop solar policies, and published research work has been considered in the study. Various research articles were analyzed as antecedents of behavioural intention to adopt SHS and for understanding the research gaps. Editorial articles from newspapers like The Hindu and The Tribune helped provide the current statistics regarding rooftop solar in the country and the advancement or lag in implementing the related policy measures.

3.8 Data collection procedure and pilot study

The study was based on a self-structured questionnaire. Hence, the validation of the questionnaire was done by experts i.e. academicians, psychologist who had expertise in behavioural science, SHS distributor, Punjab State Power Corporation Limited (PSPCL) engineer as well as green social worker. Incorporating their suggestions, items which were incomprehensible or repeated were removed or simplified. Few questions were clubbed as the questionnaire was believed to be too lengthy. This exercise improved response accuracy. The questionnaire thus prepared was administered to 100 households that fulfilled the

inclusion/exclusion criteria as a pilot group. These target respondents were met in-personal and the questionnaire's inferences and confidentiality were ensured. Some respondents were contacted via emails. Convenient sampling was recommended in the pilot study to obtain the basic data and trends regarding behavioural intention to adopt SHS. The pilot survey results validated the questionnaire, and the study was taken further ahead when the results came significant. The pilot group's response was overall favourable.

3.8.1 Validity and Reliability

Validity, often known as "truthfulness" or "accuracy," refers to the extent to which your questionnaire determines the data that it is meant to measure. The questionnaire was validated by the experts, i.e., academicians, psychologists, engineers, and SḤŚ distributors.

Reliability applies to a measure when identical results are obtained under the same conditions over a period of time. To assess the reliability and validity of the scales PLS-SEM was used. Some items were omitted because of lower factor loadings. The model's reliability was first established by examining the Composite reliability (rho_a and rho_c) values for the individual constructs, which came out to be above 0.7, confirming the scale's overall reliability (as shown in Table 3.3) (Hair et al., 2022; Henseler et al., 2012).

3.9 To explore the frequency of Ecosocial work practices among Indian social workers

To attain objective 3, the data was collected via an electronic survey sent to 118 social workers, practicing in different parts of India. The survey questionnaire explored their views on environmental sustainability issues and green technologies in both their private and professional lives. The questionnaire was adapted and modified from Nojd et al., (2024). The Likert scale responses on a scale of 1 (Never) to 5 (Always) were recorded via Google Forms. There were two open-ended questions to understand the current practices and lifestyles adopted by social workers.

The inclusion criteria used were as follows:

a. Only professional social workers were included who were at least having a bachelor's in social work degree.

b. The minimum age of the professional was 21 years, to ensure they completed the bachelor's degree.

c. Only those social workers who were working in the public, private, or third sector were included.

The Descriptive statistics were analyzed using MS Excel. The frequency and percentage of the recorded statements were shown using bar graphs.

3.10 Tools and Techniques

Descriptive statistics were analyzed using MS Excel. Statistical tools like factor analysis were applied to test the hypotheses. Partial Least Square- Structural Equation Modeling (PLS-SEM) using SMART PLS4 (Ringle et al., 2015) to conduct the Confirmatory Factor Analysis (CFA) to identify the adoption drivers and adoption inhibitors toward behavioural intention to adopt SHS by the urban households of Punjab. The study used the Statistical Package for Social Sciences (SPSS) to compare the attitudes of adopters and non-adopters towards drivers and inhibitors using the Mann-Whitney U test. An overview of the statistical procedures is mentioned in Table 3.4 below.

3.10.1 Descriptive Statistics

Descriptive statistics involves summarizing numerical and categorical data in a concise and useful way to provide information about the observations that have been made. This is done by calculating the frequency distribution, and the same is portrayed through tables and figures for various constructs such as age, gender, education, monthly family income, and the socio-economic status of the respondents.

3.10.2 Structural Equation Modelling (SEM)

Partial least square-structural equation modeling (PLS-SEM) was applied to determine the projected research model. Utilizing a multivariate statistical analysis technique, PLS-SEM analyses the relationships between latent variables, i.e., constructs, and their observed variables, i.e., measurement items. The explication of the variance in the dependent variables is the primary objective of this variance-based approach. SmartPLS4 software is currently being used especially for PLS-SEM analysis. It is a user-friendly software that provides a wide-ranging set of tools for conducting PLS-SEM analysis with an ability to handle complex relationships between the latent variables. PLS-SEM is mainly used for non-normal data, evaluates the multiple interrelated dependent relationships, and can even handle small data sets; hence, it has become quite popular over covariance-based- structural equation modeling, i.e.,

CB-SEM, which assumes multivariate normality. Thus, keeping in mind the wide usage and the global acceptance of PLS-SEM, it was considered appropriate to apply variance-based PLS-SEM rather than covariance-based CB-SEM in the current research work (Sarstedt et al., 2017; Hair et al., 2018).

3.10.3 Statistical Package for Social Sciences (SPSS)

SPSS, standing for Statistical Package for the Social Sciences, is a widely used software in social sciences research for analyzing and interpreting data (Frey, 2017). Data was analyzed in Phase 2 using the SPSS (Statistical Package for the Social Sciences) software version 20. Descriptive statistics and the Mann-Whitney U Test (Wilcoxon, 1945) were used to analyze the difference between the adopters' attitudes and non-adopters attitudes towards the perception of adoption drivers and barriers to adopting SHS. The Mann-Whitney U test, or Wilcoxon rank-sum test, is a non-parametric statistical method used to compare the distributions of two independent samples in research. In contrast to the t-test used for normal data, the Mann-Whitney U test does not require the assumptions of normality or homogeneity of variance (Whitley & Ball, 2002). This test relies on the ranking of observations from the two samples instead of their actual values, making it a valuable alternative when the data fails to satisfy the assumptions of parametric tests. The test then determines whether the ranks for the two groups differ significantly, demonstrating a difference in the underlying distributions (Hoffman, 2019).

3.11 Research Framework

3.12 Conceptual Research Model

Figure 3.5 highlights the conceptual research model depicting the hypothesized relationship among the constructs, i.e., adoption drivers, adoption inhibitors, and their relation with behavioural intention. Venkatesh et al., (2003) proposed the unified theory of acceptance and

use of technology (UTAUT) theory, which consists of four significant variables: Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Venkatesh et al. (2012) modified his UTAUT model and expanded it further by adding constructs such as Price Value, Hedonic Motivation, and Habits. The UTAUT2 model was modified for our study. The price value construct was modified to include financial motivation. The SHS habit is new to India and is not a relevant variable; hence, it was adapted as an environmental motivation for checking prosumers' and consumers' adoption of green habits. Facilitating conditions were revised to knowledge and awareness, which are important determinants of adopting any new technology. A new construct of energy motivation was added to the model based on an additional literature review (Parsad et al., 2020). All eight factors form the construct adoption drivers which influences the urban households' behavioural intentions to adopt SHS. The conceptual research model examines the same.

Parsad et al., (2020) conducted a survey in Kerala, a southern state of India. They revealed that households considering the adoption of solar panels reported three major inhibitors i.e. financial barriers, technical barriers and knowledge and institutional barriers. From a systematic review, Shakeel and his associates found that solar PV is a relatively new technology, and a lack of awareness about its functionality, technical aspects and value may act as a barrier to its adoption at the household level. Approximately 32% of the studies included in their review considered technical issues and assessed their influence on the adoption of solar PV (Shakeel et. al., 2023). According to Sun (2015) the high initial cost and the lack of knowledge are two major barriers to the slow adoption of Solar Photovoltaic Systems. Thus, based on the literature review, a multidimensional construct of adoption inhibitors was formulated, which is significantly defined by Technical Barriers, policy and regulatory barriers, socio-economic barriers, and knowledge and institutional barriers.

Socio-demographic indicators are also important in influencing behavioural intention to adopt solar home lighting systems by the households. Zander et al., (2019) reported a negative relationship of age with adoption, indicating that younger people are more likely to use solar PV. Conversely, Lin and Kaewkhunok (2021) found that the age of the household head is positively associated with adoption of solar energy. Zeru and Guta (2021), reported that the gender of households' heads was found to be statistically significant ($P < 0.1$) and negatively associated with the attitude of households towards SHS. They showed that households headed by males are 5.9% less likely to have a favorable attitude towards SHS. Malik (2022) analyzed a dataset of 140 respondents from different income and education levels and concluded that

there was a positive relationship between education level and awareness as well as income and likelihood of adoption. Thus, age and gender have been used to evaluate their interaction effect on the relationship between adoption drivers and behavioural intention. However, they have not been used as moderators in previous studies. In his research, Aggarwal (2019) mentioned the moderators in UTAUT2 but did not study their impact. The novelty of our research also lies in using Moderators, i.e., age and gender, to check their moderation impact on the relationship between adoption drivers and behavioural intention. Additionally, monthly family income and education level have been studied as control variables for behavioural intention. Figure 3.4 evidently demonstrates the proposed conceptual research model as discussed above.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

Data analysis and interpretation are the most critical steps in the research process and need to be done objectively and accurately. This chapter presents the results obtained after computerized statistical analysis of the collected data and, thereby, the interpretation of data. The observations and statistical derivations are presented in tables and illustrated with suitable figures. After presenting the data and analyzing their statistical significance, the results are connected to the research questions and conclusions are drawn. The key findings are summarized. This helps to find the underlying facts, extract meaningful insights and gives the data more meaning. This chapter presents the findings of phase I, phase II and phase III in sections 4.1, 4.2, 4.3 and 4.4.

The results have been described under four sub-sections i.e., 4.1 deals with the descriptive analysis of the study population, i.e., a detailed demographic profile of the adopters and non-adopters of the urban households of Punjab. Section 4.2 identifies the factors influencing the behavioral intention of the study population to adopt the Solar Home Lighting System (SHS). This section also deals with the influence of demographic variables as moderators (age, gender) and control variables (income, education) on the behavioral intention to adopt SHS. Section 4.3 analyzes the existing policies and challenges concerning disseminating the SHS. It also compares the attitude of adopters and non-adopters and checks for any significant difference between the same using Mann-whitney U-test. Section 4.4 displays the findings regarding the ecosocial work practices among Indian social workers.

4.1 Descriptive Analysis of Study Population

Descriptive statistics of the respondents are presented in Table 4.1.1. The study population comprises 500 respondents belonging to urban households in Punjab, India. They were divided into SHS adopters (N = 250) and non-adopters (N = 250). The table 4.1.1 below shows the first section of the questionnaire for adopters and non-adopters, which includes questions regarding the respondents' demographic profiles. The frequency and percentage are calculated for each category.

Table 4.1.1 Socio-demographic attributes of adopters and non-adopters (Source: Self-compiled)

4.1.1 Age of the respondents

A maximum number of respondents were aged more than 50 years in both groups (adopters; N = 112, non-adopters N = 103); however, regarding the youngest age group (18-30 years), non-adopters were three times greater than the number of adopters. The same is depicted in Figure 4.1.1.

Fig. 4.1.1: Distribution of study population according to their age groups

4.1.2 Gender of the respondents

Gender-wise analysis is shown in Figure 4.1.2. The current study exhibited that among SHS adopters, almost 78.4 % of the respondents were males, whereas only 21.6 % were females.

Fig. 4.1.2: Distribution of study population according to their gender

4.1.3 Socioeconomic status of the respondents

Updated modified Kuppuswamy scale was used to determine the respondents' socioeconomic status. This most commonly and widely used scale for urban settings in India is based on three parameters: education, occupation, and income (Sood, 2022). A maximum number of SHS adopters belonged to the upper middle class (51.6 %) and upper class (37.6 %), while very few to the lower middle (8.4%) and upper lower class (2.4 %). Figure 4.1.3 displays the percentage distribution of the study population (N = 500) in accordance with their socioeconomic status.

Fig. 4.1.3: Distribution of study population according to their socioeconomic status

4.2 Identifying factors influencing the behavioral intention of the study population for the adoption of the solar home lighting system

The main objective of the current study was to explore the question of what inspires urban households to adopt a solar home lighting system (SHS) in Punjab, one of the wealthiest states of India with adequate solar potential. To meet this objective, our research leverages the framework of the extended unified theory of acceptance and use of technology (UTAUT2) to identify adoption drivers as well as inhibitors. The proposed research model was tested using structural equation modeling in Smart PLS4. The findings are presented in this subsection, as following:

4.2.1 Measurement model analysis

The measurement model was evaluated in two stages. First, the twelve reflective exogenous constructs including Performance Expectancy (PE), Effort Expectancy (EE), Hedonic Motivation (HM), Financial Motivation (FM), Environmental Concern (ENVM), Energy Motivation (EM), Social Influence (SI), Knowledge and Awareness (KA), Technical Barriers (TB), Policy and Regulatory Barriers (PRB), Socio-economic Barriers (SEB) and Knowledge and Institutional Barriers (KIB) were evaluated in line with their reliability and validity. The research was checked for common method bias and multicollinearity concerns by assessing the inner variance inflation factor (VIF) values by checking the VIF values for all the latent variables as predictors of a random variable. Hence, the results show that all values are less than 3.3, implying no Common method bias (CMB) in the data (Kock, 2015; Sarstedt et al., 2017).

To assess the reliability and validity of the proposed measurement model PLS-SEM was used. Some items were omitted because of lower factor loadings. The model's reliability was first established by examining the Composite reliability (rho_a and rho_c) values for the individual constructs which came out to be above 0.7, confirming the scale's overall reliability (as shown in Table 4.2.1) (Hair et al., 2022; Henseler et al., 2012). The convergent validity was demonstrated by considering the average variance extracted. The AVE values were > 0.5 for all the latent constructs, confirming the convergent validity. Table 4.2.2 shows the results of HTMT ratio, which is the most novel and conservative approach to analyze discriminant validity (Henseler et al., 2015), where the results should be less than 0.85 or 0.9 based on recent literature (Henseler et al., 2015). Table 4.2.1 also shows that all VIF values are less than 3.3, indicating no pathological collinearity of the sample (Sheather, 2009; Sarsedt et al., 2017).

In the second stage, using the disjoint two-stage approach (Sarstedt, 2019), Performance Expectancy (PE), Effort Expectancy (EE), Hedonic Motivation (HM), Financial Motivation (FM), Environmental Concern (ENVM), Energy Motivation (EM), Social Influence (SI), and Knowledge and Awareness (KA) established Adoption drivers as a higher-order construct. Socio-economic Barriers (SEC), Knowledge and institutional Barriers (KIB), Technical Barriers (TB), and Policy and Regulatory Barriers (PRB) established Adoption inhibitors as a higher-order construct. Adoption drivers and Adoption inhibitors have been taken as a reflective higher-order construct because of the nature of dimensions; all the lower-order constructs can be viewed as a representative sample of all the possible items available within the conceptual domain of the Adoption drivers and inhibitors (Nunnally & Bernstein, 1994). All the lower order constructs are highly correlated and interchangeable (Sarstedt et al., 2016). Individual items should be interchangeable, and any single item can generally be left out without changing the meaning of the construct, as long as the construct has sufficient reliability (Jarvis et al., 2003). Additionally, we take the age and gender of the adopters and non-adopters as moderating variables for determining the relationship of the adoption drivers to the behavioral intention of the solar home lighting system. Monthly income and education are taken as control variables for behavioral intention. The measurement model results of the higher order model are given in Table 4.2.3. Convergent reliability of our higher-order constructs, i.e., Adoption Drivers and Adoption Inhibitors, is established with values of 0.909 and 0.745 respectively of the composite reliability and AVE value being > 0.5 (Hair et al., 2022; Henseler et al., 2012). Discriminant validity was also checked through HTMT ratio represented through Table 7. HTMT ratio represented through Table 4.2.4 reflects that all values are less than 0.90 or 1 and hence propose that discriminant validity has been justified (Henseler et al., 2015). VIF value is also < 3.3 for the higher order constructs i.e., Adoption Drivers and Adoption Inhibitors which is acceptable for full collinearity results (Kock & Lynn, 2012).

4.2.2 Structural model analysis

The outer loadings for all variables considered are significant as shown in Table 4.2.5. The bootstrapping results show that all the eight independent variables, i.e. Performance Expectancy (β = 0.780; p value = 0.000) , Effort Expectancy (β = 0.836; p value = 0.000), Hedonic Motivation (β = 0.689; p value = 0.000), Financial Motivation (β = 0.833; p value =

0.000), Environmental Concern (β = 0.637; p value = 0.000), Energy Motivation (β = 0.654; p value = 0.000), Social Influence (β = 0.686; p value = 0.000), and Knowledge and Awareness (β = 0.824; p value = 0.000), were found to be significant and load on Adoption Drivers to Behavioral Intention. Similarly Technical Barriers (β = 0.845; p value = 0.000), Policy and Regulatory Barriers (β = -0.181; p value = 0.046), Socio-economic Barriers (β = 0.900; p value = 0.000) and Knowledge and Institutional Barriers (β = 0.766; p value = 0.000) were found to be significant and loading on Adoption inhibitors. Hence, this confirms **H1, H2 and H4 and all these hypotheses are accepted.** The values suggest that outer loadings are highest for effort expectancy and financial motivation, inferring that reduced electricity bills and the easy switching effort to any new technology is a major motive for households to adopt SHS. In contrast, environmental concern is the least loaded on adoption drivers, which makes us think about, 'do households actually adopt SHS to reduce global warming, or is that just a byproduct of the economic viability of SHS?' This is also in line with the study by Schelly (2014), which established that environmental values were not enough nor were the first mover motivation to trigger adoption intent.

The main results are represented through path coefficients and total effects depicted in Table 4.2.6. Adoption Drivers of solar home lighting system have a positive effect (β = 0.750) on behavioral intention (p≤0.001). Adoption Inhibitors negatively affect behavioral intention (β = -0.011). however, this impact is statistically insignificant (p = 0.817). Hence, **H3 is accepted while H5 is partially accepted.** The value of R2 is 0.511, and R^2 adjusted is 0.503. This indicates that the proposed model accounted for 51.1% of the variance in behavioral intention, in which the R^2 value reflects how much all independent variables together explain the changes in the dependent variable. The structural model results were again checked to examine if there is any confounding effect in our model, by introducing additional variables, i.e. education of household head and monthly family income, as control variables. The path coefficient between adoption drivers and behavior intention showed negligible change (from 0.782 to 0.750) with no change in significance level (p=0.000), as depicted in Figure 4.2.2 and Figure 4.2.3. Similar findings were obtained for the relationship between Adoption inhibitors and Behavior Intention. Nevertheless, both of these control variables exhibited significant relationship with behavior intention. The β value for monthly family income is - 0.140 (p=0.000), indicating that the households with higher monthly family income (≥184,376 rated as 1 and ≤9226 as 7) strongly intend to adopt SHS. Surprisingly, the beta value (0.142, p=0.000) for education level of household head (professional rated as 1 and illiterate as 7), suggested that people with lower

level of education were more interested in adopting SHS. This implies that educated people need to be more aware of the domestic use of green energy. Thus, monthly family income and education level of household head controls the behavior intention of the urban households for the adoption of residential rooftop solar. However, the addition of these control variables does not change the overall relationship between independent variables and the dependent variable. Consequently, we can infer that confounding effects are not present, as there are no significant changes in the path coefficients upon introducing the control variables in our structural model. Hence, we accept H6 i.e. monthly family income and education level of household head are the control variables and have no confounding effect on the model.

The model evolved in the current study has revealed higher strength of relationship between adoption drivers and behavior intention with an increase in the age of respondents, shown in Figure 4.2.4, as the Adoption drivers increases, the behavioral intention also increases. Age

moderated this relationship with $\beta = 0.097$ and $p = 0.001$. The positive relationship suggests that at a higher level of age, the relationship which age is moderating becomes stronger whereas negative relationship for gender ($\beta = -0.150$ and $p = 0.069$) indicates that females have higher behavioral intention for the adoption of SHS shown in figure 4.2.5. Thus, we can infer that female at older age have stronger intention to adopt solar energy for the production of domestic electricity.

To check the model fit, the SRMR value was assessed which was 0.078 which is an acceptable value for a good model fit (Sarstedt et al., 2017). The blindfolding procedure was run in SMART-PLS to examine the value of Q^2 and determine whether our model has predictive relevance or not. Q^2 values > 0.50 depict large predictive relevance of the PLS path model. Model has given value of Q^2 as 0.549 for Behavioral Intention, confirming high predictive relevance for our model (Shmueli et al., 2016; Hair et al., 2019).

4.3 Analysis of the existing policies and challenges with respect to the dissemination of the Solar Home Lighting System including green social work

To analyse the existing policies, including green social work, the findings have been divided into two subsections: SHS usage experience, and Attitude of urban households towards adoption of SHS. Data was analyzed using the SPSS (Statistical Package for the Social Sciences) software version 20. Descriptive analysis was used to understand ground reality in context with SHS usage experience of adopters whereas Mann-Whitney U Test was used to analyze the difference between the adopters'attitudes and non-adopters attitudes toward the perception of drivers as well as barriers to the adoption of SHS. The responses of adopters and non-adopters on the Likert scale have been displayed with the help of charts.

4.3.1 SHS Usage Experience

The descriptive statistical analysis in this subsection is related to the responses collected in section I of the survey questionnaires from the urban households of Punjab that were currently using the solar home lighting system, termed adopters in this study (N = 250), and not the non-adopters (N = 250). It was observed from Figure 4.3.1 that the maximum no. of adopters installed SHS of 3-5 KW solar PV capacity followed by 5-8 KW and then 1-3 KW. Significantly few respondents installed 8-10 KW or above it. A rooftop solar system in India costs nearly Rs. 50,000/- per KW. This means a householder has to spend Rs. 1,50,00 to Rs. 2,50,000 for 3-5 KW. When asked, "How did you finance your SHS?" only two respondents said they bought it in installments. All other respondents bought SHS by paying the total amount. This finding indicates that few financial options are available to urban households in Punjab for purchasing solar rooftops. Dutt (2020) explored the obstacles hindering the growth of the solar rooftop market in Delhi - the capital of India, by integrating perspectives from solar vendors, implementing agencies, and users/potential users in his study and found that the cost issue was aggravated by the lack of finance for the customers interested in solar rooftop.

Figure 4.3.1. Solar PV capacity of SHS adopted by the urban households (N = 250)
(Source: Self compiled)

Respondents were asked about the monthly reduction in their electricity bill after installing SHS. The majority of the respondents (88%) stated that 80-90%, which reduced their electricity bill could be considered a huge financial advantage (Table 4.3.1). It is imperative to mention that all of the households participating in this study had on-grid solar rooftops wherein, through a system of net-metering, any unused or excess solar energy flows back into the grid and offsets the household's electricity bill. Depending on consumption patterns, this could even mean consumers earning money, though the world over, the general experience shows a reduction in bills.

Table 4.3.1. Reduction in electricity bill after SHS installation in urban households (N
Perhaps the most discouraging finding of this study was that only 5.2% of urban households received subsidies for their SHS connection (table 4.3.2). Although most households (70%) agreed upon receiving the training, only one householder from the Amritsar district reported attending a training camp for Rs. 7000/-. All other householders got informal training from their vendors. This finding was directed towards organizing training camps or information seminars for this very purpose. When asked, "In the last 12 months, did you pay for repairs/parts/maintenance of SHS?" only 10.4% of respondents said they spent some amount on the repair or maintenance. These expenses ranged from Rs. 200/- to 20,000. Maintenance was mainly related to the regular washing of the solar panels. in general, these washing charges are Rs. 30/- per panel. SHS demands minimal upkeep. They are quite sturdy and have an expected lifetime of approximately 25-30 years without any maintenance. The primary maintenance requirement is to thoroughly cleanse them free of residue twice to four times annually using a high-pressure water nozzle. This vital cleaning regimen ensures that the sun may radiate luminously on the surface, maximizing the amount of light available to be converted into electrical power. However, households lack sufficient information regarding the necessary maintenance support (Parsad et al., 2020).

When asked about their experience of technical glitches while using rooftop solar, the findings follow a similar trend to the previous question on repair/parts/maintenance of SHS.14.8% of households experienced one or more technical glitches. The interviews conducted also revealed

that the most frequent technical glitch faced by the SHS users was related to faulty net meters and tripping of switches. To this, one of the Executive Engineer at PSPCL said

"The meter provides inaccurate readings or the switches trip for one main reason. i.e., improper earthing. The aluminum copper joint used to install SHS is secured solely with black tape. This compromise on earthing quality creates a faulty load generation setup, thus impacting the net meter and switches."

Table 4.3.3. Sources of information for the adopters (N = 250) (Source: Self compiled)

Table 4.3.3 indicated that the most frequently used source of SHS information was friends and neighbors (35.2%), followed by family members (18.4%), manufacturers/vendors (12.8%), and social media (10.4%). Surprisingly, only 2.8% of respondents got the information from the government schemes. Still more surprisingly, rather shockingly, only 1.2% reported receiving the information from an NGO or green social work organization. These findings are well in line with a systematic review conducted by Alipour et al., (2020). This suggests that neither the government nor the volunteer organizations are making the required efforts to promote this low-carbon technology. Another important observation from this table suggests the negligible role television plays, implying that television is not used for environmental advertisements. Our discussions in interviews also revealed that there are no schemes regarding solar rooftop installation in Punjab. There are only Centre-level schemes, for example, recently, the Union government of India has rolled down the new Rs. 75,000/- crore PM Surya Ghar Muft BijliYojana (rooftop solar free electricity scheme) wherein the Central government will subsidize 60% of the installation cost. (PIB, 2024). The scheme envisages reaching the target of one crore houses in three years.

4.3.2 Attitude of urban households towards the adoption of SHS

Attitude scales are generally intended to measure attitudes objectively and in a quantifiable way. They comprise a set of slightly contentious statements, usually presented in questionnaire format (Hicks, 2004). In the present study, the second section of the questionnaire was used to measure the attitude of the study population to find out what they feel about the adoption of solar home lighting systems. Respondents were asked to indicate the degree to which they

agreed or disagreed with each statement. Figures 4.3.2 to 4.3.9 present the percentages of responses of urban households of Punjab, on the Likert scale, for each item of the performance expectancy, effort expectancy, hedonic motivation, financial motivation, environmental concern, energy motivation, social influence and knowledge & awareness, respectively (adopters; $N = 250$, non-adopters; N = 250). High scores on the statements related to product traits, whereas low scores on the statements related to barriers on the Likert scale indicated a positive attitude of urban households towards adopting SHS.

Figure 4.3.2 Likert scale responses to performance expectancy statements (Source: Self compiled)

Figure 4.3.3 Likert scale responses to effort expectancy statements (Source: Self compiled)

Figure 4.3.4 Likert scale responses to hedonic motivation statements (Source: Self compiled)

Figure 4.3.5. Likert scale responses to financial motivation statements (Source: Self compiled)

Figure 4.3.6. Likert scale responses to environmental concern statements (Source: Self compiled)

Figure 4.3.7. Likert scale responses to energy motivation statements (Source: Self compiled)

Figure 4.3.8. Likert scale responses to social influence statements (Source: Self compiled)

Figure 4.3.9. Likert scale responses to knowledge and awareness statements (Source: Self compiled)

Figure 4.3.2 and 4.3.3 display the findings from a Likert scale style questions which rank respondents' level of agreement with various statements on performance expectancy and effort expectancy of SHS, respectively. Performance expectancy assesses how effective a scheme is helping households achieve their goals of lowering their energy bills and contributing to the conservation of scarce natural (Sahu et al., 2021). Effort expectancy measures how much individuals feel comfortable in using the system and ease to adopt (Aggarwal et al., 2018). It is evident from figure 4.3.2 that the majority of adopters feel that SHS is not only reliable and efficient for managing their electricity requirements but also easy to use even if one has not used it before. On the other hand, nearly half of the non-adopters had no opinion about the performance expectancy of this solar system. Similar observations were made for "effort expectancy" of SHS. This indicates that the non-adopters were not very aware of the performance expectancy as well as effort expectancy of SHS. While this lack of awareness about the reliability and efficiency of SHS may be the reason for the non-adoption of solar energy by the non-adopters, the adopters of the current study were positively disposed towards adopting SHS. This difference in attitudes is supported by the statistically significant higher mean rank for adopters compared to non-adopters (table 4.3.4 and 4.3.5). Thus, as compared to non-adopters, adopters rate SHS as greater in performance expectancy and effort expectancy, therefore **H8a and H8b are supported.** This substantiates with a similar piece of research conducted in central England which suggested that the 'early majority' need convincing that solar systems are maintenance free and the installation process is simple with minimal disruption. This is likely predictable, as individuals who are not acquainted with the technology will generally lack knowledge about the everyday operations of the systems(Faiers & Neame, 2006).

Hedonic motivation measures the influence of hedonic or emotive parameters on the behaviour intention of potential buyers of rooftop solar systems (Aggarwal et al, 2018). The Likert scale responses of our study population on hedonic motivation have been displayed in figure 4.3.4. It is evident that in comparison to non-adopters (11.2%), a larger percentage of adopters (24%) like to try a new product before others do. Similar kind of difference was observed for other parameters of hedonic motivation, namely, very satisfying to be among the first to install SHS (38.8% of adopters, 17.6% of non-adopters), purchasing SHS is an exciting experience (36.8% of adopters, 19.2% of non-adopters), happy to install SHS (62% of adopters, 37.6% of non-adopters), always curious to adopt new technology (32% of adopters, 25.6% of non-adopters) and keeping up with new trends in innovation is an enjoyable experience (50.8% of adopters,

27.6% of non-adopters). Table 4.3.4 and 4.3.5 suggests that this difference is statistically significant implying that as compared to non-adopters, adopters are highly motivated to purchase/install rooftop solar. Thus, **H8c is accepted.**

Figure 4.3.5 showcases the responses of participants on statements concerned with financial motivation for domestic use of solar lighting system. About 70-75% of adopters believe that SHS is a practical and cost-effective option to other sources of energy and they need not worry about electricity consumption after the installation of SHS due to a reduction in monthly bills. Surprisingly most of them were not in agreement with the statement that they were highly motivated to adopt SHS due to initial subsidies offered to the households by the government. This suggests that the positive attitude of urban households towards domestic use of solar energy is because of its financial advantages and not the subsidies provided by the government which is very much inspiring from the social marketing perspective as the long-run success of the solar mission is when it evolves devoid of any state-supported subsidy as a social revolution with social acceptance and use of solar technologies (Aggarwal et al., 2019). Thiam (2011) in Senegal also highlighted the significance of the 'social receptiveness of renewable technologies'. Among non-adopters, 45.2% of the respondents strongly agree with the statement related to a reduction in monthly bills, despite their neutral opinion on the Likert scale regarding the price of a normal solar grid and the subsidies provided by the government. Nonetheless, they exhibited a negative attitude towards maintenance cost, asa handful of non-adopters strongly agreed with the statement "The maintenance cost of SHS is affordable" in comparison to 55.2% of adopters. Interestingly, when asked about the willingness to invest in the future, 42.8% of adopters already using SHS, were still willing to invest in future solar energy projects, compared to only 24.8%of non-adopters. Certainly, non-adopters of the present study exhibited an unfavorable and neutral attitude toward adopting SHS. Table 4.3.4 and 4.3.5 endorse these results with statistically significant high scores of adoptersovernon-adopters for the financial motivation to use solar energy.Compared to non-adopters, adopters rate SHS as greater in financial rewards, hence, **H8d is accepted.**

Urban households, representing adopters and non-adopters, were asked to record their responses to various statements related to environmental concerns (figure 4.3.6) and energy motivation (figure 4.3.7). Approximately 75% of the adopters desire to reduce carbon footprints through the use of clean energy and strongly agree with the statements that SHS is a pollution-free energy resource and is an excellent initiative to deal with climate change.

Therefore, they are highly motivated to reduce global warming by adopting SHS. This adoption would be their contribution to protecting the environment in a proactive style. Notably, while many of the non-adopters (about 50 %) agreed with the statements related to environment concerns and energy motivation, their level of agreement was statistically significantly lower, as indicated by the results of the Mann-Whitney U test (table 4.3.5), **supporting hypothesis H8e and H8f**. The higher percentage of environment-concerned urban households among the adopters is likely attributable to a higher rate of adoption of solar energy for residential electricity utilization. An empirical study of urban residents in Shanxi Province, China has also indicated that environmental concern, environmental knowledge, and attitudes have significant impacts on and positive correlations with the residents' willingness to purchase energy-efficient appliances (Li et al., 2019). Similarly, Liu et al., (2013) showed that residents are generally supportive of renewable energy development given its positive impacts on the environment; however, they focused on rural households in Shandong Province of China.

Urban households' perceptions of social influence in adopting solar rooftops are displayed in Fig. 4.3.8. It is evident that most of the adopters, as well as non-adopters, always take feedback and reviews from peer group members on their purchases. Nevertheless, the percentage of respondents was much higher among adopters than non-adopters for their agreement on statements: "Green purchase intention gives me social approval" and "My friends and neighbors shared with me the benefits of the solar home lighting system" indicating a favorable attitude of adopters towards social acceptance of clean energy and therefore **supporting proposed hypothesis H8g**. This difference in the attitudes of adopters vs. non-adopters has statistically been confirmed by the Mann-Whitney U test (table 4.3.5). Liu et al., (2013) focused on renewable energy (electricity) deployment in rural households in Shandong Province. They used the analytical framework of TPB. It was found that 84 percent of households' choices would be influenced by their neighbor's energy choices and behavior patterns.

According to Rogers and Shoemaker's theory, consumer's knowledge about benefits and drawbacks of the product is the first step in determining whether or not it will be accepted (Hanafizadeh and Khedmatgozar, 2012). It is observed from figure 4.3.9 that about 50 to 60% of the adopters had the awareness about the importance of SHS, availability of vendors and necessary resources to use SHS. On the other hand, only one fourth of the non-adopters had the said knowledge and awareness about SHS. The findings of Mann-Whitney U test (table 4.3.5) indicates that this difference is statistically significant, hence **H8h** is accepted. Thus,

knowledge and awareness is one of the major factors that could influence the behaviour intention to adopt SHS. Interestingly, almost half of the total respondents had a neutral opinion of the statement "Awareness programs motivate me to purchase SHS." The probable reason for this finding could be that such programs are not very frequently organized in the state of Punjab. This highlights the need of engaging urban households through workshops, seminars and newsletters by green social workers.

Table 4.3.4. Attitude towards perception of adoption drivers of SHS (Rank table)

Figures 4.3.10 to 4.3.13 present the percentage of responses, on the Likert scale, for each item of the inhibitors to the adoption of SHS, namely technical barriers, policy and regulatory barriers, socio-economic barriers, and knowledge and institutional barriers, respectively (Adopters; $N = 250$, Consumers; N = 250). According to hypothesis H8e, it was assumed that as compared to non-adopters, adopters would perceive a lower level of technical barrier while adopting SHS. Figure 4.3.10 shows how most adopters feel almost no technical barriers to installing, using, and maintaining residential solar systems. This is in sharp contrast with non-adopters' attitude, as only 13.6% strongly disagreed, and 21.2% disagreed with the statement that I will not get enough technical assistance at the time of installation and during the usage of SHS. Additionally, more than 80% of the respondents among non-adopters did not feel that roof mounting of SHS can cause either damage or loss of access to the roof of their houses.Low scores on the statements related to barriers on the Likert scale indicated a positive attitude of adopters towards adopting SHS compared to non-adopters (Tables 4.3.6 and 4.3.7). While these findings very well **support hypothesis H8i**, the manufacturers and the vendors must build up trust in the potential buyers by working on the technical barriers as previously, other studies have also revealed that the households considering the adoption of SHS are likely influenced by technical barriers as their ignorance of SHS technology including issues pertaining to permitting, planning and maintaining it over its lifecycle (Walter et al., 2018; Beck & Martinot, 2012; Zhang et al., 2012; Margolis & Zuboy, 2006).

Figure 4.3.11 highlights urban households' level of agreement on the Likert scale for various statements related to policy and regulatory barriers to adopting domestic solar energy. About 70-75% of respondents reported some level of agreement with an approximately even split across adopters and non-adopters for the statements: "There is a lack of development of innovative schemes on the part of policymakers to promote adoption of SHS" and

"Government agencies are not providing free demonstration sessions of SHS." Nonetheless, the percentage of households reporting their agreement with statements related to inadequacies of government incentives, lack of legal binding over price value and scarcity of promotional strategies or attractive offers provided to potential buyers of SHS was higher among adopters than non-adopters. When asked to rate the statement regarding their unwillingness to purchase SHS as the subsidies are insufficient, adopters showed mixed responses, with 39.2% agreeing, 26.4% having no opinion, whereas 34.4% showed their disagreement on the statement. This implies that adopters' purchase intent is not dependent upon subsidies provided by the government. A similar kind of response was obtained previously when asked about subsidies in Figure 4.3.11. Thus, both adopters and non-adopters seem to be dissatisfied with existing policies and regulations related to the adoption of solar energy in the state of Punjab, although adopters showed more concern perceiving a higher level of policy and regulatory barriers in the context with SHS. Table 4.3.6 and 4.3.7 provides statistical information for this difference in the attitudes of both adopters and non-adopters which indicates that **H8j is rejected**. Obviously, this finding highlights the need to bring into effect the policy and regulations that would encourage domestic consumers to adopt solar energy. For example, as established by Urpelainen and Yoon (2017), the product demonstrations for solar technology improves awareness and therefore the demonstration sessions and the awareness program should be organized frequently.

Urban households who participated in the present study were asked to respond on the statements related with socio-economic barriers to adoption of SHS. It can be observed from Figure 4.3.12 that about 89.6% of adopters reported disagreement with the statement "I am afraid to adopt SHS as it is a new product." It was further observed that more than 90% of adoptersdid not believe that the installation of SHS needs an abundance of space or makes the appearance of their houses ugly. When asked about their perception of economic risk, 87.2% of adopters, compared to only 53.6% of non-adopters, disagreed that adoption of SHS involves a high level of economic risk due to uncertainty regarding return on investment. This may be attributable to a substantial reduction in monthly billing as reported by the adopters in the previous statement (Table 6). These results suggest that adopters feel a lower level of socio-economic barriers to adopting energy-efficient behavior than non-adopters. Furthermore, this difference in their attitudes is statistically significant, as displayed in tables 4.3.6 and 4.3.7 and thus, **supports hypothesis H8k**. Thus, it is evident that these socio-economic barriers could be behind the lackluster attitude of non-adopters, which is explained by many other researchers,

for example “lack of trust in available information on PV,” “uncertainty of the costs associated with operation and maintenance” and “the long timeline for return on investment” (Parsad et al., 2020; Rai et al.,2016; Rai & Robinson, 2013; Rai &McAndrews, 2012).

Figure 4.3.13 displays the responses of urban households on knowledge and institutional barriers to adopting SHS. Not even a single adopter strongly agreed with the statement, "I worry about the necessary information required for using/maintaining." This means that most of the adopters had necessary information about SHS. In contrast, among non-adopters, 25.6% of urban households had no opinion on this statement, and 20.4% agreed that they had no information about the usage of this technology.It was further observed that about 50-55% of adopters believed that (i) there is a lack of knowledgeable firms and vendors dealing with distribution, installation, and consultation, (ii) companies do not provide enough experiment opportunities for SHS, (iii) I do not have access to the quality material of SHS and (iv) I do not know how to interpret the profit of excess energy sold back to State Electricity Board. While this concern of adopters indicates a need to pay attention to Knowledge and Institutional Barriers, the results of the mann- whitney test (Tables 4.3.6 and 4.3.7) suggest that adopters' attitudes were still positive towards adopting SHS compared to non-adopters, hence, **hypothesis H8l is accepted**. Thus, except H2f, the analytical results of this study are fairly consistent with the proposed hypotheses.

Figure 4.3.10. Likert scale responses to technical barriers statements (Source: Self compiled)

Figure 4.3.11. Likert scale responses to Policy and Regulatory barriers statements (Source: Self compiled)

Figure 4.3.12. Likert scale responses to Socio-economic barriers statements (Source: Self compiled)

Figure 4.3.13. Likert scale responses to knowledge & institutional barriers statements. (Source: Self compiled)

Table 4.3.6. Attitude towards the barriers to adoption of SHS (Rank table)

4.4 Exploring the frequency of Ecosocial work practices among Indian social workers

An ecosocial approach strives to integrate environmental aspects with social aspects on all levels of social work practice: personal, individual, group, community, and structural (Boetto, 2017).To attain third objective of study, the data was collected via an electronic survey sent to 118 social workers, practicing in different parts of India. The survey questionnaire explored their views on environmental sustainability issues and green technologies in both their private and professional lives. There is an evident dearth of eco-social work literature in social work curriculum which renders practitioners unsure regarding their responses to environmental concerns (Reu &Jarldorn, 2022). Hence, they were provided with a broad definition of green social work that was formulated by Lena Dominelli: "Green social work is that part of practice that intervenes to protect the environment and enhance people's well-being by integrating the interdependencies between people and their socio-cultural, economic and physical environments, and among peoples within an egalitarian framework that addresses prevailing structural inequalities and unequal distribution of power and resources" (Dominelli, 2012).

Table 4.4.1 displays the findings regarding the socio-demographic characteristics of the social work professionals. Most of the respondents belonged to the age group of 21-30 years (65.3%) followed by 31-40 years (22.9%). Approximately half of them were females (55.9%) and half were males (44.1%). All of the respondents were social work degree holders. In this connection, it was indeed encouraging to observe that a majority of the respondents (83.9%) had a master's degree in social work with 13.6% holding a Ph.D. degree and just a handful of them having only a bachelor's degree. With respect to their experience, 72 respondents were practicing social work from the last about three years. Additionally, a maximum percentage of social workers was practicing in public sector (44.1%), followed by third sectors (36.4%) and private sectors (19.5%).

Table 4.4.1: Sociodemographic characteristics of social workers (Source: Self compiled)

The descriptive analysis regarding the frequency of eco social work practices has been presented in this section in the form of bar graphs (figure 4.4.1 to 4.4.10), with 1-5 designated on the scale as follows:

1-Never, 2- Rarely, 3- Sometimes, 4- Often, 5- Always

The ecosocial approach and environmental sustainability issues have emerged on the social work agenda due to the exceedingly important need to respond to global warming and its effects on human well-being (IFSW 2022). This study has explored the prevalence of green social work practices in India. Nonetheless, it was quite discouraging to find that only 21.2% of social workers had heard about green social work. 16.1% of them always discuss the difference between renewable and non-renewable energy sources with their clients. Similarly, 23.7% of respondents always discuss the environmental sustainability issues such as global warming, during social work practice. It was further observed that a hand full of social work professionals (15.3%) always talk to their clients about reducing carbon footprints through the use of clean energy. Although 35.6% of respondents incorporate energy motivation into their work with clients, many of them do not ask about green purchase intention to their clients. Thus, this empirical study has demonstrated that more than half of the social work professionals do not discuss, incorporate or promote the use of renewable energy sources such as solar home lighting system while working with their clients.

Figure 4.4.1 to 4.4.9 exhibited Likert scale responses on the statements indicating personal interest of social workers to participate or organize seminars, workshops and awareness campaigns related with environmental sustainability practices. Approximately, 70-75% of respondents had participated at least once in seminars on green energy and work with client groups on addressing current environmental challenges in their city in addition to organizing awareness programs in their fieldwork community.Thus, Green social work is not widely known among the Indian social workers, still they believe that it can promote sensitization towards environmental sustainability issues. Hence, within the context of energy-efficient behaviours, there is a national call for social work professionals to incorporate green social work into their practices.

4.5 Concluding remarks

This chapter analyzed the data collected from adopters as well as non-adopters. The chapter analyses features of drivers and inhibitors towards behavioural intention to adopting SHS. It also focuses on socio-demographic variables such as age, gender, education and income and their role as moderators and control variables respectively. The chapter includes model development and validating the model. The chapter further compares the attitude of adopters and non-adopters towards SHS adoption in terms of their likert scale responses on the items of identified drivers and inhibitors. The chapter concludes by analyzing the eco-social work practices among the Indian social workers.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND FUTURE SCOPE

As cities grow and urbanization accelerates, India risks surpassing global benchmarks for energy efficiency and carbon emissions. In such a situation, a massive transition to large-scale renewable energy can support environmental sustainability, drive socio-economic development, and become a true catalyst for a liveable planet Earth. This study, using urban households of Punjab– the northern state of India, investigates their attitude and energy behaviour towards adopting the solar home lighting system (SHS) that can generate energy directly at its point of use – in homes.

5.1 Discussion of Results and hypotheses testing

While Chapter 4 describes the study's findings along with their qualitative and quantitative analysis, this chapter elaborates on these findings in terms of research objectives and hypotheses. The findings have been discussed in light of previous studies and existing literature. It also delves how relevant and significant are these results, what are their theoretical as well as practical implications and then argues for the conclusion that has been drawn after the analysis. Section 5.1 discusses what inspires or inhibits households to adopt a solar home lighting system (SHS) in Punjab, section 5.2 explores how the socio-demographic attributes influence the attitude and energy behaviour of urban households towards SHS, section 5.3 throws light on dissemination policies and section 5.4 discusses the panorama of green social workers and section 5.5 presents a model proposed with retrofitting interventions to improve adoption rate by urban households.

5.1.1 Evaluating the drivers and inhibitors for the adoption of the solar home lighting system amongst urban households of the State of Punjab

According to Silva and Andrade (2020), in India, solar energy consumption as a primary source of energy is only 0.5%, as compared to other countries. The widespread adoption and use of solar energy are dependent on its uptake at the household level. This is the first study investigating the feasibility of the UTAUT2 model in the SHS adoption scenario for Punjab State, India. The study

has explored several factors influencing the adoption behaviour of urban households and categorized them into drivers and inhibitors. Accordingly, section 5.1.1.1 discusses the adoption drivers whereas discussion regarding the adoption inhibitors has been presented in section 5.1.1.2

5.1.1.1 Adoption drivers of SHS

The drivers that emerged from the present study are grouped into eight factors, as below:

1. **Performance Expectancy**

   Performance Expectancy measures how much households perceive a system, such as SHS, as useful in achieving household goals in terms of lowering their electricity bills and contributing to reducing the use of limited natural resources (Sahu et al., 2021; Aggarwal et al., 2019; Chang et al., 2019; Saleh et al., 2014; Lewis et al., 2013; Venkatesh et al., 2012; Ghalandari, 2012). It emerged as a significant adoption driver leading to behavioural intentions of respondents for SHS adoption. Most of the adopters in our study believed that SHS is reliable and efficient to manage their electricity requirements. Based on this finding, it is reasonable to state that the success expectation of the SHS play a major role in determining its domestic adoption.

2. **Effort Expectancy**

   Effort Expectancy is the degree to which a person believes that using SHS would be free of effort (Hansen et al., 2018; Abdullah et al., 2016; Hamid et al., 2016; Davis, 1989). The analysis of Likert responses suggested that majority of the adopters believed that SHS could be easily installed and maintained. More importantly, our structural model analysis indicated that effort expectancy is the important motivating factor that can influence household's decision to adopt the solar energy. This finding is well in line with previous research reports that it is important for users to see RT SPV as a product that can be installed easily in their house, easy to maintain and a product that will work seamlessly with their existing appliances (Aggarwal et al., 2019).

3. **Hedonic Motivation**

   Our study has established that Hedonic Motivation has a statistically significant influence on the behavioural intention of urban households to adopt SHS. This finding is consistent with previous studies (Aggarwal et al., 2020; Rowlands et al., 2002), which indicated that Hedonic Motivation is a highly relevant factor beyond conventional price-value

perception. It is evident from the results of this study, that in comparison to non-adopters (11.2%), a larger percentage of adopters (24%) like to try a new product before others do. Hence, it is very satisfying for them to be among the first to install SHS. Thus, purchasing SHS is an exciting and enjoyable experience for urban households with curiosity to adopt new technology.

4. **Financial Motivation**

Price/value beliefs modified as a Financial Motivation for our model were found to be more significant than other items, which is in line with earlier research (Kumar et al., 2022; Kumar & Hundal, 2019; Pathania et al., 2017; Roulleau & Lloyd, 2008). When asked about their perception of economic risk, most adopters who participated in our study, did not agree that adoption of SHS involves a high level of economic risk due to uncertainty regarding return on investment (ROI). This perception was further strengthened by our observation that reduction in their monthly electricity bills ranged from 60% to 100%. It is reasonable to state that ROI is the main financial motivating factor for the acceptance of solar rooftops. Jayaraman et al., (2017) also concluded that higher economic returns, in the form of savings on energy bills or exchanging surplus energy for a price of SHS, enhance the likelihood of adoption. Given that solar technology is a long-term investment, estimation of the length of time needed to recover the amount invested, i.e., a payback period, is by far the most popular financial statement metric (Lu et al., 2019; Alipour et al., 2020; Weerasinghe et al., 2021).

5. **Environmental Concern**

It refers to people's willingness to recognize and endorse efforts to resolve ecological challenges (Aggarwal et al., (2019), Li et al., (2019), Hsu's (2018), Steg et al., (2014)]. Our results indicate that habit modified as Environmental Concern acts as a significant driver of adoption, which is supported by previous research (Kumar et al., 2022; Palm, 2017; Muaafa et al., 2017) and is contrary to the findings of Schelly, 2014 and Balcombe et al., 2013. Customers in today's era are proactive about environmental concerns, but these studies established that environmental values are not enough. This is somewhat justified by the lowest weight of Environmental Concern among the remaining items in our model. Aggarwal et al., (2020) reported that green habits were also associated with lower weight. Because a household is concerned about the environment, this does not necessarily mean

that it would adopt SHS. Households might feel that their individual efforts to save the environment alone will not solve the problem.

6. **Energy Motivation**

   The study extended the model by adding a new driver, Energy Motivation, to the research study. It is also positively associated with adoption drivers, supported by a previously reported study (Parsad et al., 2020). More than 70% of our urban households believed that the energy reliability of solar home lighting systems motivates them to adopt it. Liu and his associates also revealed that residents are generally supportive of renewable energy development given its positive impacts on the environment; however, their study was focused on rural households (Liu et al., 2013).

7. **Social Influence**

   The impact of social influence as an adoption driver on behavioural intention is also consistent with previous research studies (Singh, 2013; Schelly, 2014; Wolske et al., 2017; Kumar et al., 2019) indicating that solar purchase intent evolves with Social Influence, and consumers help shape their opinions (Palm, 2018). This also implies that people value and listen to their friends, colleagues, relatives, and opinion leaders before adopting new technology for their household.

8. **Knowledge and Awareness**

   The results of this study exhibited that household Knowledge and Awareness of green sources of energy increase the likelihood that they will adopt SHS. Numerous researchers have supported this finding in the earlier studies (Balcombe et al., 2013; Rai and Robinson, 2013; Heiskanen and Matschoss, 2017; Kesari et al., 2018).

Thus, it is evident from this empirical study that the above-discussed eight factors are the significant drivers of the adoption of SHS by urban households. It can be further interpreted that Effort Expectancy ($\beta = 0.836$; p-value = 0.000) and Financial Motivation ($\beta = 0.833$; p-value = 0.000), account for the maximum significant variance in Behavioural Intention. This is followed by Knowledge and Awareness ($\beta = 0.824$; p-value = 0.000), Performance Expectancy ($\beta = 0.780$; p-value = 0.000), Hedonic Motivation ($\beta = 0.689$; p-value = 0.000), Social Influence ($\beta = 0.686$; p-value = 0.000), Energy Motivation ($\beta = 0.654$; p-value = 0.000) and Environmental Concern ($\beta = 0.637$; p-value = 0.000). These findings suggest that reduced electricity bills and the easy switching effort to any new technology are major motive for households to adopt SHS. In contrast,

Environmental Concern is the least loaded on adoption drivers, which makes us think about, 'do households adopt SHS to reduce global warming, or is that just a byproduct of the economic viability of SHS?' This is also in line with the study by Schelly (2014), which established that environmental values were not enough nor were the first mover motivation to trigger adoption intent. The related hypotheses are presented in Table 5.1.1.

Table 5.1.1 Hypotheses testing of Adoption drivers

5.1.1.2 Adoption Inhibitors of SHS

Urban households belonging to the state of Punjab are facing certain barriers, as listed below:

1. **Technical Barriers**

   It refers to the reluctance by households to adopt SHS due to its technological risk and complexity because of the absence of fundamental standards in the durability and reliability of the solar PV technology leading to a suboptimal design of the installed rooftop system (Rathore et al., 2019; Manju & Sagar, 2017; Karakaya & Sriwannawit, 2015; Zhang et al., 2012). Approximately 80% of our non-adopter households feel that they will not get enough technical assistance at the time of installation and during the usage of SHS. This points out that manufacturers and vendors must build trust in the potential buyers while installing, using, and maintaining residential solar systems. These findings are well in line with numerous studies reporting that the households considering the adoption of SHS are likely influenced by technical barriers such as their ignorance of SHS technology including issues of permitting, planning and maintaining it over its lifecycle (Walter et al., 2018; Beck & Martinot, 2012; Zhang et al., 2012;Margolis & Zuboy, 2006).

2. **Policy and Regulatory Barriers**

   Policy and Regulatory Barriers refer to the hindrance in the diffusion of SHS due to inadequate implementation of policy incentives and lack of timely subsidies (Parsad et al., 2020; Rathore et al., 2019; Khan et al., 2017; Manju & Sagar, 2017; Karakaya & Sriwannawit, 2015; Zhang et al., 2012). One of the key observations of this study was as compared to non-adopters, adopters were more negatively disposed towards the present

status of policy and regulations related to residential rooftops, in Punjab. This infers that policy and regulatory barriers is the most significant inhibitor to SHS adoption. For example, a lack of promotional strategies is perceived by almost all respondents. This observation is supported by numerous studies (Wolske et al., 2017; Newton et al., 2015; Muyingo, 2015; Ek & Matti, 2014).

3. **Socio-economic Barriers**

   The high initial investment cost of SHS and lack of knowledge of suitable financing mechanisms makes the adoption process complex for households (Rathore et al., 2019; Khan et al., 2017; Sun, 2015; Zhang et al., 2012). The high initial cost and the payback period is a significant impediment for domestic solar technologies (Ansari et al., 2013). The likert scale responses of non-adopters for the statements related to financial motivation suggested that the price of normal solar grid is not affordable for them which is why they are not willing to adopt SHS. The negative effect of high cost of solar technology on its adoption has been reported by no. of studies (Alrashoud & Tokimatsu, 2019; Makki and Mosly, 2020; Sackey, 2020).

4. **Knowledge and Institutional Barriers**

   These are the outcomes of bureaucratic procedures (delay in sanctioning of SHS licensing and installation by public officials) and complex regulations in the deployment of SHS; thus impeding the industrialists and entrepreneurs from entering the market (Parsad et al., 2020; Rathore et al., 2019; Khan et al., 2017; Sun 2015; Zhang et al., 2012). It was observed in our study that most of the respondents believed that there is a lack of knowledgeable firms and vendors dealing with distribution, installation, and consultation. The households do not have access to the quality material of SHS and do not know how to interpret the profit of excess energy sold back to the State Electricity Board. This lack of knowledge and awareness regarding the product can be a severe barrier to diffusion (Choudhary et al., 2014). It is needed to raise awareness and confidence among consumers regarding the potential of solar power systems and the associated advantages (Philibert, 2006).

The related hypotheses are presented in Table 5.1.2.

Table 5.1.2 Hypotheses testing of Adoption Inhibitors

5.1.2 Impact of socio-demographic attributes on the attitude and energy behaviour of urban households towards SHS

In this section, current study has discovered the significance between the selected socio-demographic attributes and the attitude of households towards the adoption of SHS. These socio-demographic attributes were age, gender, and education of the householders, along with their monthly family income. The basis for the selection of these variables was a study conducted by Alipour et al., (2020) who systematically reviewed 173 types of research on the various factors influencing domestic adoption of solar PV and found that the socio-demographic dimension was applied in 86% of the total research papers, representing the most traditional explanatory variables: age, income, gender, and education of household. These four alone were employed in 45% of the total number of studies.

Unexpectedly, a greater proportion of the younger respondents were non-adopters rather than adopters (table 4.1.1), suggesting that the younger generation has a very limited awareness of solar technology, which is disappointing. It is imperative here to mention that in both groups, the maximum no. of respondents was aged more than 50 years. The reason may be that either the Head of the family or, in the absence of the Head of the family, another family member who is active in the decision-making process was interviewed. The model evolved in the current study has revealed a higher strength of the relationship between adoption drivers and behaviour intention with an increase in the age of respondents. As the Adoption drivers increase, the behavioural intention also increases. Age moderated this relationship with $\beta = 0.097$ and $p = 0.001$. The positive relationship indicates that older householders were more concerned about adopting SHS than their younger counterparts. Lin and Kaewkhunok [64] also reported that the age of the household head is positively associated with adoption. This is possibly attributable to their age-related experience, well-settled life, and more time to get engaged in discussions with peer members on clean energy. On the other hand, younger people are in the process of managing the basic needs of their families and do not have the savings necessary for such an expense. Conversely, Briguglio and Formosa (2017) suggest that younger people may have limited funds available for installation; however, the possibility of gaining benefits for a longer period encourages uptake. Zander et al., (2019) assessed the impact of age and found a negative relationship with adoption: younger people are more likely

to use solar PV, and the likelihood of adoption reduces with increased age. Considering these contradictory reports, it is important to encourage future generations to adopt alternative energy sources such as solar home lighting systems as the world tackles climate change. There is a need to highlight the solar technologies and projects from around the Punjab State and the Nation. A comprehensive social marketing campaign can be employed for the same.

Interestingly, a negative relationship for gender (β = -0.150 and p = 0.069) indicates that females have higher behavioural intention for the adoption of SHS. The credible explanation provided by Zeru and Guta (2021) for the significant association of gender towards SHS is that women are more responsible and highly attached to household energy use in developing countries. Faiers and Neame (2006) also found that female respondents in Central England were less likely to think that solar would negatively affect the visual landscape. This suggests that male household heads need to be sensitized to residential solar energy usage.

Considering education and financial status as key aspects of socio-demography of any region, education of household head and monthly family income were introduced as control variables, in our model. Both of these control variables exhibited significant relationship with behaviour intention. The β value for monthly family income is - 0.140 (p=0.000), indicating that the households with higher monthly family income (≥184,376 rated as 1 and ≤9226 as 7) strongly intend to adopt SHS. This finding is well in line with that of Liu et al., (2013) who reported that residents with a higher income level are more likely to be willing to pay more for green electricity. Similarly, Sirgin et al., (2015) and Kowalska-Pyzalska (2018) also found that higher income positively influences adoption, as greater financial liquidity enables householders to buy solar PV. In contradiction to these reports, Bashiri and Alizadeh (2018) argue that those on lower incomes are more likely to adopt solar PV: people with higher incomes care less about how much they are spending on energy; this higher spending on energy is not likely to adopt solar PV, whereas those on limited incomes always strive to find alternative ways to reduce their energy bills to balance their monthly budget.

Surprisingly, the beta value (0.142, p=0.000) for the education level of the household head (professionals rated as 1 and illiterate as 7), suggested that people with a lower level of education were more interested in adopting SHS. Contrary to this finding, Bélaïd and Garcia (2016) have

showcased how attitudes toward energy-saving behaviour are encouraged by educational attainment. Apparently, educated people have better access to various sources of information regarding the consequences of global warming and the availability of technology to deal with them. Hence, higher education translates into a higher level of perceived environmental concern. Nevertheless, the findings of our study implies that educated people need to be more aware of the domestic use of green energy.

Based on the above discussion on selected socio-demographic attributes, it would be reasonable to state that urban households with older and wealthier females; as heads of family; are positively disposed towards adopting SHS. At the same time educated people need to be more positively disposed to SHS adoption through seminars and workshops in schools and higher educational institutes. The related hypotheses are presented in Table 5.1.3.

Table 5.1.3 Hypotheses testing of socio-demographic variables

5.1.3 Examining the existing policies and challenges concerning the dissemination of the Solar Home Lighting System

The existing policies and challenges concerning the dissemination of the solar home lighting system have been examined in the present study, based on the usage experience of adopters and the distinction in the attitude of adopters and non-adopters.

An attitude can be defined as "a psychological tendency to view a particular object or behaviour with a degree of favor or disfavor" (Albarracin et al., 2005). Certainly, non-adopters of the present study exhibited an unfavorable attitude toward all the adoption drivers identified in this study. In contrast, the adopters were positively disposed towards them, namely performance expectancy, effort expectancy, hedonic motivation, financial motivation, environmental concern, energy motivation, social influence, and knowledge and awareness about domestic solar energy. Previously, many studies have reported a positive relationship between attitude and the use of solar PV (Kowalska & Pyzalska, 2018; Wolske et al., 2018).

It was further observed in this study that, as compared to non-adopters, adopters perceived lower levels of technical barriers to the installation, usage, and maintenance of residential solar systems. Similar findings were found with respect to socio-economic barriers as well as knowledge and institutional barriers. Fascinatingly, both adopters and non-adopters seem to be dissatisfied with existing policies and regulations related to the adoption of solar energy in the state of Punjab, although adopters showed more concern perceiving a higher level of policy and regulatory barriers in the context with SHS.

The hypotheses related to these results have been presented in Table 5.1.4.

Table 5.1.4 Hypotheses testing of attitude of adopters and non-adopters

Despite the obvious economic benefits, non-adopters in our study, have shown a negative attitude towards domestic solar technology. This may be due to a lack of financing mechanisms, as only 0.8% of our respondents got their SHS in installments. This unavailability of credit or financing mechanisms has been reported as one of the significant inhibitors to the adoption of SHS (Ugulu 2019; Sacky et al., 2020).

It is important to discuss that the reduction in electricity bills by SHS results in imprudent use of the energy produced by SHS adopters as they do not care for the energy savings for the environment. XEN at PSPCL, during the FGD session, said "SHS adopters in urban areas use too many electrical appliances even at the peak times of electricity load on PSPCL i.e. 8-11 pm, i.e. when everybody is back from office and relaxing in their own rooms, with air conditioners, TV, laptops and now air purifiers on. Their negligent attitude imposes an additional burden on the machinery of the State electricity board, resulting in escalated needs for infrastructure such as transformers, grids, net meters, etc., to meet the peak demand." One of the solutions lies in mobilizing households to adopt energy-conserving practices, such as turning off electrical appliances when not in use, to decrease their overall consumption. As highlighted by one of the PSPCL officers during FGD, another effective way to deal with this newly generated problem of the infrastructural load on PSPCL is that Punjab is planning to shift to a net billing framework from a net metering framework. Both programs provide compensation to SHS owners for exporting surplus power to the grid. However, their distinction resides in the manner in which households are reimbursed. Net metering credits often correspond to the retail electricity rate, which is the cost that the SHS adopters pay for electricity. Conversely, net billing credits are

proportional to the wholesale rates (usually lower than the rates we import electricity from the utility grid) fixed by our electricity supplier, i.e., PSPCL in this case. To the best of our knowledge, ours is the first study to report the proposed net billing framework for compensation in India, which would be more viable for the state electricity board.

One of the key observations of this study was as compared to non-adopters, adopters were more negatively disposed towards the present status of policy and regulations related to residential rooftops, in Punjab. This infers that policy and regulatory barriers is the most significant inhibitor to SHS adoption. For example, a lack of promotional strategies is perceived by almost all respondents. This observation is supported by numerous studies (Wolske et al., 2017; Newton et al., 2015; Muyingo, 2015; Ek & Matti, 2014). Apart from curiosity and interest, the promotional strategies create a sense of responsibility in the customers and motivate them to show purchase intentions which in turn encourages them to motivate other customers to show purchase intentions (Atulkar 2022). However, there is no single promotional strategy related to SHS adoption in Punjab. As per the decision of the Govt. of Punjab, the facility of free 600 units of electricity bimonthly/300 units of electricity monthly has been granted to all domestic consumers for consumption of electricity from 1.7.2022 onwards. For the First time, around 89.72% of domestic consumers (up to 17th Dec-2022) received Zero bills in the last billing cycle (PSPCL, 2022). This strategy of granting freebies by the government of Punjab has made urban households more reluctant to switch to this greener form of energy.

Recently announced PM Surya Ghar Muft Bijli Yojana is available pan India, for households that are installing 1-3 KW solar systems. However, the maximum no. of adopters installed SHS of 3-5 KW solar PV capacity followed by 5-8 KW. This suggests that the requirement for most of the households in urban areas of Punjab is >3KW and therefore they are not eligible to get subsidies under this scheme of Govt. of India. This inequitable approach will be seen as policymakers failing to motivate urban households to adopt SHS. There is already huge dissatisfaction among the adopters' concerning subsidies, as only 5.2% of respondents received subsidies. Some respondents said that they are still awaiting, others said that they are not aware about the subsidies. Interestingly, most of the respondents did not agree with the statement that "I am highly motivated to adopt SHS due to initials subsidies offered to the households by the government". While the State government must take some greater steps to provide subsidies, a care-free attitude toward

state-supported subsidy could be considered as social acceptance - a vital step for massive transition to large-scale renewable energy.

Our research has raised concern about trustworthiness in the manufacturers, vendors, engineers and government officials. The vendors do not provide appropriate earthing while installing SHS. The electrical engineers informed, during FGD, that earthing should be connected to each point with proper clamping at each joint. It was observed that most common technical glitch, encountered by the respondents, was tripping down of main switch or MCB switch. Therefore, vendors need to supply a good quality of MCB switch or connecting strips. Similarly, the employees of state electricity board should take proper care while installing net metering equipment. This meter should never be installed on terrace. It should always be kept on the ground and both meters – the net meter (bi-directional) and generation meter (unidirectional) should not be installed close to each other. Sometimes there is non-availability of net meters due to which the households have to wait for their solar system to start working. PSPCL needs to improve its infrastructure along with workmanship. Burning of inverter has been reported by some of the respondents. Such incidences are avoidable if the inverter is kept in ventilated space. These real-time experiences would build up mistrust between a consumer and an energy supplier, be it a manufacturer, vendor, private sector, or government official. Additionally, this kind of social influence will create a negative impact on adoption rate of SHS.

It is here that the recent ruling of the Supreme Court of India paves the way for legal accountability on energy suppliers. In its first, the Supreme Court, through its judgment on 21st March 2024, has recognized a right to be free from the adverse effects of climate change as a distinct right, citing Articles 14 (equality before law and the equal protection of laws) and 21 (right to life and personal liberty) of the Indian Constitution, as important sources. Court's observation has a potential to enhance climate action both on the demand side and the supply side. For example, accelerating state capacities by driving the allocation of funds in addition to functions as well as functionaries. A recent study, conducted by Adebayo and his associates within the context of Sweden, has advised policymakers and governing bodies to encourage increased investment in research and development (R & D) by implementing policies that offer incentives to businesses and institutions, allocating more resources to projects aimed at improving energy efficiency technologies. Consideration should be given to economic incentives like carbon pricing or the implementation

of a cap-and-trade system. These market- driven approaches to managing CO2 can motivate businesses to invest in energy-efficient measures by establishing a direct correlation between reducing emissions and gaining financial benefits. (Adebayo et al., 2024).

5.1.4 Exploring the frequency of ecosocial work practices among Indian social workers

Our results clearly depicted that very few (21.2%) of the professional social workers in India had heard about green social work. Climate change is the current issue of social justice; it is affecting the well-being of all. Thus, more engagement of social workers is urgently required in climate mitigation. We have also discussed in our second objective how minimal attention is being paid to state- level policy making related to dissemination of green products like SHS. Social work advocacy in the same could bring a noticeable behavioural change amongst urban communities to adopt a green lifestyle (Pattison et al., 2021). Social workers have expertise in encompassing community organization, systems thinking, interprofessional practice, and competencies in engagement, assessment, intervention, and evaluation which is essential for facilitating climate mitigation and transitioning away from fossil fuels (Mason et al., 2022). We also collected data regarding the source of information for SHS amongst the adopters. Still more surprisingly, rather shockingly, only 1.2% reported receiving the information from an NGO or some environmental organization. These findings are well in line with a systematic review conducted by Alipour et al., (2020). This suggests that neither the government nor the volunteer organizations are making the required efforts to promote this low-carbon technology. Social workers working with environmental organizations need to come together by shifting their focus to community-level interventions, which can be through capacity building through community solar initiatives (Chan et al., 2017), municipality networks, and community choice aggregation (Gunther & Bernell, 2019). Knowledge and awareness were one of the main drivers of SHS adoption in our model. To bring about the same, social workers may conduct workshops and educational programs amongst the urban communities to enhance understanding regarding the consequences of climate change, its ramifications, and the relevance of sustainable initiatives such as adopting SHS and other renewable technologies. This encompasses instructing the community on energy conservation, waste minimization, and the advantages of sustainable technologies (Hawkins, 2023).

Social workers can also play a significant role as advocates of policy change. Social workers can be vocal advocates for policy changes to lower emissions and mitigate greenhouse gas and carbon

footprints. Social workers operating locally may champion smart ecological development, enhanced emission regulations, and support for those most affected by climate change. Social workers at the state and municipal levels can concentrate on promoting ecologically friendly legislation, including national carbon reduction policies and renewable energy programs, while simultaneously educating and advocating for the distinct needs of vulnerable populations. Social workers can also work with communities, using the optimum community resources to develop climate resilience or intervention plans. They can also work with students in schools and colleges, educating them about SHS and renewable technologies to bring about a behavioural change amongst the younger generation at an early stage.

5.1.5 Designing a model for imbibing the drivers and tackling the barriers to the adoption of the solar home lighting system

To attain the objective 4, this study has proposed a model that has been designed on the basis of the identified adoption drivers and inhibitors. Figure 5.1.5 displays the framework of the proposed model, which is divided into blocking mechanism and driving mechanism. The blocking mechanism contains the adoption inhibitors and is illustrated, in the proposed model, by arrows pointing in a direction that is opposite to where the driving mechanism is pointing. The driving mechanism has adoption strategies, adoption drivers and retrofitting interventions to achieve sustainable adoption of SHS by urban households.

Figure 5.1.5. Proposed model (Source: Self compiled)

The above retrofitting interventions can help policy makers better direct their strategies by tweaking and tailoring SHS adoption practices by using strategies like constraining the unambiguous govt. policies, soliciting innovative finance mechanisms to fund SHS for households and building competence amongst the SHS manufacturers and vendors. Green social workers can ignite a people-powered revolution, empowering individuals and communities to become ambassadors of change, marking a significant stride toward sustainable and renewable energy sources. India is on an original quest to fulfill its rising electricity demand while decarbonizing its sources of production. SHSs are an essential component of the transition toolkit because they make

it possible to consume responsibly, manage energy effectively, and integrate distributed energy resources affordably.

5.2 Theoretical implications

Our research suggested that green habits/environmental concerns had the least weight among all the drivers. Thus, assuming that all SHS prosumers are earth-loving environmentalists may simply not be the case. Promoting SHSs as an environmentally friendly option is not enough to encourage its dissemination. New concepts are coming up such as Sustainability marketing and Sustainability Advertising which can affect sustainable lifestyles by offering sustainable products to consumers, one such being as solar home lighting system. Both have a positive influence on consumer's purchase intention (Sharma & Kaur, 2024). Thus, the major firms selling SHS, the marketing managers as well as the digital media experts need to work on an overall marketing strategy to reach a wider audience by stressing on the green marketing aspect of SHS, which is equally relevant as the economical and budget-friendly aspect of SHS. Research supports that green purchasing and eco-design of new technologies positively affect environmental outcomes (Eltayeb et al., 2010). Thus we need to stress on developing an environmentally conscious design of SHS and promote it as a green purchasing option among the urban communities.

Knowledge and awareness play a significant role in shaping the attitudes of individuals toward renewable energies, often influencing decisions about whether to adopt SHSs. SHS and its merits/demerits should be included in the curriculum of students at the UG/PG level to help young people understand its benefits and encourage deliberations on environmental issues. Government should provide funds to initiate research work for the development of sustainable energy and encourage students by waiving the academic fees for pursuing energy-related courses. To have an access to climate-friendly technologies, the government must assist in technology transfer between developed nations. The billing framework of an SHS is slightly tricky according to feedback from all prosumers. The electricity bills should mention all the details meticulously, and timely seminars and exhibitions should be organized by PSPCL to bring policy makers, vendors and consumers to the same platform for open discussions and innovative solutions for all dissemination problems.

5.3 Practical Implications

During our survey, many consumers reported that currently, the price value of SHSs is not being regulated by any of the state agencies in Punjab because the different vendors are quoting exorbitant rates with large variations in prices for every district, thus discouraging their transition to being prosumers. Agencies such as the Punjab Energy Development Agency (PEDA) and Punjab State Power Corporation Limited (PSPCL) need to control the pricing of SHSs to avoid any hidden costs and fix the tariff charges per kilowatt (KW). The Punjab government has provided 600 units of free power to every household per billing cycle in the state since July 1, 2022. This policy needs to be revised because these freebies are one of the reasons that consumers of Punjab are not adopting solar energy for domestic use. Tough minimum energy standards for households for example the nearby Union Territory of Chandigarh has made installing SHS mandatory for households built on land areas measuring 500 sq. yard and above. Punjab government should adopt this strategy with the addition of some innovative incentives. Technical glitches related to SHS need to be addressed immediately by manufacturers and vendors to build up the trust between consumers and SHS suppliers.

Green social workers can help recruit community members as community health workers (CHW) (Chhabra et al., 2018) to the local environmental NGO's to make the best utilization of community resources in building sustainable communities. These leaders can train community members to spread awareness regarding sustainable lifestyles and provide education regarding new technologies such as SHS and financing options, which can definitely help instill a change.

5. Conclusion and Policy recommendations

This study was conducted to examine the current panorama of SHS adoption in India, with a special emphasis on the State of Punjab, a region with high solar penetration. This research leverages the framework of the extended unified theory of acceptance and use of technology (UTAUT2) and builds a quantitative approach to identify the adoption drivers and inhibitors and thus the behavioural intentions of solar home lighting systems in the urban communities of Punjab. Based on the high significance value for our model, it is concluded that UTAUT2 constructs are

significant adoption drivers influencing the intention of urban households to use SHS technology. Specifically, these constructs, in the order of statistical significance, are effort expectancy, financial motivation, knowledge and awareness, performance expectancy, hedonic motivation, social influence, energy motivation, and environmental concern. Significant adoption inhibitors identified in our model are socio-economic barriers, technical barriers, knowledge and institutional barriers and policy and regulatory barriers. Adoption Drivers of Solar home lighting system have a positive effect ($\beta = 0.750$) on behavioural intention ($p \leq 0.001$) whereas adoption Inhibitors negatively affect behavioural intention ($\beta = -0.011$). However, this impact is statistically insignificant ($p = 0.817$). The research study's novelty lies in using age and gender as moderators and studying their impact on the relationship between adoption drivers and behavioural intention. Monthly family income and education level of household head are the control variables and have no confounding effect on the model. Age and gender significantly moderate the relationship between adoption drivers and behavioural intention. Also, to the best of our knowledge, it's the first empirical study done by a social worker to evaluate the awareness about the ecosocial approach adopted by social workers and their efforts in sensitizing communities about the same for sustainable development. It is also an attempt to check the actual knowledge about green social work in India.

Thus, this investigation on attitude and energy behaviour has guided us to understand the most effective ways to mobilize the urban households to adopt solar home lighting systems and take responsibility for sustainable energy transition. Following are the policy recommendations based on the findings of present study.

i. Leaving the traditional concepts, this study has provided a different perception to the understanding of attitude and energy behaviour of urban households. The older people and females are now at the forefront of households' energy decision-making. While climate action requires 100% of the population, empowering women would mean better climate solutions and an increased rate of SHS adoption.
ii. To spread the advantages of sustainable energy to the people, especially the youth, the government must launch certain campaigns. Universities, research institutions, and schools should incorporate energy-related courses in their curriculum so that youth can pursue higher studies in these courses. Government should provide funds to initiate research work

for the development of sustainable energy and encourage students by waiving the academic fees for pursuing energy-related courses. To have an access to climate-friendly technologies, the government must assist in technology transfer between developed nations.

iii. While it is important to encourage the non-adopters to adopt SHS, it is equally important to develop energy efficient behaviours among adopters. For example, switching off the electric appliances when not in use, judicious use of electric hot plate for preparation of food, change of washing machine temperature, installation of smart metering system, etc. Recently launched, Smart Meter Services Mobile Application by PSPCL, is a smart energy meter platform that allows consumers to monitor and analyze their energy consumption data in real-time. It also enables them to make online payments and view their energy usage history, helping them to manage their energy consumption more efficiently and reduce their bills

iv. Financial benefit, in terms of reduction in monthly electricity bills, is the most important motivating factor. However, at the same time, the high initial cost is inhibiting urban households from adopting SHS. Hence financial incentives such as a tax rebate or subsidy, could enhance the adoption rate. A subsidised financial package, with a low interest to spread the cost of SHS over a period of years, would be more attractive.

v. More trustworthy environmental advertisements, in TV and Internet, are an effective way to educate consumers with the knowledge about green products and help them make informed decisions.

vi. As advocated by one of our respondents from Ludhiana District, the display of simple messages about cost benefits of SHS adoption, on the electricity bills, can enhance awareness among non-adopters.

vii. Tough minimum energy standards for households for example the nearby Union Territory of Chandigarh has made installing SHS mandatory for households built on land areas measuring 500 sq. yard and above. Punjab government should adopt this strategy with the addition of some innovative incentives.

viii. All domestic manufacturers of India should be on the list as an "approved" manufacturing facility which means a company is certified by National Institute of Solar Energy as legitimately manufacturing solar panels within its premises and not importing modules.

This is in accordance with The Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirement for Compulsory Registration) Order, 2019 that has been in effect from April 1, 2024. The major advantage of being on the list is the eligibility to compete for the government's tenders for its flagship solar energy programs including recently announced PM Solar Rooftop Scheme. There should be a stringent quality checks on domestic manufacturers while ensuring that solar power is affordable to most Indians.

ix. Indian policymakers and governing bodies should encourage an increased investment in R & D that is focused on energy efficiency. Creating an environment conducive to innovation in clean technologies should be a priority for policymakers and the government.

x. The government should strengthen environmental laws for multinationals currently operating in Punjab to guarantee that they adopt eco-friendly practices. For example, businesses and industries utilizing the technologies that are known to cause harm to environment should be stringently penalized. Policymakers should stimulate proactive engagement in energy efficiency initiatives such as encouraging the adoption of solar rooftops, to promote India's sustainability goals.

Limitations and future scope

This research has specific shortcomings that have been recognized for future investigations to address. There are a total of 28 states and eight union territories in India. However, the primary data has been collected from the state of Punjab, including some information from secondary sources related to a nearby union territory of Chandigarh. Consequently, future research should compare this data with other states and union territories in India. Secondly, our analysis focuses primarily on the attitude of urban households towards adopting SHS. Hence, future studies comparing these findings with the attitude of rural households would provide useful insights for suitable policy formulations. Another limitation was the inclusion of on-grid SHS only. Thus, no issues related to off-grid solar systems have been addressed in the study. Considering the average lifespan of solar panels in SHS is twenty-five years, there exists significant potential for future researchers to concentrate on the management of e-waste generated by solar panels. Future researchers may investigate a structured recycling framework for e-waste to attain environmental sustainability.

As this research focuses on a comprehensive study to understand urban households' behavioural intentions, a single study cannot include all the factors that are responsible for such intentions. Since the study was conducted in the state of Punjab, we can validate this research by testing the findings for other states of India with average sunshine and high per capita income. Second, we can increase the sample size to improve the generalizability of the results. Finally, our study includes age, usage and socioeconomic status as moderators, leaving significant room for future researchers to explore the moderating effect of gender and household size on the behavioural intentions of adoption drivers, which might provide insight. Additionally, since the average industry standard for solar panels is 25 years, the next major question for future researchers could be how to manage the e-waste that would be generated from solar panels. Future researchers might want to develop an organized recycling infrastructure for e-waste (for instance, those identified by Gautam et al., (2022) and others) for further sustainable development and producer responsibility.

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