THE IMPACT FACTORS AFFECTING CONSUMER TOWARDS REPURCHASE INTENTION MODERATED BY COGNITION OF SUBSIDY POLICY AND COMMUNITY ATTACHMENT FOR RESIDENTIAL DISTRIBUTIVE PHOTOVOLTAIC SYSTEMS IN HEBEI, CHINA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AC	Awareness of consequence
AT(ATT)	Attitude
CHIC	Clean Heating Industry Committee
CO_2	Carbon dioxide
CPIA	China Photovoltaic Industry Association
EC	Environmental concerns
EFC	Energy Foundation China
ETPB	Extended theory of planned behavior
f^2	Effect Size
FITs	Feed-in tariff
GW	Gigawatt
GWh	Gigawatt-hour
HBDRC	Hebei Development and Reform Commission
HTMT	Heterotrait-Monotrait Ratio of Correlations
IBRD	International Bank Reconstruction and Development
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
IV	Independent variable
MEE	Minstry of Ecology and Environment of the People's Republic of China

MJ	MegaJoule
MV	Moderator variable
NBS(NBSC)	National bureau of statistics of China
NDRC	National Development and Reform Commission
NEA	National Energy Administration
P^2	Partial Eta Squared
PBC	Perceived behavioral control
PLS-SEM	Partial Least Squares Structural Equation Modeling
PM	Particulate matter
PMO	Perceived moral obligation
PPAP	Photovoltaics Poverty Alleviation Project
PV	Photovoltaic
Q^2	Predictive Relevance
R^2	R-squared
RDPS	Residential distributive photovoltaic systems
R&D	Research and Development
RI	Repurchase Intention
RMB	Renminbi
SCIO	The State Council Information Office of the People's Republic of China
SIC	The State Information Center

SN	Subjective norm
SP	Subsidy Policy
TPB	Theory of planned behavior
TRA	Theory of reasoned action
UN	The United Nations
VIF	Variance Inflation Factor
WHO	World Health Organization
3D	Three-Dimensional

KESAN FAKTOR-FAKTOR YANG MEMPENGARUHI PENGGUNA TERHADAP NIAT PEMBELIAN SEMULA DIMODERASI OLEH KOGNITIF DASAR SUBSIDI DAN IKATAN KOMUNITI BAGI PENGAGIHAN KEDIAMAN SISTEM FOTOVOLTAIK DI HEBEI, CHINA

ABSTRAK

Subsidi China untuk sistem fotovoltaik pengedaran kediaman (RDPS) sebelum ini menaikkan kadar pemasangan luar bandar, tetapi teknologi tenaga boleh diperbaharui utama ini menghadapi kemunduran selepas subsidi ditarik balik pada tahun 2021. Walau bagaimanapun, beberapa kajian telah meneroka faktor yang mempengaruhi hasrat penduduk luar bandar untuk membeli semula RDPS dalam era pasca subsidi. Untuk menangani jurang ini, kajian ini mengguna pakai teori lanjutan bagi tingkah laku terancang (ETPB) sebagai rangka kerja teorinya, meneliti faktor yang mempengaruhi niat pembelian semula RDPS pengguna dengan kognisi dasar subsidi dan keterikatan komuniti bertindak sebagai pembolehubah penyederhana. Tinjauan kuantitatif telah dijalankan, melibatkan 515 responden luar bandar di Wilayah Hebei. Kebimbangan alam sekitar ditetapkan sebagai pembolehubah bebas, manakala sikap pengguna, norma subjektif, kawalan tingkah laku yang dirasakan, dan kewajipan moral yang dirasakan bertindak sebagai pembolehubah pengantara. Keputusan menunjukkan bahawa kebimbangan alam sekitar dikaitkan secara signifikan dan positif dengan empat pembolehubah pengantara, yang seterusnya memberi kesan positif yang ketara ke atas niat pembelian semula RDPS penduduk luar bandar di Hebei. Selain itu, peranan penyederhanaan kognisi dasar subsidi dan keterikatan komuniti disahkan. Kajian ini mengesahkan kebolehgunaan ETPB dalam menjelaskan hasrat pembelian semula RDPS penduduk luar bandar dan

memperkayakan penyelidikan sedia ada dengan menggabungkan dua pembolehubah penyederhana.

THE IMPACT FACTORS AFFECTING CONSUMER TOWARDS REPURCHASE INTENTION MODERATED BY COGNITION OF SUBSIDY POLICY AND COMMUNITY ATTACHMENT FOR RESIDENTIAL DISTRIBUTIVE PHOTOVOLTAIC SYSTEMS IN HEBEI, CHINA

ABSTRACT

China's subsidies for residential distributive photovoltaic systems (RDPS) previously drove up rural installation rates, but this key renewable energy technology faced a setback after subsidies were withdrawn in 2021. However, few studies have explored factors influencing rural residents' intentions to repurchase RDPS in the post-subsidy era. To address this gap, this study adopts the extended theory of planned behavior (ETPB) as its theoretical framework, examining factors affecting consumers' RDPS repurchase intentions with subsidy policy cognition and community attachment serving as moderating variables. A quantitative survey was conducted, involving 515 rural respondents in Hebei Province. Environmental concern was set as the independent variable, while attitude, subjective norm, perceived behavioral control, and perceived moral obligation acted as mediating variables. Results show that environmental concern is significantly and positively associated with the four mediating variables, which in turn exert significant positive impacts on rural residents' RDPS repurchase intentions in Hebei. Additionally, the moderating roles of subsidy policy cognition and community attachment are verified. This study confirms the applicability of ETPB in explaining rural residents' RDPS repurchase intentions and enriches existing research by incorporating the two moderating variables.

CHAPTER 1

INTRODUCTION

1.1 Introduction

With improvements in solar technology and declining costs of photovoltaic (PV) products, it is possible to generate affordable electricity using PV systems while minimizing environmental impact. In addition to meeting growing energy demands, PV products can reduce pollution and carbon emissions, as well as improve the livelihoods of households in both economic and energy poverty, of which the most outstanding was the residential photovoltaic distributive systems (RDPS). With the support of favorable government policies and the commercial market, RDPS has become one of the most promising and cost-competitive technologies for sustainable power generation. As a result, RDPS is becoming increasingly popular in developing countries whose installations are continuously increasing, especially in rural areas and remote places. Taking advantage of the large-scale subsidies promoted by the Chinese government, China has become the largest producer of photovoltaic energy in the world. As an example, Hebei Province, ranked among the top in photovoltaic installations capacity, suffers from severe air pollution, power shortages, and a relatively heavy burden of poverty alleviation. The purpose of this chapter is to introduce the general outline of the research. This chapter introduces the general outline of the research. The introduction introduces the study’s background first followed by problem statement, research questions, research objectives, significance of the study, key terms and the variables investigated in the study. An overview of the remaining chapters in the thesis is given at the end of the chapter.

1.2 Background of the Research

Repurchase intention has become a critical issue in consumer behavior and sustainability research, as it reflects not only the initial adoption of a technology but also the long-term continuity of its use (Guo et al., 2022). In the case of Residential Distributed Photovoltaic Systems (RDPS), repurchase intention determines whether early adoption can evolve into stable, repeated investment that sustains both the photovoltaic market and broader environmental goals. A declining trend in repurchase intention threatens the long-term viability of RDPS, since without continuous reinvestment, users may abandon or discontinue systems, undermining the effectiveness of renewable energy initiatives.

This challenge is particularly relevant in China, where RDPS has been widely promoted as a strategic solution to two pressing issues: environmental pollution and electricity shortages. China's rapid industrialization and reliance on coal-fired energy have contributed to severe air pollution, with Hebei Province identified as one of the most pollution-intensive regions in the country. At the same time, rural areas often experience unstable electricity supply, which creates demand for distributed and renewable energy alternatives. RDPS was introduced as a way to alleviate these dual challenges by reducing emissions and supplementing electricity needs in rural households (Qin et al., 2022). However, if rural residents are reluctant to repurchase or reinvest in RDPS, the long-term contribution of the technology to reducing pollution and addressing energy shortages will be significantly weakened.

1.2.1 Current Situation of Environmental Pollution in Rural Areas of Hebei

Due to its fluidity and diffusion, air pollution exerts a greater impact on human health and economic growth than soil or river pollution (Feng et al., 2020). According to the World Health Organization (WHO), 7 million deaths occur worldwide each year as a result of air pollution, among them 4 million premature deaths due to by means of polluting fuels for cooking. WHO guidelines define average and ultimate levels of particulate matter (PM), ozone, nitrogen dioxide, and sulfur dioxide based on their health impacts (Zi et al., 2021) and with an estimated $60 million to $270 million in economic losses resulting from air pollution (Hossain, 2019). Air pollution is more common in developing countries, for example, solid fuel combustion indoors is one of the primary sources of indoor pollution in developing countries, whereas the situation has not existed in developed countries. This situation can be attributed to solid fuels such as biomass or coal are the primary source of energy for cooking and heating in many developing countries (EFC, 2022). Among these developing countries, China needs to be mentioned. Because aside from being the world's largest developing country, China is also the world's largest polluter (Wang et al., 2020).

Energy consumption in China is increasing rapidly due to its rapid economic growth, industrialization, and urbanization (Guo et al., 2022). Many environmental problems have arisen from the rapid economic growth, including energy shortages and air pollution during its urbanization and industrialization processes (Han et al., 2020). In the past 30 years, China has experienced dramatic economic growth fueled largely by fossil fuels-especially coal, which emits most of the air pollutants (Lu et al., 2020). Of the coal used in China every year, half for heating and electricity, one-third is industrial coal, and the remaining 15% is scattered coal, which is mainly used for civilian life, agricultural production, and village and township enterprise production in rural areas (EFC, 2022). In the Chinese context, rural areas are generally defined as administrative regions outside urban districts, characterized by villages and townships with agricultural as the main industry, lower population density, and relatively underdeveloped infrastructure compared to cities. (NBS, 2020)

In 2019, China's rural scattered coal consumption was about 140 million tons, accounting for more than 90% of the country's non-industrial coal (Huang, 2021). Coal is an essential energy source in China, especially for household usage, scattered coal combustion has been the primary method in rural area for heating, lighting and cooking (Zou and Luo, 2019). China as the world's largest developing country, with nearly half of its population living in rural areas. While rural energy consumption makes up only 15% of the country's total, but rural pollution, especially sulfur dioxide and nitrogen dioxide, amounts to 40% of it (Tilt, 2019). The reason was due to there is still a heavy reliance on traditional biomass energy in rural China, such as crop residues, firewood, and biogas instead of commercial energy sources (Huang et al., 2020). The production process of bulk coal lacks desulfurization and denitrification processes, and combustion will form harmful gases such as sulfur dioxide and nitrogen oxides, which will undergo chemical reactions to generate secondary PM2.5 (Wu et al., 2020). Direct combustion of scattered coal, firewood, and straw as the main energy source has become the major causes of severe air pollution. Civilian scattered coal combustion produces a large amount of indoor and outdoor air pollutants and greenhouse gases, which have adversely impact on people's living environment and health (EFC, 2022). In the end of 2020, the rural heating area in northern my country is 7 billion square meters, and the heating energy structure is dominated by scattered coal, which has a large amount of pollution emissions(CHIC, 2021).China, with the largest population in the world, is becoming increasingly concerned about regional air pollution caused primarily by PM2.5 especially in rural areas (Zhang et al., 2019; Xie et al., 2020).

Throughout China, Beijing-Tianjin-Hebei is the region with the worst haze pollution in recently years and Hebei Province is the most polluted among the region(Song et al., 2020).The hourly concentrations of 48 cities in the Beijing-Tianjin-Hebei region and it surrounding areas have reached severe pollution levels, and the hourly concentration of PM2.5 is as high as 304 micrograms per cubic meter (MEE, 2020). According to the ranking of cities with the worst air in China in August 2022 released by the Ministry of Ecology and Environmental of People's Republic of China, Hebei Province occupies 7 places in the top ten.

As mentioned before, the core area of China's domestic consumption of scattered coal is the vast rural areas. There is, however, a difference in urbanization rates between two municipalities directly under the Central Government, Beijing and Tianjin are 87.50% and 84.88% respectively and the rural populations are 2.74 million and 2.08 million respectively. The main rural population of Beijing-Tianjin-Hebei region is concentrated in Hebei, with a rural population of 28.94 million (NBS, 2022). In Hebei province, 80% of scattered coal in rural areas is burned for heating in winter and 46% of the monthly average PM2.5 concentration was attributed to rural residential coal in winter (Xie et al., 2020). The coal consumption space density in Hebei is 30 times the global average that would threaten public health and the environment (Wang et al., 2019). As a result of the extremely severe haze problem, reducing scattered coal pollution and promoting energy transition are crucial to its rural area long-term growth in order to improve air quality and public health (Chen and Chen, 2019).

Researchers proved that residential distributive photovoltaic systems (RDPS) can be used as a source of electricity in developing countries to ease pollution, especially in rural and remote areas in China (Ding et al., 2022; Song et al., 2021; Wang et al., 2020). RDPS are solar photovoltaic installations located close to the point of consumption, typically on rooftops or building-integrated structures, which generate electricity for on-site use and may feed excess power into the grid (IEA,2022). The significance of installing RDPS is demonstrated by the fact that household appliances are the primary source of CO_2 emissions, accounting for 70% of all emissions globally (Ali et al., 2019). Besides, the clean heating work in rural areas in the north, especially in Hebei, is facing complex economic problems and the dilemma of relatively lagging behind in the improvement of energy efficiency in rural buildings (NEA, 2023b). In order to strengthen the prevention and control of air pollution, change the energy consumption structure, and cut down on the consumption of scattered coal, the rural areas of Hebei must vigorously promote the clean utilization and development of renewable energy sources such as solar energy. Under the pressure of controlling air pollution, the alternative use of solar energy in rural areas of Hebei is the best choice to reduce pollution. RDPS are regarded as an important solution to the problem of scattered coal in Hebei rural areas at this stage (Chen and Chen, 2021).

1.2.2 Current Situation of Electricity Shortage in Rural Areas of Hebei

Electricity is a basic industry and the lifeblood of the national economy (Bao et al., 2023). Since 2021, China’s economy has continued to grow, residents’ consumption has recovered steadily, and the demand for electricity and gas has increased significantly. However, in some parts of the country, it has been extremely cold in winter and extremely hot in summer, electricity and coal have been scarce, rainstorms and floods have been frequent, and the tight power supply balance is difficult to resolve (NEA, 2021a). Besides, with the increasing electricity demand in the future, the regional structural imbalance between electricity supply and demand may still exist, leading to a higher probability of power outages.

The power supply in China is relatively tight again since the peak of winter in 2019. In 2021 and 2022, the power supply will be tight in the summer and winter peaks, and even severe shortages may occur in some areas. This is still a large-scale power shortage caused by inadequate power supply, and it cannot meet the growing demand for power, especially in rural area (Qin et al., 2022). According to the State Grid, approximately a third of power outages reported to power supply companies are rural areas (State Grid, 2022). In 2020, the surge in rural electricity consumption has brought a severe test to China's stable power supply. Since the beginning of winter Hebei and other places have successively issued "power curtailment" notices (Zhang et al., 2021).

Hebei Province has an increasing power shortage problem, and residential distributive photovoltaic systems are in highly demand. There are some provinces have both high level of electricity demand and renewable energy potential, Hebei is a typical example (Li et al., 2022). Data indicates that electricity usage is highest in Hebei with a 46%, followed by Yunan and Guizhou (Wang and Jiang, 2017). Moreover, the coal consumption space density in Hebei is 30 times the global average that would threaten public health and the environmental (Wang et al., 2019). However, its primary energy self-sufficiency rate has been low, the self-sufficiency rate of primary power production is only 3.78%. The supply of coal, oil and electricity and other energy resources are heavily reliant on external transfer from other provinces. Energy scarcity and potential future threats have led Hebei place solar energy at the priority.

Furthermore, the contradiction between power supply and demand in Hebei Province is especially notable, especially during peak periods of electricity consumption in summer and winter (Bao et al., 2023). During the peak periods of summer and winter electricity consumption, the power supply and demand situation of Hebei is tense, especially in rural areas. As Hebei Province further promotes the reduction of coal production capacity, the development of coal, electric power and other industries is limited, while the demand for energy is rigidly increasing, and there is an annual electricity shortage of 100 billion kWh (Ni, 2023). In 2021, the power gap in Hebei Province will reach 100.54 billion kWh (NBS, 2022). The full-caliber maximum load of the State Grid Hebei Electric Power Company will reach 41.98 million kilowatts in 2021, and the maximum peak-to-valley difference rate will reach more than 40%, and the peak-to-valley difference will continue to expand, posing a huge challenge to the grid balance adjustment and power supply guarantee (Mi, 2023). It is estimated that the peak summer load in 2023 will be 46.5 million kilowatts, a year-on-year increase of 4.7%, and there will be a power gap of 1.6 million kilowatts. During the peak period of electricity consumption in winter, the maximum load is 43 million kilowatts, a year-on-year increase of 5.35% in Hebei. In the event of extreme weather, failure of inter-network connection lines, etc., the gap may be further expanded (HBDRC, 2023).

Adding to the gloom, the primary energy self-sufficiency rate has been low in Hebei, the self-sufficiency rate of primary power production is only 3.78% (SIC, 2016). It is heavily dependent on external transfers from other provinces for the supply of coal, oil and electricity. In addition to relying on purchased electricity for a long time, Hebei is also actively striving for temporary support for purchased electricity (Wang et al., 2018). As mentioned before, power shortages are more pronounced in rural areas because of the distribution network in rural areas is weak and cannot meet peak demand. The problem is more prevalent in old urban areas, remote areas, and places where the pace of development is too fast. Because of factors such as distance, terrain, and lack of investment in infrastructure, electricity supply in rural areas is affected by limited grid connections (Han and Wu, 2018). Hebei's rural power grids still lag behind urban power grids in indicators such as capacity per household and reliability of power supply, and there is a gap between urban and rural power grid foundations and operation and maintenance levels, so there is even a lack of sustainable power. Power outages are frequent and long-lasting in rural areas due to a lack of power generation capacity (Wu et al., 2019). Insufficient power supply in rural areas of Hebei restricts the development of rural economy and society. The extreme imbalance between energy and power supply has become an important and fundamental task. Thus, the tight supply-demand balance will force the government to research alternative primary energy sources (Tang et al., 2018).

To protect the environment, reduce pollution, and ensure energy security, the energy infrastructure must undergo major transformations in Hebei rural areas. Thus, energy scarcity and potential pollution threats have led Hebei place solar energy at the priority. To alleviate the condition, the development of residential distributive photovoltaic systems can not only achieve energy conservation and emission reduction in Hebei rural areas, but also alleviate its shortage of electric energy situation.

1.2.3 The Photovoltaics Poverty Alleviation Project in Rural Areas of Hebei

China has conducted poverty alleviation and development work on a large-scale and organized basis since the mid-1980s. Since the beginning of the fight against poverty in 2015, the cause of poverty alleviation in China has been advancing rapidly and great achievements have been made (Liu et al., 2021). Poverty alleviation in China is mainly aimed at impoverished areas, which refer to rural areas of China where per capita consumption lies below the national average (Xu et al., 2019). Poverty alleviation is a major priority for the Chinese government, particularly in rural areas. Impoverished people who live in remote rural areas that are generally characterized by limited resources, frequent natural disasters, as well as overpopulation, insufficient government investment, poor infrastructure, low incomes, and a lack of basic social services (Chang et al., 2021). According to the poverty alleviation standard of the Chinese government, the annual per capita net income of rural residents is 2,300 RMB and main poverty alleviation targets are rural residents from poor areas whose adequate food and clothing problems have not been satisfactorily resolved. Nearly 800 million people in China have been lifted out of extreme poverty in the past 40 years by incomes below the International Poverty Line defined by the World Bank, contributing more than 70% of the poverty reduction worldwide (IBRD, 2022).

In China, there are approximately 66 percent of poor people still living in rural areas, and energy infrastructure is one of the greatest barriers to poverty alleviation in these areas (Wu et al., 2019). In rural areas, where energy is both scarce and unreliable, the transition to renewable energy, such as solar power, will help meet the growing energy demand, reduce carbon emissions, and improve rural residents' livelihoods (Liu et al., 2021). Photovoltaic poverty alleviation project contributes to sustainable development by providing both clean energy and power generation (Wang et al., 2020). Poverty eradication is one of the Sustainable Development Goals of the United Nations (UN, 2018), and it is a very important social, economic and political task for China to enter a new era of socialism with Chinese characteristics. The development of residential distributive photovoltaic systems in rural areas could contribute to the attainment of both the United Nations' sustainable development goals of promoting clean energy and eliminating poverty (Zhuang et al., 2021).

To alleviate poverty and promote sustainable development, access and use of clean energy are essential (Huang et al., 2021). Among poverty eradication measures, energy-related poverty measures were found to be the most effective in China (Chen et al., 2022). There are a large number of unused lands, idle homesteads and a series of low-efficiency land in the vast rural areas in China. Rural areas have vast territory, low population density, idle roofs and abundant land resources in rural areas, providing inherent convenience for the construction of distributive photovoltaic systems (Wang et al., 2022). Statistics show that the roof area of various buildings in rural China is more than 20 billion square meters, which can be installed with 2 billion kilowatts of photovoltaics, and the annual power generation capacity can be close to 3 trillion kilowatt-hours (NEA, 2023b). Hebei is one of the provinces in China with a relatively heavy task of poverty alleviation. There are 62 impoverished counties in total, including 45 nationally designated impoverished counties and 17 provincially designated impoverished counties. There are as many as 2.323 million officially registered poverty-stricken households (Pan, 2020). Thus, the development of residential distributive photovoltaic systems in Hebei rural areas can not only help reduce carbon emissions but also improve living conditions for rural families who suffer from poverty and energy shortages. To solve the above problem, Chinese government realized that the construction of a new rural energy system based on RDPS in rural China may become an effective way to alleviate environmental pollution, improve the quality of power supply, and help rural economic and social development (Zi et al., 2021).

The photovoltaic poverty alleviation project (PPAP) is one of the ten major projects of targeted poverty alleviation in China (Wu et al., 2022). According to PPAP policy documents, poverty reduction is the primary driver rather than renewable energy development and environmental protection (Liao and Fei, 2019). With the strong support of the Chinese government, the National Energy Administration and the State Council Poverty Relief Development Leading Group Office announced The Work Scheme on Carrying Out the PPAP in 2014, with the intention of conducting a statewide pilot PPAP. That is, in areas with suitable natural conditions, make full use of the idle rooftop of each rural residents, install residential distributive photovoltaic systems to generate power, and provide energy for rural production and life in an all-round way. At the same time, surplus electricity and processed or gasified biomass energy can be exported to cities, becoming a new economic source in rural areas (NEA, 2014). Researchers found that PPAP has stable income and low risk and is considered to be one of the most effective poverty alleviation industries for the poverty (Zou and Luo, 2019). This is China's first policy that combines climate change, low-carbon development and poverty alleviation, aiming to provide rural communities with a new economic income path through distributive photovoltaic power generation, while promoting low-carbon development in rural communities (Wolske et al., 2018). Specifically, families were encouraged to diversify their energy sources and improve their living standards. The object of photovoltaic poverty alleviation is the registered poor households in registered poverty-stricken villages included in the scope of

China's PPAP implementation, and priority is given to supporting deeply impoverished areas and poor people with weak labor capacity. A large-scale program has been implemented by the Chinese government to systematically deploy PPAP in rural areas. Through three primary types of projects, PPAP supports solar installations in rural areas facing high levels of poverty: village-level arrays, joint construction arrays, and residential distributive rooftop installations targeted at the poor (Zhang et al., 2020). Actively promoting PPAP in impoverished rural area is a new way to reduce poverty by organically combining new energy development and poverty alleviation goals (Liu et al., 2021). In 2016, the National Energy Administration of the country, in collaboration with the State Council Poverty Alleviation Office, issued the first batch of PPAP to promote stable and increased incomes for the poor and the expansion of the photovoltaic power generation market with a total scale of 5.16 million kilowatts, involve a total of 20,000 impoverished rural areas in 14 provinces (NEA, 2016). China launched the pilot work of photovoltaic poverty alleviation and pushed this measure of benefiting the people to 6 provinces as pilots, and Hebei Province was among the first batch of pilots in 2016. 30% of Hebei's centralized photovoltaic power plant indicators are given priority to 10 deeply impoverished counties to carry out photovoltaic poverty alleviation to promote stable income and increase income of the poor (NEA, 2017). The transition to renewable energy sources can not only meet growing energy demand but also reduce carbon emissions and improve the livelihoods of rural households who suffer from deficiency in energy and economic (Liao and Fei, 2019).

In terms of environmental governance, due to low combustion efficiency and serious pollution, Hebei Province has been valued and controlled by the state in recent years. In addition to fully implementing various national policies and measures to promote photovoltaic industry development, Hebei Province has researched and formulated supporting policies for local, giving preference to the photovoltaic industry in terms of capital, land, finance and taxation. The Hebei Provincial Development and Reform Commission and the Hebei Provincial Poverty Alleviation Office jointly issued the first batch of village-level PPAP plans in 2017. 1,412 village-level PPAP station projects will be built, with a total scale of 615,506 kilowatts, covering 2,006 registered poverty-stricken villages in 23 counties, helping 90,843 impoverished households (HBDRC, 2016). From 2018 to 2020, residential distributive photovoltaic systems in Hebei Province grew rapidly, especially from 2019 to 2020, with a growth rate of 159%, far exceeding the national level. In 2020, the National Energy Administration announced the new installed capacity of photovoltaics in China. Among all provinces, the newly installed photovoltaic capacity in Hebei is about 7.16GW, year-on-year increase of 120%, becoming the largest province in the country for newly installed photovoltaic capacity, accounting for about 15% of the country's total new installed capacity in that year (NEA, 2020a).

1.2.4 The Effect of Government Photovoltaics Subsidy Policies in Rural Areas of Hebei

The government has played an integral role in promoting renewable energy (Ndiritu and Engola, 2020). The Chinese government adopts a wide range of policies that support the development of distributive photovoltaics. These policies include those relating to electricity prices, grid connection standards, project management, and financial subsidy policies support (Li et al., 2020). The Chinese government has promulgated a series of subsidy policies to support the development of the photovoltaic industry, which can be divided into three phases. The first phase is mainly based on installation subsidies form 2009 such as “Golden Sun Demonstration Project” and ‘‘photovoltaic building’’, kicking off the domestic distributive photovoltaics market (Wang, 2020). By that China’s photovoltaic industry has grown into a strategic emerging industry in just over ten years, and subsidy policies played an important role in stimulating the growth of the industry (Zhou et al., 2020).

The subsidy policy for RDPS shows a trend of national subsidy-driven gradually moving towards grid parity and local subsidy support and enter the second phase. Subsidies for grid electricity prices are the main method for the second phase of photovoltaic subsidy, a variety of policies have been implemented by the government to promote photovoltaic (PV) technology innovation for rural areas, including feed-in tariffs (FITs), renewable portfolio standards and tax incentives (Che et al., 2022). FITs are the primary subsidy policy responsible for the surge in distributive PV installations in China. FITs have proven to be the most effective way to promote photovoltaic energy (Dong et al., 2021). It is not only possible for the rural residents to receive government subsidies and earn a profit from the electricity it produces, alternatively it can sell surplus electricity back to the grid, earning a profit and becoming self-sufficient from the state (Zhang et al., 2022). By selling excess electricity, residential distributive photovoltaic systems connected to the grid can generate significant profits for low-income, landless rural residents as well as providing rural job and education opportunities (Li, et al., 2020; Zhang, 2022). On the basis of national support policies, Hebei Province has formulated supporting policies in line with the provincial conditions, especially financial subsidy policies, and increased support for the development of the photovoltaic industry. In Hebei, the on-grid electricity price of village-level photovoltaic power stations is implemented in accordance with the latest electricity price policy of the National Development and Reform Commission, that is, the three benchmark electricity prices of 0.5 MW and below are 0.65 RMB, 0.75 RMB and 0.85 RMB respectively. If it is completed and put into operation at the end of 2018, the provincial subsidy standard is 0.2 RMB/kWh, and it will be subsidized for 3 consecutive years (HBDRC, 2018).

Distributive photovoltaics ushered in a new development pattern. The Hebei Provincial Development and Reform Commission also officially issued policies related to distributive photovoltaics on the roof of the entire county (City, District) to promote the development of residential distributive photovoltaics systems (HBDRC, 2022). Hebei has completed the plan to add more than 2.5GW of distributive photovoltaic installed capacity in 37 county-wide distributive photovoltaic pilot counties in the province, with a government investment of more than 10 billion RMB in the end of 2022 (Pan, 2022). Recently, a series of policies have been introduced to promote the development of residential distributive photovoltaics, there has been a significantly increase in the installed capacity of household photovoltaics. In 2022, the new household installed capacity was 5.06GW, accounting for 20% of the country's new household photovoltaics installed capacity. Hebei has ranked second in the national residential distributive installed capacity for three consecutive years and is the main force of household installed capacity (NEA, 2023a).

As a result of energy shortages and climate change concerns, there is a global shift towards renewable energy sources. Renewable energy sources are becoming increasingly popular as technology advances and cost efficiency drives consumer preferences (Das et al., 2021). The photovoltaic industry has developed at an unprecedented pace in the world over the past few years. Due to the high subsidy system, China’s photovoltaic industry has also grown rapidly, forming a comprehensive photovoltaic industry chain with international competitiveness, which is helping to shape the energy structure. Solar power generation, including residential distributive photovoltaic systems (RDPS), increased by 20.7 % compared to 2020, accounting for over 4.3 % of total power generation (IEA, 2021). The development of RDPS as a vital component of the photovoltaic sector is extremely important in improving the energy structure, accounting for a record high of 39% of new installed capacity through the year. It has become driving the revolution in consumption and production of energy and has played a pivotal role in advancing the realization of the Sustainable Development Goals (Chen et al., 2021).It has played an important role in promoting energy transformation through rapid development of photovoltaic power generation especially for rural areas (Wang et al., 2020). Existing literature reveal that the subsidy from government exerts a substantial beneficial influence on the sustainable development of PV industry, especially in rural area (Ding et al., 2018; Dong et al., 2021; Liu et al., 2021; Wang et al., 2021; Zhang et al., 2021). According to the China Photovoltaic Industry Association, the subsidy cumulative installed capacity of RDPS installations surpassed 10 GW by the end of 2021, reaching 21.6 GW. In 2021, the number of new subsidies installed RDPS reached 873,000 and the subsidy cumulative number of installed households has exceeded 2.4 million, reaching 2.432 million (CPIA, 2021). Development of RDPS in the photovoltaic sector is critical to boosting the realization of the Sustainable Development Goals, improving the energy structure, and driving the revolution in energy consumption and production (Chen et al., 2021).

1.2.4 (a) Increase in Government Financial Pressure of Photovoltaic Power Generation Projects

However, due to the astounding growth of RDPS capacity, China is being pressured for financial assistance. By the end of 2019, 26.36 million kilowatts of photovoltaic poverty alleviation power stations had been built, benefiting 4.15 million households and generating about 18 billion RMB in annual power generation revenue, exceeding the previously set target of helping 2 million poor households. By this time, China has completed its photovoltaic poverty alleviation construction task in accordance with its national plan (NEA, 2020b). Subsidies gap accumulated with the increasing number of newly constructed PV power generation units. The Renewable Energy Development Fund is currently the only source of photovoltaic feed-in tariff (FITs) subsidy funds, which are obtained from the renewable energy surcharges levied in the electricity prices of power users. An annual subsidy demand of more than 150 billion RMB was calculated for the seven batches of renewable energy projects (Liu et al., 2021). However, the annual renewable energy surcharge can only collect 75% to 80% of the receivable amount, totaling about 57 billion RMB in 2020 (Ministry of Finance of the People's Republic of China, 2020). The fund would also subsidize all renewable energy, including solar, wind, biomass and other renewable energy sources. Therefore, even if half of the annual levy is allocated to the solar energy industry, subsidies for all photovoltaic projects cannot be met.

Moreover, as photovoltaic power generation projects continue to increase, the gap in subsidy funds will only expand every year. From 2017 to 2019, the subsidy gap reached 150 billion RMB, 233.1 billion RMB, and more than 300 billion RMB respectively. By 2020, a subsidy gap exceeding 200 billion RMB was reported, which will result in the withdrawal of subsidies in the future (Zhang et al., 2021).

Accumulative arrears of 400 billion RMB are anticipated by the end of 2021 for renewable energy power generation subsidies, and the gap in electricity price subsidies is expected to reach its peak in 2028 (Peng, 2022). As the fiscal subsidy gap widens, the government faces more financial pressure. The National Energy Administration issued "Notice of the National Development and Reform Commission and the National Energy Administration on Actively Promoting the Unsubsidized and Parity Work of Wind Power and Photovoltaic Power Generation". There are a total of 16 provinces participated in the construction of subsidized photovoltaic demonstration projects and withdrawn from national subsidy grid parity, including Hebei Province (NDRC, 2019).

1.2.4 (b) The Effects of Photovoltaics Subsidy Policies Withdrawal in Rural Areas of Hebei

Moreover, the National Development and Reform Commission recently issued a notice to clarify the 2021 new energy on-grid tariff policy. According to the new policy, the central government will no longer provide subsidies for newly built photovoltaic power generation and other power generation projects, and the grid parity will be implemented. In the 2021 photovoltaic subsidy policy, although central subsidies for centralized photovoltaic power plants and industrial and commercial distributive photovoltaics have been cancelled, subsidies for new household photovoltaics will still be retained at a subsidy standard of 0.03 RMB/kWh until the subsidy is withdrawn in 2022 (NDRC, 2021). Photovoltaic power generation has begun a new phase of development without subsidies and no longer enjoys central financial subsidies. After the central subsidy was withdrawal, the local government subsidy policy also withdrawal one after another. Over 300 cities and rural areas across the country have adopted new policies that gradually phase out photovoltaic subsidies which included rural areas in Hebei Province. It has affected hundreds of millions of people, the entire photovoltaic industry, and several photovoltaic power generation projects across the country. This means that photovoltaic users need to pay more than the average consumer to support green electricity and meet their energy needs. Consumers' appetites for residential distributive photovoltaic systems (RDPS) may diminished by the cancellation of the subsidy policy. As the Figure1.1 and Figure 1.2 shows, the installation of distributive photovoltaic systems was more sensitive to the declines in subsidies. The subsidy reduction for RDPS in 2018 resulted in a significant decline which fell by 41.8% in the new PV capacity installed. In terms of the distributive market, household photovoltaic construction will continue to support the distributive photovoltaic power generation market. Despite the reduction of subsidies, the total installed capacity will still show an upward trend in 2021 and reached a peak in 2024. However, from the Figure1.2 when the total residential distributive photovoltaic systems installed capacity in the country is rising rapidly, Hebei Province, as one of the major photovoltaic provinces, is showing a downward trend .

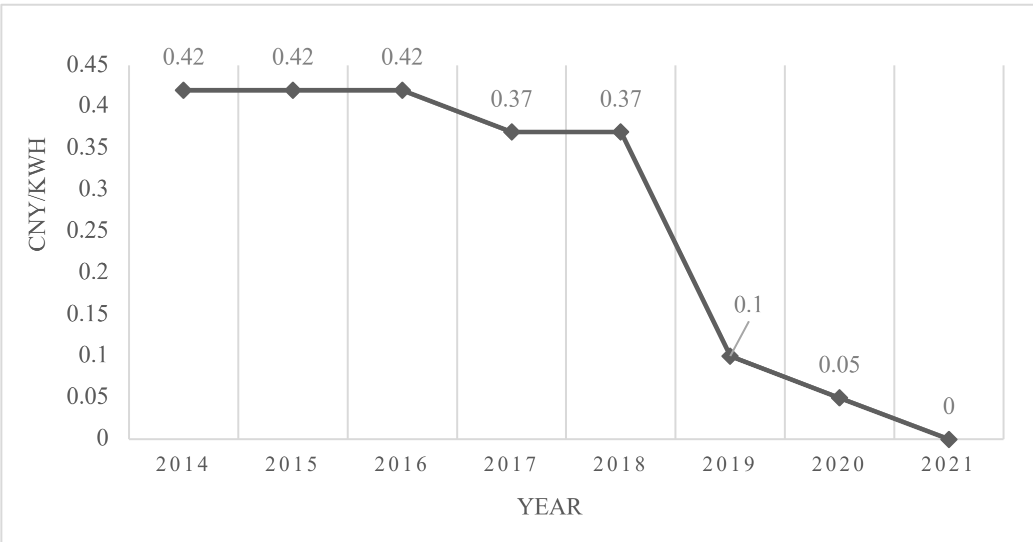

Figure 1.1 Photovoltaic subsidy amount for RDPS from 2014 to 2021 (NDRC, 2022)

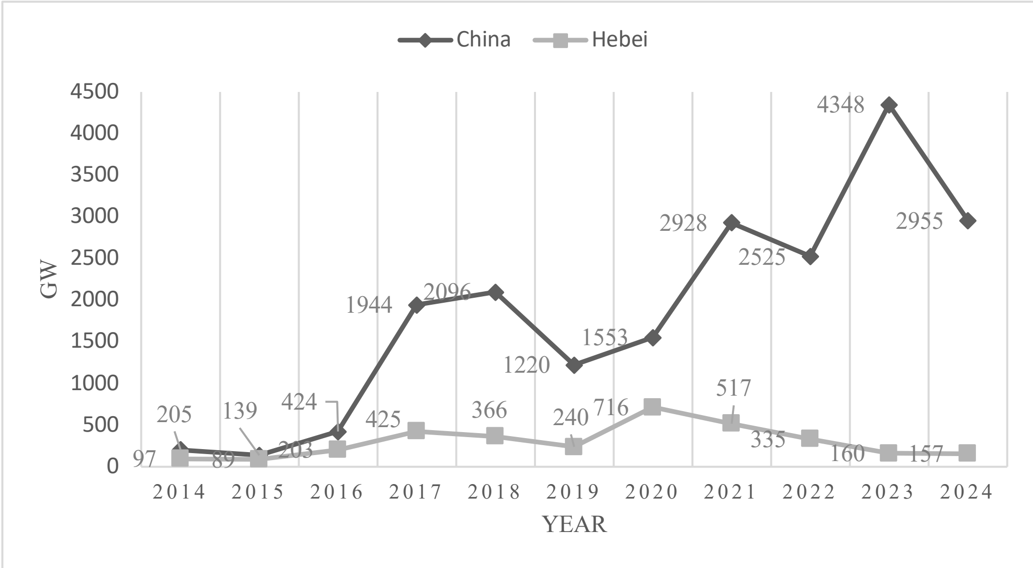

Figure 1.2 Newly installed RDPS capacity from 2014 to 2024 (NEA, 2025)

Recent national installation data illustrate this shift in stark terms in Hebei. In 2023, it further decreased to 160,showing a decline of about 52.2%. This was not an isolated year: the decline also deepened in 2022 and 2024, with newly RDPS installations falling by 35.2% and 1.9%, respectively. This dramatic shift signals that fewer existing users are opting to repurchase in RDPS, whether through capacity expansion, component upgrades, or parallel installations.

1.2.5 A Decrease Trend of Repurchase Intention of Residential Distributive Photovoltaic Systems in Hebei Rural Area

Chinese policymakers have enacted subsidy policies encouraging rural residents to install and use residential distributive photovoltaic systems to promote renewable energy. As mentioned earlier in the background section, subsidy policies from the government play a crucial role in supporting the development of residential distributive photovoltaic systems (RDPS) (Das et al., 2021). Renewable energy development relied heavily on government subsidies in the early stages (Pan, 2022). In recent years, household distributive photovoltaics have developed rapidly under the subsidy policies in China. By 2020, a subsidy gap exceeding 200 billion RMB was reported, which will result in the withdrawal of subsidies in the future (Zhang et al., 2021). Therefore, a major issue has arisen with the withdrawal of subsidies: As the rural residents have enjoyed subsidies over the years whether they will be willing to repurchase residential distributive photovoltaic systems when cost increases in Hebei.

Among all provinces, the newly installed photovoltaic capacity in Hebei is about 7.16GW, year-on-year increase of 120%, becoming the largest province in the country for newly installed photovoltaic capacity, accounting for about 15% of the country's total new installed capacity in that year (NEA, 2020a). However, the newly installed residential distributive photovoltaic capacity has decreased by 5.06GW in 2022(NEA, 2023a) compared to 5.17GW in 2021 (NEA, 2022) and 7.16GW in 2020 (NEA, 2020a). Surprisingly, according to data from the National Energy Administration, the number of newly residential distributive photovoltaics in the first three quarters of 2023 dropped sharply to 1.7GW (NEA, 2023c).

In recent years, multiple data sources have revealed a marked decline in the repurchase rate of RDPS in China, with Hebei Province being a notable example (NEA, 2025). Historically, Hebei's rural PV adoption was driven by favorable subsidies, strong governmental promotion, and community-based poverty alleviation projects. These measures resulted in rapid uptake between 2016 and 2021, during which the province consistently ranked among the top in RDPS installations (Lau et al., 2021). However, the momentum has slowed considerably since the withdrawal or reduction of key financial incentives. The post-subsidy market environment has proven less attractive for existing PV owners contemplating system expansion, upgrade, or replacement.

Besides, government also urgently needs to further promote the construction of clean energy such as RDPS to revitalize the countryside, reduce the impact of environmental pollution, and achieve the 2030 carbon neutrality goal as soon as possible. In terms of environmental pollution and power gap, Hebei is one of the worst provinces in the country. In order to continuously improve the installation rate and penetration rate of rural residential distributive photovoltaic systems, it is important to identify the factors that affect repurchase intentions in rural areas of Hebei and reflect these factors in the marketing strategies of photovoltaic companies and the formulation of local policies.

1.3 Problem Statement

The declining trend of repurchase intention toward Residential Distributed Photovoltaic Systems (RDPS) among rural residents in Hebei has become increasingly significant as mentioned above. This sharp decline is concerning, as it not only threatens the sustainability of the RDPS market but also undermines China's broader environmental goals, given the nation's strong emphasis on renewable energy development and ecological protection. Due to these reasons above, more empirical evidence is needed to provide a comprehensive understanding of determinants that could influence rural resident's repurchase intention of RDPS in Hebei. However, few previous research on RDPS has focused on rural area in Hebei which existed a population gap. To have a better understand about the RDPS, there are numerous studied investigated factors influencing residents' purchase intention for RDPS in Malaysia (Ahmad et al., 2017), Poland (Angowski et al., 2021), Singapore (Zhang et al., 2022), Uganda (Aarakit et al., 2021), Bangladesh (Masukujjaman et al., 2021) and Italy (Prete et al., 2017). Ahmad et al. (2017) using Theory acceptance model analyses the public's acceptance towards solar PV adoption in Malaysia and find that PV technology behavior intention is most strongly influenced by the attitude. Zhang et al. (2022) applied agent-based diffusion model to investigate the RDPS in Singapore. These views propose different theoretical framework for investigating the purchase intention on RDPS drawn from different theories instead of ETPB theory. Besides, consider about the geographical factors, these studies are target on different area. But only a few studies focus on China.

In term of the ETPB model in this study by Chen and Tung (2014), the results of this empirical study suggest that the ETPB model has a good explanatory power in predicting the pro-environment intention with environmental concern and perceived moral obligation. The study aims to understand the determinants affect consumer's repurchase intention of residential distributive photovoltaic system (RDPS). From a behavioral perspective, the decline in repurchase rate can be interpreted through the lens of the ETPB, which posits that consumer's purchase intention toward the renewable energy applications such as repurchase intention can be triggered by an individual's attitude (attitude toward purchasing residential distributive photovoltaic systems), perceived social pressure to engage or not (subject norm), perceived ability to engage or not under the control of an individual (perceived behavioral control), perceived obligation to act in a morally right way (perceived moral obligation) and individual's awareness of environmental problems coupled with willingness to act