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Ruxin Wu
Central South University
Mu Huang
Central South University
Wei Shi
1395523841@qq.com

Central South University

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Research on the Impact of Energy-saving Policy Tools on Energy Conservation Behavior of Public Staffs: Evidence Based on Questionnaire Survey and Survey Experiment

Ruxin Wu, Mu Huang and Wei Shi[1](corresponding author)

School of Public Administration, Central South University, Changsha 410075, China

Abstract: Exploring the impact mechanism of energy-saving policies tools on the energy conservation behavior of public sector employees in the context of dual-carbon, and assisting in the low-carbon transformation and development of society. This paper takes public sector employees as the research object, and through questionnaire survey and survey experiment 2 sub-studies to explore in-depth the role mechanism of energy-saving policy tools for public sector employees' energy conservation behaviors and the differences in the impact of various types of energy-saving policy tools. The survey study, grounded in the Stimulus-Organism-Response Theory and the Extended Theory of Planned Behavior, selects 414 public sector employees as survey subjects to validate the psychological model of energy conservation behavior triggered by energy-saving policy tools. The survey experimental study is a 4×2 between-subjects experiment (N=270) for energy-saving policy tool types (four levels) and leadership energy conservation behavior (two levels), exploring the differing impacts of energy-saving policy tools on public sector employees' energy conservation behavior choices. Empirical research findings:(1) Energy-saving policy tools aimed at organizations and individuals both directly influence public sector employees' energy conservation behavior. (2) Social norm and energy conservation willingness significantly mediate the impact of energy-saving policy tools on public sector employees' energy conservation behavior. (3) command-and-control energy-saving policy tools have the greatest impact on public sector employees' energy conservation behavior, followed by economic incentive, informational, and volunteering energy-saving policy tools.

Key words: energy-saving policy tools; energy conservation behavior; public sector; social norm; personal norm

Introduction

The report of the 20th National Congress of the Communist Party of China points out that it is necessary to accelerate the green transformation of the development mode, implement a comprehensive conservation strategy, and promote the formation of green and low-carbon production and lifestyle. Individuals, families and organizations are the main consumers of energy,

[1] E-mail: 1395523841@qq.com

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Ethical review and approval were waived for this study. Central South University has Institutional Review Boards for biomedical research, but there is no dedicated ethics committee for low-risk social science questionnaire studies. This study is a minimal-risk social science questionnaire and survey experiment. All participants were fully informed of the research purpose before participation, and informed consent was obtained. All data collected were anonymized without any personally identifiable information. The research was performed in accordance with the ethical principles of the Declaration of Helsinki.

Consent to participate: Informed consent was obtained from all participants prior to taking part in the survey.

Human Ethics and Consent to Participate declarations: not applicable

among which the energy consumption of organizations is almost twice that of families(Nilsson, Afndersson, &Bergstad, 2015). As one of the main consumers of organizational energy, the public sector's building energy consumption accounts for over 4.26% of the total energy consumption of the whole society, and its carbon emissions rank fourth. It is an important front for energy conservation and carbon reduction in China(Zhao&Zhang, 2021). Meanwhile, the public sector, as an important promoter and manager of energy conservation and emission reduction, plays a leading and exemplary role in energy conservation activities throughout society(Zou, Zhu, &Zhang, 2024). The central government attaches great importance to energy conservation and carbon reduction in the public sector and has introduced a number of systems. The Energy Conservation Law revised in 2007 first proposed "energy conservation in public institutions". In 2021, multiple departments issued the "Implementation Plan for Deepening the Green and Low-Carbon Leading Action of Public Institutions to Promote Carbon Peaking", clearly setting out the annual energy consumption and carbon emission total requirements for public institutions across the country by 2025, and proposing plans for creating and selecting green and low-carbon demonstration units.

However, at present, there are problems such as unclear rights and responsibilities in energy conservation work in the public sector(Suo&Ding, 2023), and green and low-carbon development has fallen into an awkward situation where it is "important in talk, secondary in implementation, and unnecessary in action"(Zhao&Zhang, 2021). Therefore, guiding the public sector and individuals to participate in energy conservation and environmental protection work and promoting energy conservation behaviors among employees is of great significance for achieving the low-carbon and energy-saving goals of the public sector and accelerating China's green transformation(Xu, 2022).

In terms of energy conservation policy and behavior research, existing studies have shown that different energy-saving policy tools have different impacts on energy conservation behaviors and effects(Mi&Yang, 2017), but the internal mechanisms have not been fully explored. At present, only a few studies have focused on the influencing factors of energy conservation willingness and behaviors of public sector employees such as civil servants in government departments(Zhang&Wang, 2012; Zhang, Zhang, &liu, 2017), librarians(He&Cui, 2021), personnel in public institutions in the Pearl River Delta region(Yang, Du, Zhang, et al., 2021), and university employees in Germany(Heib, Hildebrand, &Kortsch, 2023). Current studies mostly focus on energy conservation behaviors of families and private groups. For example, in the field of household energy conservation, sociodemographic factors such as income and education(Frederiks, Stenner, &Hobman, 2015), as well as psychological perception factors such as subjective norms and energy-saving attitudes(Ding, Wang, Liu, et al., 2017), can influence energy conservation behaviors. Intervention measures such as persuasion(Rainisio, Boffi, Pola, et al., 2022) and motivation(Wang, Lin, &Li, 2018) also have an impact on family energy conservation behaviors. In the workplace, energy is regarded as a public good(Chu, 2023), and the conclusions of resident behavior studies have limited reference for employee behavior(Al-Shemmeri&Naylor, 2017). The researchers expanded their research field to the workplace and explored the influence of various factors such as personal norm(Nascimento, Jose, Ricardo, et al., 2019) and the energy-saving atmosphere of the organization(Staddon, Cycil, Goulden, et al., 2016) on employees' energy conservation behaviors.

A review of the current research status in the academic circle reveals that there are

deficiencies in the existing studies: on the one hand, there is a lack of empirical research that explores the relationship between policy tools and energy conservation behaviors from a process perspective; On the other hand, micro research mainly focuses on households and the private sector, and there is a relative lack of macro policy research on energy conservation behaviors of public sector employees from a public perspective. At present, research on energy conservation behaviors of enterprise employees is still in its infancy, and insights into energy conservation behaviors of public sector employees are even more scarce. The research on energy-saving policy tools and energy conservation behaviors of public sector employees is generally in a fragmented initial stage. The influence mechanisms of both and the effects of different types of energy-saving policies also need further exploration.

In conclusion, this study will start from the research perspective of behavioral public management and explore the impact of energy-saving policy tools on the energy conservation behaviors of public sector employees and the differences in the impacts of different energy-saving policy tools through two studies. Study1 uses the questionnaire survey method to explore the influence mechanism of energy-saving policy tools on the energy conservation behaviors of public sector employees and identify the transmission path of their psychological effects. Study2 employs the survey experiment method to analyze the differences in the impact of various energy-saving policy tools on the energy conservation behaviors of public sector employees.

Study 1: A Questionnaire Survey Study on the Impact of Energy-saving Policy Tools on Energy Conservation Behaviors of public sector employees

1 Theory

This research is based on the *Stimulus-Organism-Response Theory*. Among them, the stimulus (S) is the external factor in the surrounding environment that prompts a person to carry out behavior. The organism (O) is the processing process of the internal psychological changes of an individual in the process of transforming the stimulus into the final behavioral response. The response (R) is the final response of the stimulus object to approaching or avoiding behavior. Therefore, the *Stimulus-Organism-Response Theory* describes the complete process of the occurrence of a certain behavior. The extended planned behavior theory model assumes that behavioral intentions are influenced by attitudes, subjective norms, perceived behavioral control, personal moral norms, and descriptive norms. Due to the flexibility and openness of this theory, new influencing variables can be added to enhance the explanatory power of the overall theoretical model framework.

Among them, the energy-saving policy tools in this study are at the *stimulus* level, exerting external influences on individuals. At the *organism* level, some variables and action paths in the extended theory of planned behavior are borrowed, including three mediating variables: Social norm, personal norm, and energy conservation willingness. The *response* level is energy

conservation behavior. The variable combinations in each layer of *Stimulus-Organism-Response* form a cross-layer multi-chain mediation model to reveal the influence mechanism of energy-saving policy tools on the energy conservation behaviors of public sector employees. The energy-saving policy tools serving as independent variables in this study can be classified into two categories: energy-saving policy tools for organizations and energy-saving policy tools for individuals. For instance, the requirement in policy texts that *public sectors set annual, quarterly or monthly energy-saving targets* falls under energy-saving policy tools for organizations. The requirement in the policy text that *public sector employees should turn off electrical devices when not in use* falls under the category of energy-saving policy tools targeted at individuals. energy conservation behaviors, as the dependent variable of this study, refer to various actions taken by public sector employees in the public sector that are conducive to energy conservation and usage. Among them, the public sector includes government agencies, various types of public organizations, etc. The energy-saving policies and regulations issued by the government, as well as the energy conservation behaviors and views of the surrounding people on energy conservation, will form social norm. The personal qualities of public sector employees form personal norm. Energy conservation willingness is the most direct psychological driving force that leads individuals to implement energy conservation behaviors. These three psychological factors, as mediating variables, play a chain mediating role between energy-saving policy tools and employees' energy conservation behaviors.

2 Hypothesis

2.1 Energy-saving Policy Tools and Energy Conservation Behavior

In the private sector, energy-saving policy tools have a significant positive impact on the energy conservation behavior of rural residents(Scherbaum, Popovich, &Finlinson, 2008). In the public sector, various types of energy-saving policies will also prompt rural residents to exhibit energy conservation behaviors consistent with those in the private sector(Zhao, Zhao, &Song, 2022). Moreover, librarians, as public sector employees, will also receive positive regulatory effects from the policy environment and thus exhibit more proactive energy conservation behaviors(Rainisio, Boffi, Pola, et al., 2022). However, due to the differences in the target groups affected by the formulated energy-saving policies(Ma, Ma, &Yan, 2023), and the differences in energy conservation and emission reduction policies implemented for household micro-individuals and industry enterprises(Zeng, Wang, &Huang, 2020), this study classifies the energy-saving policy tools that directly or indirectly affect the energy conservation behaviors of public sector employees and proposes the following research hypotheses:

H1a: Energy-saving policy tools for the organization positively influence energy conservation behavior.

H1b: Energy-saving policy tools targeting individuals positively influence energy conservation behaviors.

2.2 Perceived Social Norm as a Mediator

Social norm refer to the rules and standards perceived by members of a group or organization(Wu, Huang, &Lang, 2023). Environmental policies influence farmers' willingness to classify domestic waste through the mediating variable social norm(Guo, Li, Li, et al., 2019). The public can

comply with policies and practice environmental protection behaviors, and social norm play a significant promoting role(Shi&Zhang, 2022; Bian&Duan, 2023). Social norm are effective predictors for promoting energy conservation behaviors among residents, consumers and company employees(Teng, Zhang, &Liu, 2020; Teng, Fan, Deng, etal., 2021; Yu&Xiao, 2021). Most public sector employees may be concerned that not implementing this behavior will affect others' perception of them or not meet the requirements of the organization. As a result, they will also engage in green behaviors such as energy conservation and electricity saving that are consistent with the behaviors or regulations of others. Based on the above analysis, the following hypotheses are proposed:

H2a: Perceived social norm play a mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H2b: Perceived social norm play a mediating role between energy-saving policy tools for individuals and energy conservation behaviors.

2.3 Personal Norm as a Mediator

Personal norm refer to the acceptance and absorption of social norm by individuals as their behavioral guidelines, which belong to internalized social norm(Teng, Bian&Duan, 2023). When individuals perceive the legitimacy of policies, different manifestations of individual social norm will arise. In view of this, Cialdini and Trost classify social norm into two categories: descriptive social norm and command-based social norm. Descriptive social norm refer to normative motives in specific situations and will generate a sense of obligation to implement certain specific behaviors(Cialdini&Trost, 1998). An individual's sense of responsibility for environmental issues will stimulate personal norm, and then lead to pro-environmental behaviors(He, Huang, Chen, et al., 2022). Personal norm are a key factor influencing the garbage classification behavior of urban residents(Liu, Peng, &Fang, 2023) and also a mediating factor that prompts dormitory students to develop energy conservation behaviors under internal and external stimuli(Zhang, Nketiah, Shi, et al., 2023). Therefore, public sector employees may also be influenced by policies in their work, transforming the energy-saving work requirements stipulated by policies into internalized personal obligations, and thus spontaneously generating energy conservation behaviors. This study proposes the following hypotheses:

H3a: Personal norm play a mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H3b: Personal norm play a mediating role between energy-saving policy tools targeted at individuals and energy conservation behaviors.

2.4 Energy Conservation Willingness as a Mediator

If energy-saving policies can encourage public sector employees to practice energy conservation behaviors, energy conservation willingness should play a prominent role in this. According to the perspective of organizational behavior, the effective completion of any target behavior stems from an individual's behavioral willingness (the degree of effort they are willing to make). It is precisely for this reason that theories such as *attitudinal behavior theory*, *planned behavior theory*, and *rational behavior theory* all regard an individual's behavioral willingness as the anemone for their implementation of behavior. Mi Lingyun's research points out that when an individual's energy conservation willingness is stimulated, it will promote the generation of energy conservation

behaviors(Guo, Li, Li, et al., 2019), and the same is true for librarians working in libraries(Al-Shemmeri&Naylor, 2017). If public sector employees are to actively practice energy conservation behaviors, they may need to have a strong energy conservation willingness. This study proposes the following hypotheses:

H4a: Energy conservation willingness plays a mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H4b: Energy conservation willingness plays a mediating role between energy-saving policy tools targeted at individuals and energy conservation behaviors.

2.5 Chain Mediators

As a member of society, individuals have close connections with others, events and things around them. Studies have shown that personal norm play a mediating role in the influence of social norm on individuals' pro-environmental behaviors(Ma&Liu, 2023). Besides having a direct impact on energy conservation willingness, social norm also exert indirect influences through personal norm(Chu, 2023). personal norm and energy conservation willingness have a chain mediating effect on energy conservation behaviors(Li, Jiang, &Cai, 2022). Furthermore, descriptive social norm and imperative social norm, as stimuli to individuals, can significantly influence personal norm and indirectly drive individuals' willingness and behavior to save energy(Ru, Chen, Wang, et al., 2022). From this, it can be inferred that social norm, personal norm, and energy conservation willingness constitute a chain mediator in which energy conservation policies affect energy conservation behavior. After the implementation of energy-saving policies, individuals, influenced by descriptive social norm, may adopt behaviors consistent with those of the majority due to herd mentality. The long-term repetition of such behaviors is the process in which descriptive social norm are partially transformed into personal norm. When individual behavior is long constrained by imperative social norm dominated by social sanctions, it will also prompt some of these imperative social norm to be internalized as personal norm. Furthermore, when the personal norm of public sector employees are inconsistent with social norm, if they have long been influenced by the social norm that require them to practice energy conservation behaviors as stipulated by energy-saving policies, their original views on energy conservation behaviors may also change as a result. For instance, they may either believe that energy conservation behaviors should not be implemented or have few thoughts and awareness about implementing them. Some have transformed into believing that energy conservation behaviors should be taken. As a result, the personal norm of public sector employees have been enhanced, and their willingness to take energy-saving actions and the possibility of doing so will increase accordingly. Based on the above analysis, the three mediating variables may combine to form a chain mediator that exerts an influence. Therefore, the following hypothesis is proposed:

H5a: Perceived social norm and personal norm play a chain mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H5b: Perceived social norm and personal norm play a chain mediating role between energy-saving policy tools for individuals and energy conservation behaviors.

H6a: Perceived social norm and energy conservation willingness play a chain mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H6b: Perceived social norm and energy conservation willingness play a chain mediating role between energy-saving policy tools for individuals and energy conservation behaviors.

H7a: Personal norm and energy conservation willingness play a chain mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H7b: Personal norm and energy conservation willingness play a chain mediating role between energy-saving policy tools targeted at individuals and energy conservation behaviors.

H8a: Perceived social norm, personal norm, and energy conservation willingness play a chain mediating role between energy-saving policy tools for organizations and energy conservation behaviors.

H8b: Perceived social norm, personal norm, and energy conservation willingness play a chain mediating role between energy-saving policy tools for individuals and energy conservation behaviors.

Based on theoretical derivation and research hypotheses, the theoretical model diagram of this study is shown in Figure 1:

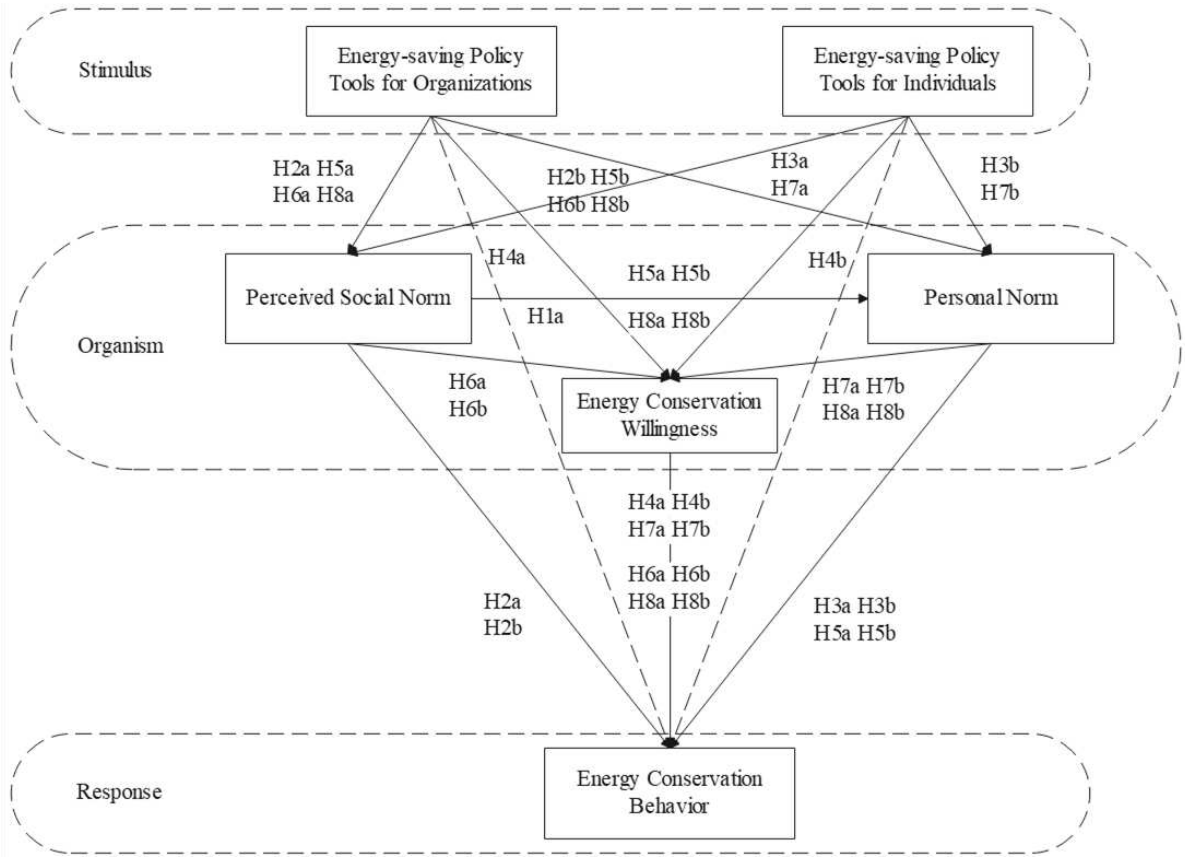


Figure 1. Research Hypothesis Model

3 Method

3.1 Sample

A total of 471 questionnaires were collected in the formal survey, among which 414 were valid, with an effective rate of 87.9%. The formal questionnaire of this study consists of 53 items (including questions measuring control variables such as social procedural and demographic variables), and the sample size meets the requirement of 5 to 10 times that of the questionnaire items.

3.2 Measure

The formal measurement tools of this study include 6 research variables and 26 items, and each item adopted the Likert 5-point scoring method. However, since energy conservation behaviors have certain moral tendencies, previous studies have shown that when investigating moral and ethical behaviors, the respondents may be more inclined to give more popular responses to meet social expectations. Therefore, in order to avoid data bias affecting the validity and reliability of the research, social desirability was also included as a control variable in the questionnaire for this study(Zhang, Jin, &Lou, 2016). The Anticipatory Response Scale (RD-16) was used to measure the social desirability effect of the respondents. The higher the comprehensive score, the more socially approved their responses were. Table 1 presents the descriptive statistics.

Table 1. Variables Measuring Items and References

Variable	Number of items	Reference	Cronbach' α
Energy-saving Policy Tools for Organizations	7	Wu et al., the author's own compilation	0.940
Energy-saving Policy Tools for Individuals	4	Wu et al., the author's own compilation	0.812
Perceived Social Norm	5	Guo et al., the author's own compilation	0.940
Personal Norm	3	Shi and Zhang, the author's own compilation	0.897
Energy Conservation Willingness	4	He and Cui, the author's own compilation	0.904
Energy Conservation Behavior	3	He and Cui, the author's own compilation	0.833

4 Results

4.1 Validity Analysis and Common Method Bias Test

After packaging each research variable(Xuan et al., 2023), confirmatory factor analysis was conducted using AMOS27.0. The results of confirmatory factor analysis are shown in Table 2. As can be seen from this table, the fitting index of the six-factor model not only meets the statistical standard but also has the best fitting effect among all factor models, indicating that the discriminant validity among the variables in this study is good.

Table 2. Comparison of Measurement Models

Model	X^2/df	RMSEA	GFI	AGFI	NFI	RFI	IFI	TLI	CFI
Baseline model: Six-factor model	2.977	0.069	0.949	0.906	0.967	0.948	0.978	0.965	0.978
Five-factor model	8.306	0.133	0.853	0.757	0.899	0.856	0.91	0.871	0.909
Four-factor model	12.195	0.165	0.767	0.641	0.84	0.789	0.851	0.803	0.851
Three-factor model	14.899	0.183	0.711	0.576	0.795	0.742	0.806	0.755	0.805
Two-factor model	17.482	0.2	0.681	0.546	0.751	0.697	0.762	0.709	0.762
Single-factor model	23.303	0.232	0.611	0.455	0.663	0.596	0.673	0.607	0.672
Single-factor	2.363	0.057	0.960	0.926	0.974	0.959	0.895	0.976	0.985

model+Method factor								

Notes: ①Six-factor model: OP, IP, SN, PN, ECW, ECB; Five-factor model: OP, IP, SN+PN, ECW, ECB; Four-factor model: OP+IP, SN+PN, ECW, ECB; Three-factor model: OP+IP, SN+PN, ECW+ECB; Two-factor model: OP+IP,SN+PN+ECW+ECB; Single-factor model: OP+IP+SN+PN+ECW+ECB; ②OP: Energy-saving Policy Tools for Organizations; IP: Energy-saving Policy Tools for Individuals; SN: Perceived Social Norm; PN: Personal Norm; ECW: Energy Conservation Willingness; ECB: Energy Conservation Behavior; ③Single-factor model+Method factor: Based on the single-factor model, all items are used as indicators of the method factors.

Exploratory factor analysis was conducted using the Harman one-way test. The unrotated one-way variance interpretation rate was 46.858%, which was lower than the 50% standard. Meanwhile, the fitting index of the single-factor model performed poorly. Referring to the suggestions of Tang and Wen, the unmeasured potential method factors were controlled. Method factors were incorporated into the original single-factor model(Lauper, Moser, Fischer, et al., 2016), and all items were taken as the indicators of the method factors. After establishing a two-factor model for re-examination, it still failed to meet the standard (the increase in CFI and TLI exceeded 0.1). The reduction in RMSEA exceeded 0.05. It can be seen that there is no serious problem of common method bias in this study.

4.2 Descriptive Statistics and Correlation Analysis

Descriptive statistics and correlation analysis were conducted on the research variables, and the results are shown in Table 3. The correlation coefficients among the six variables are all significantly positively correlated at the 0.001 level. Among them, the correlation coefficient between the energy-saving policy tools for individuals and the perceived social norm is greater than 0.7, showing a strong correlation. The correlations between each pair of other variables range from 0.392 to 0.670, also showing a strong correlation.

Table 3. Means, Standard Deviations, and Correlations of Major Variables

Variable	M	SD	Energy-saving Policy Tools for Organizations	Energy-saving Policy Tools for Individuals	Perceived Social Norm	Personal Norm	Energy Conservation Willingness	Energy Conservation Behavior
Energy-saving Policy Tools for Organizations	3.519	1.009	1.000	—	—	—	—	—
Energy-saving Policy Tools for Individuals	4.053	0.900	0.651***	1.000	—	—	—	—
Perceived Social Norm	3.939	0.861	0.660***	0.711***	1.000	—	—	—
Personal Norm	4.379	0.729	0.392***	0.557***	0.618***	1.000	—	—
Energy Conservation Willingness	4.269	0.664	0.476***	0.560***	0.622***	0.670***	1.000	—
Energy Conservation Behavior	3.398	1.056	0.503***	0.447***	0.542***	0.425***	0.552***	1.000

4.3 Main Effect

The main effect test was conducted using hierarchical regression analysis, and the results are shown in Table 4. Model 1 incorporates two independent variables: energy-saving policy tools for organizations and energy-saving policy tools for individuals. Model 2, on the basis of Model 1, incorporates the control variable social desirability. Model 3, on the basis of Model 2, incorporates the demographic variable. As can be seen from Table 4, after controlling for social desirability and

demographic variables, the energy-saving policy tools for organizations (β=0.301, p<0.001) and those for individuals (β=0.169, p<0.01) have a significant positive impact on energy conservation behavior. Therefore, it is assumed that H1a and H1b hold true.

Table 4. The Main Effect Test of Model Regression

Variable	Model1		Model2		Model3	
	β	t	β	t	β	t
Energy-saving Policy Tools for Organizations	0.361	6.409***	0.316	5.695***	0.301	5.502***
Energy-saving Policy Tools for Individuals	0.194	3.451**	0.196	3.581***	0.169	3.114**
Social Desirability	—	—	0.214	5.081***	0.229	5.427***
Gender	—	—	—	—	-0.049	-1.194
Age	—	—	—	—	0.123	2.497**
Household Registration Type	—	—	—	—	0.136	3.274**
Marital Status	—	—	—	—	-0.028	-0.647
Educational Background	—	—	—	—	-0.037	-0.875
Political Status	—	—	—	—	0.006	0.131
Compilation Type	—	—	—	—	0.018	0.389
Job Grade	—	—	—	—	-0.018	-0.398
R	0.511		0.552		0.588	
R^2	0.257		0.299		0.328	
F	72.477***		59.842***		19.320***	

4.4 Mediation

The structural equation model was adopted in AMOS27.0 to verify the mediating effects of perceived social norm, personal norm and energy conservation willingness, in order to respectively test whether the four chain mediating effects formed by the combination of three mediating paths and mediating variables under two independent variables were significant.

The first independent variable, the energy-saving policy tools for organizations, was incorporated into the structural equation model for the mediating effect test. The model is shown in Figure 2, and the values displayed in the figure are the standardized path coefficients.

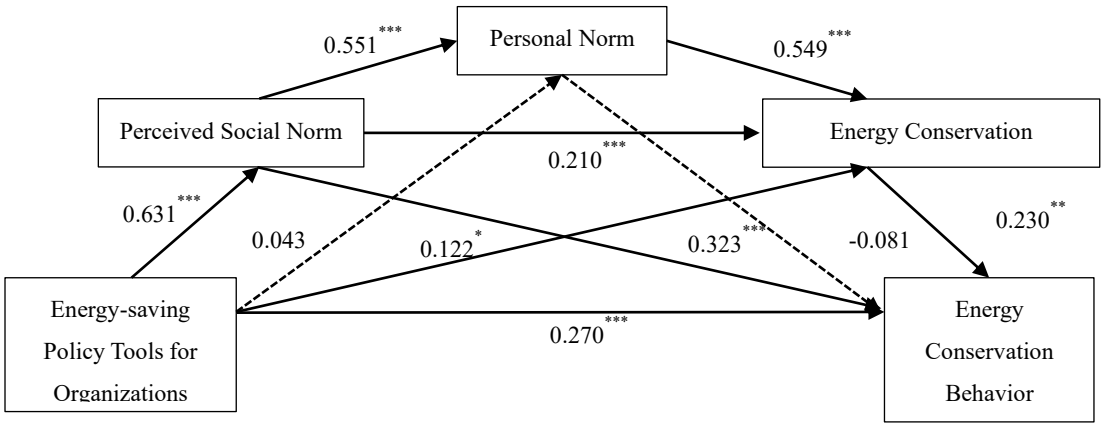


Figure 2. Mediation Model from OP to ECB

After calculation, the fitting indicators of the mediation model in Figure 2 are as follows: χ^2/df=4.432, RMSEA=0.091, GFI=0.861, AGFI=0.810, NFI=0.901, RFI=0.879, IFI=0.922, TLI=0.904, CFI=0.921. It can be found that, except for the χ^2/df, RMSEA, GFI, AGFI and RFI indicators which are good, all other fitting indicators of the model are excellent. Due to the large number of samples, it can be considered that this mediation model fits well.

Based on the structural equation model, the Bootstrap method test was conducted. The mediation test results for the energy-saving policy tools for organizations are shown in Table 5. It can be seen that the mediating effect values of the energy-saving policy tools for organizations on energy conservation behaviors through perceiving social norm and energy conservation willingness are 0.203 and 0.028 respectively, and the confidence intervals do not include 0, indicating that these two simple mediating paths are significant. The mediating effect values of the energy-saving policy tools for organizations on energy conservation behaviors through the "perceived social norm - energy conservation willingness" chain and the "perceived social norm - personal norm - energy conservation willingness" chain are 0.030 and 0.044, respectively. The confidence intervals do not include 0, indicating that these two chain-based mediating paths are significant. The confidence intervals of other intermediate paths contain 0, and thus are not significant. That is, it is assumed that H2a, H4a, H6a and H8a hold true, while H3a, H5a and H7a do not.

Table 5. Bootstrap Test for Mediation Paths of OP

Hypothesis	Path	SE	LLCI	ULCI	P
H2a	OP→SN→ECB	0.203	0.098	0.312	0.001
H3a	OP→PN→ECB	-0.003	-0.042	0.006	0.353
H4a	OP→ECW→ECB	0.028	0.003	0.079	0.029
H5a	OP→SN→PN→ECB	-0.028	-0.100	0.030	0.343
H6a	OP→SN→ECW→ECB	0.030	0.003	0.089	0.019
H7a	OP→PN→ECW→ECB	0.005	-0.009	0.037	0.369
H8a	OP→SN→PN→ECW→ECB	0.044	0.011	0.108	0.007

The second independent variable, the energy-saving policy tools for individuals, was incorporated into the structural equation model for the mediating effect test. The model is shown in Figure 3, and the values displayed in the figure are the standardized path coefficients.

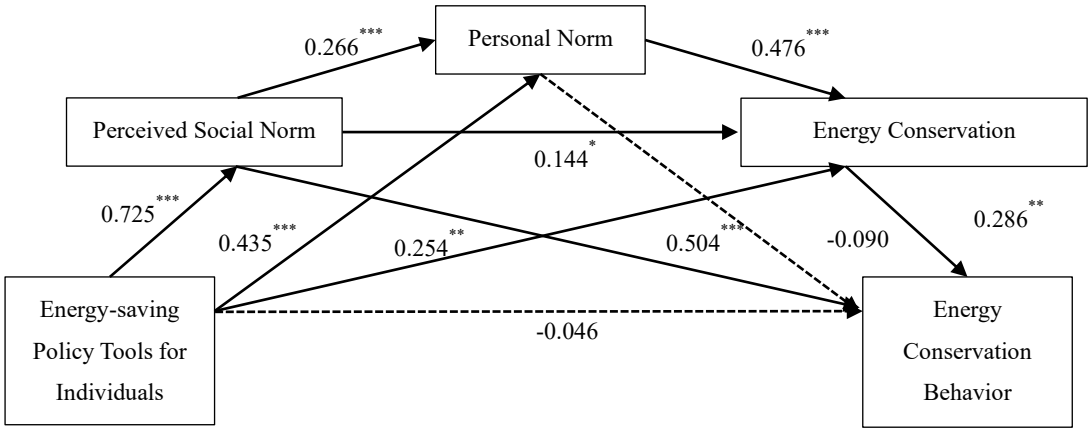


Figure 3. Mediation Model from IP to ECB

After calculation, the fitting indicators of the mediation model in Figure 3 are as follows: χ^2/df=3.329, RMSEA=0.075, GFI=0.923, AGFI=0.884, NFI=0.935, RFI=0.915, IFI=0.954, TLI=0.939, CFI=0.953. It can be found that, except for the χ^2/df and AGFI indicators which are good, all other fitting indicators of the model are excellent. Due to the large number of samples, it can be considered that this mediation model fits well.

As above, the results of the intermediary test for energy-saving policy tools for individuals are shown in Table 6. It can be seen that the mediating effect values of the energy-saving policy tools for individuals on energy conservation behaviors through perceiving social norm and energy conservation willingness are 0.365 and 0.073 respectively, and the confidence intervals do not include 0, indicating that these two simple mediating paths are significant. The mediating effect values of the energy-saving policy tools for individuals on energy conservation behaviors through the "personal norm - energy conservation willingness" chain and the "perceived social norm - personal norm - energy conservation willingness" chain are 0.059 and 0.026, respectively. The confidence intervals do not include 0, indicating that these two chain-based mediating paths are significant. The confidence intervals of other intermediate paths contain 0, and thus are not significant. That is, it is assumed that H2b, H4b, H7b and H8b hold true, while H3b, H5b and H6b do not.

Table 6. Bootstrap Test for Mediation Paths of IP

Hypothesis	Path	SE	LLCI	ULCI	P
H2b	IP→SN→ECB	0.365	0.228	0.554	0.000
H3b	IP→PN→ECB	-0.039	-0.171	0.027	0.252
H4b	IP→ECW→ECB	0.073	0.001	0.207	0.047
H5b	IP→SN→PN→ECB	-0.017	-0.071	0.011	0.221
H6b	IP→SN→ECW→ECB	0.030	-0.015	0.103	0.187
H7b	IP→PN→ECW→ECB	0.059	0.015	0.186	0.002
H8b	IP→SN→PN→ECW→ECB	0.026	0.007	0.073	0.007

Study 2: A Survey Experiment Study on the Differences in the Impact of Energy-saving Policy Tools on Energy Conservation Behaviors of Public Sector Employees

1 Method

This experimental study aims to explore the differences in the strength of the impact of different types of energy-saving policy tools on the energy conservation behaviors of public sector employees. According to the classification of energy-saving policy tools by Mi and Yang into command-and-control, economic incentive, informational and volunteering, the processing variable will be defined as four types of energy-saving policy tools, and the result variable will be energy conservation behavior. Measure the energy conservation behaviors of public sector employees through the test items.

Furthermore, some studies have found that environmentally friendly leadership styles have a positive impact on employees' willingness to participate in environmental protection activities and their active practice of green behaviors(Liu, Yuan, &Zhang, 2018; Li&Hua, 2023). Therefore, the environmental protection concepts and leadership energy conservation behaviors in the public sector where the surveyed subjects are located may also affect the energy conservation behaviors of the surveyed subjects. Therefore, in this study, leadership energy conservation behaviors was included as a moderating variable in the experimental research, and it was set at two treatment levels: leaders saving energy and leaders wasting energy.

In addition, He and Cui also found that energy-saving knowledge is an internal driving factor influencing the energy conservation behavior of librarians, who are also public sector employees. Therefore, the variable of energy-saving knowledge will be included as a confounding variable in this experimental study. However, since energy-saving knowledge is an internal variable with differences among individuals, it cannot be effectively intervened. The energy-saving knowledge level of the surveyed subjects was also examined through direct measurement.

Finally, social desirability was also included as a confounding variable in the experimental study.

1.1 Scenario Materials

This study is based on the classification and definition of energy-saving policy tools by Mi and Yang(2017), and combines the text entries of energy-saving policies in the public sector to compile situational materials. The situational materials for leadership energy conservation behaviors mainly refer to the Fatoki scale on leadership energy conservation behaviors and the situational materials and items for measuring environmental performance used by Peng et al. in their papers. At the same time, referring to the testing procedure process of the survey experiment research used by Zhang et al., situational materials for intervening in the surveyed subjects were formed.

1.2 Measure

The type of energy-saving policy tool is the treatment variable in the survey experiment. By asking the respondents which type of energy-saving policy they read belongs to, it is determined whether the respondents understand the meaning of the situational materials. The manipulation check of this variable consists of a multiple-choice question.

Energy conservation behavior, as the outcome variable in the investigation experiment, will be measured by referring to the items on energy conservation behavior proposed by He Peipei(He&Cui, 2021). There are a total of 7 items, and the Likert 5-point method will be used for scoring.

Leadership energy conservation behavior is the moderating variable in this survey experiment. To determine whether the processing level of the situational materials of leadership energy conservation behaviors has successfully manipulated the test, the role demonstration scale of Chen and Liu(Fatoki, 2022) will be adopted. This scale consists of two items and is scored using the Likert 5-point method.

Energy-saving knowledge will refer to the description of the knowledge section item items in the research on environmental knowledge and energy conservation behavior by Frick and Kaise(Peng, Yin, Hou, et al., 2020), with a total of 7 items, and the Likert 5-point method will be used for scoring.

The social desirability effect in the experimental study draws on the classic scale proposed by Schuessler et al.(Zhang, Tan, Liang, et al., 2021), consisting of 16 items, and is scored using the Likert 5-point method.

1.3 Experiment Procedure and Survey

The respondents will randomly receive 4×2 groups of situational materials (command-and-control× leadership energy conservation, economic incentive × leadership energy conservation, informational × leadership energy conservation, volunteering × leadership energy conservation, command-and-control× leadership energy waste, economic incentive × leadership energy waste, informational × leadership energy waste, volunteering × leadership energy waste) Group 1.

After the experiment began, the respondents first read the instructions of the questionnaire, making it clear that this research was an anonymous survey. They only needed to answer according to the situational materials and their own real situations. The first part of the questionnaire asked the respondents to read virtual policy context materials and the performance of leadership energy conservation behaviors. In the second part, the respondents were required to answer three questions on the types of energy-saving policy tools and the manipulation and inspection of leadership energy conservation behaviors. Then, they were asked to answer seven questions on possible energy conservation behaviors based on the content of the situational materials. In the third part, the respondents filled in 23 questions on social desirability and energy-saving knowledge. In the last part, the respondents need to fill in demographic information such as gender, age and educational background.

To eliminate the experimental influence brought by the sequential effect, the two intervention modules of policy scenario materials and leadership energy conservation behaviors were set to appear randomly in sequence in the experimental process. The above experimental procedure is shown in Figure 4.

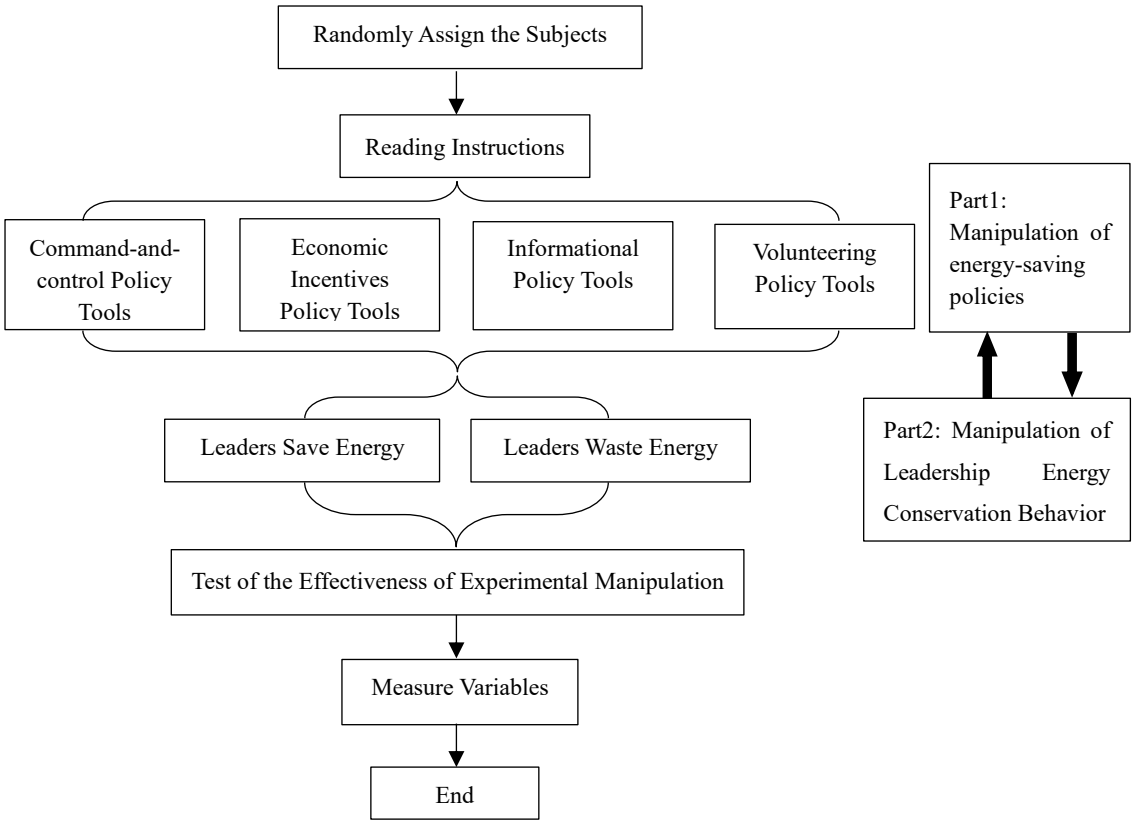


Figure 4. Experimental Flowchart

1.4 Sample

The experimental subjects are selected from the on-the-job staff of the public sector.This formal experiment collected 344 questionnaires through the online platform "Credamo See Data". 55 paper questionnaires were also distributed through the MPA classroom. Eventually, 399 survey samples were obtained. After eliminating the questionnaires that were not fully completed, had inconsistent logic or did not meet the requirements, the final number of valid questionnaires was 332, with an effective recovery rate of 83.20%.

1.5 Manipulation Check

In order to ensure that each sample received effective intervention from the situational materials, in the data cleaning stage, samples with scores less than 3 in any of the intervention questions were eliminated first. Eventually, 270 samples remained. Then, the independent sample t-test was used to test the intervention situations. The results showed that: command-and-control energy-saving policy tools ($M=4.77$, $SD=0.42$), $t(69)=94.39$, $p<0.001$; Economic incentive energy-saving policy tools ($M=4.65$, $SD=0.48$), $t(68)=80.55$, $p<0.001$; Informational energy-saving policy tools ($M=4.70$) ($SD=0.46$), $t(65)=82.40$, $p<0.001$; Volunteering energy-saving policy tool category ($M=4.65$, $SD=0.48$), $t(64)=77.73$, $p<0.001$; leadership energy-saving ($M=4.57$, $SD=0.61$), $t(136)=87.35$ $p<0.001$, leadership energy waste ($M=4.74$, $SD=0.49$), $t(132)=111.39$, $p<0.001$. The content of the situational materials in the experimental study can be well understood and recognized by the subjects under investigation.

2 Results

2.1 Descriptive Statistics

Table7 presents the descriptive analysis of each variable in the experimental study.

Table 7. Descriptive Statistical Analysis of Research Variables

Variable	Min	Max	M	SD	Skewness		Kurtosis	
					Value	SD	Value	SD
Energy Conservation Behavior	2.143	5.000	4.086	0.640	-0.437	0.148	-0.291	0.295
Energy-saving Knowledge	1.000	5.000	3.962	0.704	-0.405	0.148	0.307	0.295
Social Desirability	2.063	5.000	3.580	0.492	0.027	0.148	0.266	0.295

Table8 presents the average and standard deviation of sample size and energy conservation behaviors in different groups through comparative analysis.

Table 8. Descriptive Statistical Analysis of Energy Conservation Behavior in Different Contexts

Energy-saving Policy Tools	Leadership Energy Conservation Behavior	M	SD	N
Command-and-control Policy	Leaders Save Energy	4.257	0.565	35
	Leaders Waste Energy	4.155	0.588	35
	Total	4.206	0.575	70
Economic Incentives Policy	Leaders Save Energy	4.172	0.585	34
	Leaders Waste Energy	4.102	0.752	35
	Total	4.137	0.671	69
Informational Policy	Leaders Save Energy	4.169	0.678	33
	Leaders Waste Energy	3.974	0.705	33
	Total	4.071	0.693	66
Volunteering Policy	Leaders Save Energy	3.968	0.497	31
	Leaders Waste Energy	3.870	0.671	34
	Total	3.916	0.592	65
Total	Leaders Save Energy	4.146	0.589	133
	Leaders Waste Energy	4.027	0.683	137
	Total	4.086	0.640	270

2.2 Analysis of Variance

Analysis of variance was conducted using a univariate general linear model. It can be seen from Table 9 that when Model 1 does not consider demographic variables as control variables, the types of energy-saving policy tools, leadership energy-saving behaviors, social desirability and energy-saving knowledge will have a significant impact on energy-saving behaviors. After including demographic variables as control variables, the fitting of Model 2 was better. However, leadership energy conservation behaviors that had an impact on energy conservation behaviors in Model 1 did not have a significant impact on energy conservation behaviors in Model 2. There was no interaction between the types of energy-saving policy tools and leadership energy conservation behaviors. In addition, the gender variable in demographics can have a significant impact on energy conservation behaviors.

Table 9. Intersubjective Effect Test

Variable	Model1（R^2=0.347）					Model2（R^2=0.394）				
	SS	X^2df	MS	F	p	SS	X^2df	MS	F	p
Modified Model	38.256	9	4.251	15.366	0.000	43.419	18	2.412	9.069	0.000
Intercept	7.833	1	7.833	28.315	0.000	3.954	1	3.954	14.864	0.000
Energy-saving Policy Tools	3.446	3	1.149	4.152	0.007	2.807	3	0.936	3.518	0.016
Leadership Energy Conservation Behavior	0.879	1	0.879	3.177	0.076	0.590	1	0.590	2.219	0.138
Energy-saving Policy*Leadership Energy Conservation Behavior	0.920	3	0.307	1.108	0.346	1.054	3	0.351	1.320	0.268
Social Desirability	4.118	1	4.118	14.885	0.000	3.561	1	3.561	13.387	0.000
Energy-saving Knowledge	22.345	1	22.345	80.777	0.000	24.586	1	24.586	92.438	0.000
Gender	—	—	—	—	—	3.927	1	3.927	14.763	0.000
Age	—	—	—	—	—	0.157	1	0.157	0.590	0.443
Household Registration Type	—	—	—	—	—	0.164	1	0.164	0.616	0.433
Marital Status	—	—	—	—	—	0.176	1	0.176	0.663	0.416
Educational Background	—	—	—	—	—	0.013	1	0.013	0.050	0.824
Nature of the workplace	—	—	—	—	—	0.153	1	0.153	0.576	0.449
Political Status	—	—	—	—	—	0.419	1	0.419	1.574	0.211
Compilation Type	—	—	—	—	—	0.123	1	0.123	0.464	0.497
Job Grade	—	—	—	—	—	0.094	1	0.094	0.352	0.554
Error	71.924	260	0.277	—	—	66.760	251	0.266	—	—
Total	4617.306	270	—	—	—	4617.306	270	—	—	—
Modified Total	110.180	269	—	—	—	110.180	269	—	—	—

2.3 Pairwise Comparison and Post Hoc Examination

Since only energy-saving policy tools can significantly show differences in their impact on energy conservation behaviors in both models, next, pairwise comparisons of energy-saving policy tools will be conducted to examine whether the differences among the four types of policy tools are significant. As can be seen in Table 10, based on the estimated marginal mean of each scenario group, there are significant differences between command-and-control energy-saving policy tools and informational energy-saving policy tools, as well as volunteering energy-saving policy tools. There are also significant differences between economic incentive energy-saving policy tools and volunteering energy-saving policy tools, while there are no significant differences among other types of energy-saving policy tools.

Table 10. Paired Comparison

Energy-saving Policy Tools(a)	Energy-saving Policy Tools(b)	Mean Difference（a-b）	Standard Error	P	95%Confidence Interval of Difference Value	
					Lower	Upper
Command-and-control Policy	Economic Incentives Policy	0.132	0.089	0.142	-0.044	0.308
	Informational Policy	0.178*	0.091	0.050	0.000	0.357
	Volunteering Policy	0.318**	0.091	0.001	0.138	0.498
Economic Incentives Policy	Command-and-control Policy	-0.132	0.089	0.142	-0.308	0.044
	Informational Policy	0.047	0.091	0.609	-0.132	0.226
	Volunteering Policy	0.186*	0.092	0.043	0.006	0.366
Informational Policy	Command-and-control Policy	-0.178*	0.091	0.050	-0.357	0.000
	Economic Incentives Policy	-0.047	0.091	0.609	-0.226	0.132
	Volunteering Policy	0.139	0.092	0.131	-0.042	0.321
Volunteering Policy	Command-and-control Policy	-0.318**	0.091	0.001	-0.498	-0.138
	Economic Incentives Policy	-0.186*	0.092	0.043	-0.366	-0.006
	Informational Policy	-0.139	0.092	0.131	-0.321	0.042

Finally, a post hoc test using the S-N-K method was conducted for the four energy-saving policies. From Table 11, it can be found that under the pairwise comparison results of the four types of energy-saving policy tools, the influence of the command-and-control energy-saving policy tool on energy conservation behavior is significantly stronger than that of the volunteering energy-saving policy tool on energy conservation behavior. Based on the situation in the paired comparison, the command-and-controlenergy-saving policy tools have the greatest impact on energy conservation behaviors, followed by the economic incentive energy-saving policy tools,

the informational energy-saving policy tools, and the volunteering energy-saving policy tools in sequence. It can be seen that the results of the post hoc test are consistent with the ranking of the average impact of various energy-saving policies on energy conservation behaviors from high to low.

Table 11. Post Hoc Test

Types of Energy-saving Policies	N	Subset	
		1	2
Volunteering Policy	65	3.916	—
Informational Policy	66	4.071	4.071
Economic Incentives Policy	69	4.137	4.137
Command-and-control Policy	70	—	4.206
P	—	0.110	0.433

3 Discussion

The data analysis results of this experimental study indicate that all kinds of energy-saving policy tools can have a positive impact on energy conservation behaviors. After further post-event examination and a one-to-one comparison of the four energy-saving policy tools, it was found that the command-and-control energy-saving policy tool had the greatest impact on energy conservation behavior. However, as a moderating variable, leadership energy conservation behavior has no significant moderating effect on the impact of energy-saving policy tools on energy conservation behavior. Among the confounding variables, social desirability, energy-saving knowledge and gender have significant influences on energy conservation behaviors. It can be seen that in terms of the effect of energy-saving policy tools on energy conservation behaviors, command-and-control energy-saving policy tools have a greater influence. This is similar to the research results of Lu(2023) and Huang(2019). Command-and-control energy-saving policy tools can promote the improvement of residents' energy conservation behavior performance. However, Miand Yang believe that the energy-saving effect of command-and-control policies is not significant, and it is not as good as that of economic incentive policies and informational policies. This might be because command-and-control energy-saving policy tools are push-type policies. They achieve their goals through forced commands or prohibitions, and obtain very good energy-saving effects in the short term through high-cost investment. However, in the long run, they are prone to causing individuals to become exhausted, affecting the long-term sustainability of energy-saving effects, and even generating individual rebellious psychology(Schuessler, Hittle, &Cardascia, 1978). The other three types of energy-saving policy tools also have a significant impact on energy conservation behaviors, which is similar to the research results on the energy conservation behaviors of staff in government office buildings(Lv, 2023).

In Model 1, leadership energy conservation behavior at the confidence level of $P<0.1$ is correlated with energy conservation behavior, but there is no significant correlation after including confounding variables. This might be because energy-saving knowledge and social desirability in confounding variables have stronger predictive power. Some studies have found that the indirect effect between responsible leadership and employees' pro-environmental behavior has not occurred, but organizational commitment can play a moderating role in it(Huang, 2019); Leaders in an organization have no direct influence on employees' environmental protection behaviors(Gao,

2022). Some studies also suggest that an environmentally friendly servant leadership style can positively regulate employees' pro-environmental behaviors(Zhang, 2017), and leadership energy conservation behaviors and leadership energy-saving support can positively influence employees' power-saving behaviors(Afsar, Bilal, et al., 2020). It can be seen that if the manifestations of leadership behavior do not evolve into the management methods and styles for subordinates, subordinates may not imitate the leader's personal preference manifestations.

In addition, the energy-saving knowledge reserves of public sector employees are also an important factor influencing energy conservation behaviors, just as environmental knowledge can significantly promote sustainable energy production(Sugiarto, Agus, Cheng-Wen, et al., 2022).

Conclusions and Prospects

1 Conclusion

This study employed questionnaire surveys and survey experiments, taking public sector employees as the research subjects. Through two sub-studies, it delved deeply into the mechanism of action of energy-saving policy tools on the energy conservation behaviors of public sector employees and the differences in the impacts of various energy-saving policy tools.

A questionnaire survey based on data from 414 public sector employees found that both energy-saving policy tools for organizations and those for individuals can directly and positively influence the energy conservation behaviors of public sector employees. Perceived social norm, energy conservation willingness, "perceived social norm - energy conservation willingness" and "perceived social norm - personal norm - energy conservation willingness" play a mediating role between energy-saving policy tools for organizations, energy-saving policy tools for individuals and energy conservation behaviors of public sector employees. The mediating effect of "perceived social norm - energy conservation willingness" is significant only between energy-saving policy tools for organizations and energy conservation behaviors of public sector employees, while the mediating effect of "personal norm - energy conservation willingness" is significant only between energy-saving policy tools for individuals and energy conservation behaviors of public sector employees. The mediating role of personal norm and "perceived social norm - personal norm" between energy-saving policy tools for organizations, energy-saving policy tools for individuals and energy conservation behaviors of public sector employees is not significant.

Experimental research, based on data from 270 subjects, found that the types of energy-saving policy tools have significant differences in the impact on energy conservation behaviors of public sector employees. The impact effect value of command-and-control energy-saving policy tools on the energy conservation behaviors of public sector employees is the largest. The moderating effect of leadership energy conservation behaviors on the energy conservation behaviors of public sector employees is not significant in terms of the types of energy-saving policy tools.

2 Practical Implication

2.1 Apply Social Norm and Practice Energy Conservation Behaviors.

When implementing energy conservation policies, the role of social norm can be emphasized, and the use of social norm to promote energy conservation information can be increased. For instance, establish energy-saving model role models to encourage energy-saving pioneers to actively engage in energy-saving work and play a leading and exemplary role. Embedding descriptions that can awaken the perception of social norm in energy-saving publicity posters and slogans makes the transmission of energy-saving policy information more efficient. It is also possible to expand the channels for disseminating energy-saving information, post information slogans and posters in some high-energy-consuming and easily wasteful scenarios, and give full play to the guiding role of social norm information.

2.2 Implement Classified and Precise Policies to Highlight their Effectiveness.

The public sector should appropriately apply various energy-saving policy tools in accordance with the actual situation. For instance, in scenarios where energy consumption is huge and there is a significant amount of energy waste, command-and-controlled energy-saving policy tools can be employed. Through mandatory commands, the amount of energy waste can be rapidly reduced. Innovatively introduce economic incentive policies and apply them in the working scenarios of the public sector, linking energy consumption costs with the benefits of energy conservation behaviors. Even material energy-saving rewards can be set up to stimulate public sector employees to actively participate in energy conservation. Enrich the content of informational and volunteering policies, develop and optimize the existing policy measures, and enable various types of energy-saving policies to complement each other, forming a policy synergy.

2.3 Grasp the Key Factors and Innovate Energy-saving Measures.

The energy conservation behaviors of public sector employees exhibit both individual and group characteristics, and innovative energy-saving measures can be innovated with small efforts to achieve great results. For instance, organizing public sector employees to participate in energy conservation oath-taking activities and sign energy conservation commitments can help them make energy consumption behaviors that comply with the commitments in the future. In addition, there are differences in energy conservation behaviors among public sector employees of different genders, household registrations, and age groups. By balancing the gender ratio, household registration types, and age levels of personnel in each department and section, energy conservation and environmental protection behaviors can be promoted among employees in their work interactions.

3 Limitations and Future Directions

First, the theoretical model still needs to be improved. The theoretical model construction of this study is mainly based on the theory of planned behavior extended from the stimulus-organism-response theory. However, the extended theory of planned behavior is an open theory that can introduce new variables for research. But so far, no more novel related mediating variables have been mined from the relevant theories. In the future, novel research variables can be found from other dimensions, levels and theories to enrich the study of psychological variables or related emotional stimulating factors as influencing factors of energy conservation behaviors.

The second issue is that the sample size of the investigation experiment is relatively small. As

the experimental research needs to ensure that the manipulation checks of the subjects under investigation pass, and the sample size of each group needs to be as large as possible, if each subject under investigation only receives the stimulation of one situation, a large amount of cost will be required to recruit a number of subjects far larger than the theoretical sample size. In the future, it can be considered to modify the experimental design and adopt more effective experimental designs such as joint experiments, so that each subject under investigation can receive different levels of stimulation, and for variables that are more difficult to manipulate, intervention can be carried out from multiple aspects to enhance the reliability of the experiment.

Thirdly, there are still some differences between the data sources of the research and the actual situation. Energy conservation behavior is ultimately a variable at the behavioral level. There will still be a certain gap between the behavioral data collected through questionnaires and the actual individual behavioral performance. If energy conservation behavior can be quantified through objective and direct data such as on-site observation, diary records, and the usage of water, electricity and gas, it will make the acquisition of research data more direct and the reliability of the data higher. It can also to a certain extent reduce social desirability and enhance the authenticity and scientific nature of the research.

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