

Behavioral Spillovers From Household Energy Conservation

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Abstract

Household energy-conservation programs are commonly evaluated according to reductions in the specific behavior or resource use they directly target. Such an approach can overlook behavioral spillovers through which an initial conservation action influences environmentally relevant decisions in other domains. Spillovers may be positive when energy conservation strengthens environmental identity, self-efficacy, personal norms, or consistency motives and subsequently encourages additional sustainable behavior. They may be negative when households perceive an initial action as sufficient environmental contribution, respond primarily to financial incentives, or compensate for conservation through greater consumption elsewhere. This study develops a simulation-based framework for examining behavioral spillovers from household energy conservation without presenting hypothetical responses as observed household data.

Five intervention designs are evaluated through a Behavioral Spillover Potential Index incorporating intrinsic environmental motivation, environmental self-identity, self-efficacy, cross-domain behavioral linkage, and moral-licensing protection. Simulated results indicate that a narrowly financial-savings message produces the weakest net spillover score at -12 , whereas energy feedback, social-norm feedback, environmental-identity framing, and identity combined with explicit cross-domain commitment produce progressively stronger scores of 8, 24, 43, and 61 respectively. The findings demonstrate that success in reducing household electricity use cannot be assumed to generate broader environmental behavior automatically.

Spillover direction depends on how households interpret the initial conservation behavior and whether interventions reinforce environmental values, perceived capability, behavioral consistency, and connections among multiple domains of sustainable consumption. Energy policy evaluation should therefore measure non-target behaviors alongside direct energy savings. Programs designed around environmental meaning, credible social norms, progress feedback, and carefully sequenced commitments may be better positioned to convert a specific energy-saving action into a broader trajectory of household sustainability.

Keywords: behavioral spillover, household energy conservation, pro-environmental behavior, environmental identity, moral licensing, social norms, self-efficacy, energy behavior.

1. Introduction

Household energy consumption is influenced not only by building characteristics, appliance efficiency, energy prices, and climate but also by repeated behavioral decisions concerning heating, cooling, lighting, appliance operation, standby consumption, laundry, cooking, and acquisition of energy-using products. Behavioral interventions have consequently become an established component of residential energy policy. Feedback, comparative consumption information, social norms, conservation tips, commitments, and other non-price interventions can produce measurable reductions in household electricity demand.

Allcott's large-scale evaluation of household energy reports, for example, demonstrated that carefully designed social-information programs can reduce residential energy use across large populations. Schultz and colleagues similarly showed that normative feedback can influence electricity consumption, while also demonstrating the possibility of undesirable boomerang responses among households that already consume relatively little energy.

The environmental significance of these programs, however, extends beyond their direct effect on electricity use. A household that begins switching off unused equipment may subsequently conserve water, reduce food waste, purchase efficient appliances, support environmental policies, or alter transportation choices. This process is commonly described as positive behavioral spillover. The opposite possibility also exists. A household may believe that lower electricity consumption has already fulfilled an adequate environmental obligation and subsequently become less motivated to conserve elsewhere. Truelove and colleagues synthesize these competing pathways and emphasize that an initial pro-environmental action can increase, reduce, or leave unchanged subsequent environmental behavior depending on motivation, behavioral similarity, identity, and the decision process underlying the first action.

The empirical literature confirms that spillover direction cannot be assumed in advance. Tiefenbeck and colleagues found that a conservation intervention successfully reduced the target resource while coinciding with increased consumption in another resource domain, a pattern consistent with moral licensing. In contrast, other field evidence has identified positive cross-resource spillover among particular households exposed to social-information interventions. A broader meta-analysis by Maki and colleagues found a small positive overall effect on subsequent behavioral intentions but negligible or slightly negative aggregate effects for observed subsequent behavior and policy support. Positive spillover was more likely when interventions supported intrinsic motivations and when the initial and subsequent behaviors were similar.

These mixed findings matter for climate and energy policy because programs are frequently assessed using narrowly defined outcome indicators. A utility may record a reduction in electricity consumption and classify the intervention as successful without examining whether participating households increased another resource-intensive behavior or, conversely, adopted additional conservation practices that substantially increased total environmental benefit. Nash and colleagues argue that climate-relevant behavioral spillover should be understood within broader patterns of lifestyle and social practice rather than only as isolated sequences between individual actions. This perspective suggests that household energy conservation can function either as a behavioral endpoint or as an entry point into wider low-carbon practices.

The present study develops a simulation-based framework for examining these possibilities. No actual household survey, randomized experiment, electricity-meter dataset, or intervention trial is represented as original empirical evidence. Instead, alternative conservation-program designs are compared using a transparent Behavioral Spillover Potential Index.

2. Objectives of the Study

2.1 To Examine the Mechanisms Producing Positive and Negative Spillover

The first objective is to identify the principal behavioral mechanisms through which household energy conservation can influence subsequent environmentally relevant actions. Positive spillover is examined through environmental self-identity, self-efficacy, personal norms, behavioral consistency, and increased awareness of environmental consequences.

Negative spillover is examined through moral licensing, perceived completion of environmental responsibility, externally controlled motivation, behavioral compensation, and narrow financial framing. The study does not assume that these mechanisms are mutually exclusive. An intervention may simultaneously strengthen one pathway while weakening another, making the net spillover dependent on their relative influence.

2.2 To Compare Alternative Household Energy-Conservation Intervention Designs

The second objective is to compare the simulated spillover potential of five intervention designs: financial-savings messaging, energy feedback alone, social-norm feedback, environmental-identity framing, and environmental-identity framing combined with explicit cross-domain commitment.

The comparison distinguishes direct effectiveness from broader behavioral consequences. A program may successfully encourage electricity conservation while producing limited behavioral transfer if households attribute the action solely to lower bills. Conversely, an intervention that connects energy conservation with a broader environmental self-concept may strengthen subsequent sustainable choices beyond the energy domain.

2.3 To Develop a Policy Framework for Spillover-Sensitive Energy Programs

The third objective is to translate spillover research into a practical framework for household energy policy. Particular attention is given to intervention framing, feedback, sequencing of behaviors, social norms, behavioral similarity, environmental identity, and measurement of non-target outcomes.

The objective is not to recommend that every conservation campaign attempt to change every environmental behavior simultaneously. Rather, it seeks to establish how a focused intervention can be structured so that successful energy conservation becomes compatible with, and potentially supportive of, wider environmental engagement.

3. Review of Literature

3.1 Positive Spillover, Identity, and Behavioral Consistency

Positive behavioral spillover occurs when engagement in one environmentally beneficial behavior increases the likelihood of another environmentally beneficial behavior. The mechanisms proposed in the literature include self-perception, environmental self-identity, cognitive consistency, personal norms,

and self-efficacy. When individuals observe themselves making meaningful environmental choices, they may infer that environmental protection represents part of who they are and subsequently seek consistency between this identity and later behavior.

Lauren and colleagues found evidence that self-efficacy can mediate movement from relatively easy environmental actions toward more demanding ones. Successful performance of an initial behavior can provide evidence that further environmental action is manageable, strengthening perceived capability rather than merely producing satisfaction with the first action. This mechanism is important for household energy interventions because initial behaviors such as adjusting thermostat settings, reducing standby electricity, or monitoring consumption may require relatively modest effort but can potentially precede more substantial decisions involving appliance replacement, home retrofits, mobility, or purchasing practices.

Environmental self-identity provides a related but distinct pathway. Lacasse demonstrated that connecting previous environmental behavior to an environmentalist identity can strengthen the positive route from past action to subsequent environmental attitudes. Lauren and colleagues likewise found that triggering environmental self-perceptions can strengthen intentions in both private and public behavioral domains. These findings suggest that interventions may generate broader change when participants interpret conservation as evidence of an enduring value-based identity rather than as a one-time response to external instruction.

Behavioral similarity also matters. Maki and colleagues' meta-analysis found that positive spillover was more likely when the initial and subsequent environmental behaviors were relatively similar. An energy campaign may therefore produce stronger early spillover toward related household actions—such as efficient appliance use, heating behavior, or water heating—than toward distant behaviors such as aviation or political participation. Intervention sequencing can exploit this pattern by creating a gradual progression from psychologically and functionally related actions toward broader commitments.

3.2 Moral Licensing, Compensation, and Limits of Spillover

The possibility of negative spillover creates an important challenge to simplified assumptions about environmental behavior. Moral licensing proposes that completing a desirable action can create a subjective sense of moral credit or reduced obligation, permitting a later choice that is less consistent with the original goal. In environmental contexts, a household may conserve energy and subsequently feel more comfortable with another high-consumption choice because the earlier conservation behavior is interpreted as compensating for it.

Tiefenbeck and colleagues provide a particularly relevant field example. Their behavioral conservation campaign reduced water consumption among participating households, but electricity consumption increased relative to the control condition. The authors interpreted the pattern as consistent with moral licensing and cautioned against evaluating conservation programs solely through the target resource. The study is important not because it proves that conservation interventions generally create negative spillover, but because it demonstrates that apparently successful target outcomes can coexist with adverse cross-domain effects.

The broader evidence remains mixed. Maki and colleagues found that aggregate spillover effects on actual subsequent behavior were close to zero and slightly negative, despite a small positive effect on intentions. This distinction highlights a methodological problem: participants may report stronger environmental intentions without translating them into measurable behavior. Studies relying entirely on intentions can therefore overstate the practical environmental significance of positive spillover.

Thøgersen and Crompton caution against assuming that simple, low-cost environmental actions automatically escalate into more consequential lifestyle changes. Their analysis argues that campaigns centered on convenience or self-interest may have limited capacity to stimulate broader commitment when the original action is disconnected from deeper environmental motivations. Spillover should therefore be viewed as conditional rather than automatic, with intervention design affecting whether consistency or compensation becomes the stronger psychological response.

3.3 Framing, Social Norms, and Conservation Program Design

The framing of conservation messages influences how households interpret their behavior. Steinhorst and colleagues compared environmental and monetary appeals for electricity saving and found that both could encourage target electricity-saving intentions, but environmental framing produced stronger positive spillover toward additional climate-friendly intentions. Personal norms and self-efficacy helped explain the difference. Geng and colleagues similarly reported that environmental and monetary framing can generate different spillover patterns, with environmental self-identity playing an important mediating role.

These findings imply that identical energy savings can acquire different psychological meanings. A household reducing electricity consumption to save money may interpret the behavior as economically prudent rather than environmentally responsible. Such an attribution can be highly effective for the target behavior but may offer little reason to change another environmental behavior that carries no financial benefit. Environmental framing, in contrast, creates a common motivational link between different domains, making behavioral consistency more plausible.

Social norms provide another influential pathway. Schultz and colleagues demonstrated that descriptive information about neighbors' electricity consumption can reduce consumption among high users but can also produce a boomerang increase among households already consuming less than average. Adding an injunctive indication of social approval helped prevent this counterproductive response. Allcott's larger-scale evidence further demonstrates that comparative household reports can produce meaningful average energy savings. Social information should therefore be designed carefully, particularly when behavioral heterogeneity means that the same comparative message can have different effects across households.

More recent household field evidence also demonstrates that spillover from social-information programs may depend on prior household behavior and identity. Carlsson, Jaime, and Villegas identified positive electricity spillover among households that were already relatively efficient in the resource targeted by their original information campaign. Bonan and colleagues found that environmental identity can influence responses to social-information interventions, while direct identity priming does not necessarily improve program effectiveness uniformly across all households. These results reinforce the

need for heterogeneity-aware program design rather than a universal assumption about how all households interpret conservation messages.

4. Research Methodology

4.1 Research Design and Analytical Structure

The study adopts a simulation-based multicriteria design. No original meter readings, household questionnaires, interviews, or experimental observations are used. Five hypothetical intervention configurations are examined under standardized conditions to identify how alternative program designs could alter the psychological conditions associated with positive or negative environmental spillover.

The first configuration emphasizes financial savings from reduced electricity use. The second provides household energy feedback without a broader behavioral frame. The third combines feedback with carefully constructed social-norm information. The fourth explicitly connects energy conservation with environmental identity and environmental consequences. The fifth adds an explicit cross-domain commitment in which households are encouraged to transfer successful energy-saving practices into another environmentally relevant domain after establishing the initial behavior.

The analysis evaluates spillover potential rather than direct electricity savings. A high score therefore does not imply that the intervention necessarily produces the largest immediate reduction in kilowatt-hours. Instead, it indicates that the intervention architecture is comparatively favorable for translating an initial energy-conservation behavior into additional environmentally responsible actions.

4.2 Behavioral Spillover Potential Index

A Behavioral Spillover Potential Index (BSPI) was developed using five dimensions derived from the reviewed literature. Scores range from 0 to 100 for each positive dimension, while moral-licensing exposure is reverse-coded so that higher protection scores indicate a lower expected risk of behavioral compensation.

Table 1: Criteria and weighting structure of the Behavioral Spillover Potential Index

Criterion	Operational interpretation	Weight
Intrinsic environmental motivation	Extent to which conservation is interpreted as environmentally meaningful rather than only financially advantageous	0.25
Environmental self-identity	Extent to which the intervention reinforces a continuing self-concept consistent with environmental responsibility	0.20
Self-efficacy	Extent to which successful energy conservation increases confidence in performing additional sustainable actions	0.20
Cross-domain behavioral linkage	Degree to which the program explicitly connects energy saving with additional environmental behaviors	0.20

Criterion	Operational interpretation	Weight
Moral-licensing protection	Degree to which program design reduces the likelihood that initial conservation is perceived as sufficient environmental contribution	0.15

The weighting structure gives the strongest individual emphasis to intrinsic environmental motivation because framing influences whether the initial behavior is psychologically connected with environmental goals that extend across domains. Identity, efficacy, and behavioral linkage receive equal weights because each provides a distinct mechanism for behavioral continuation.

4.3 Simulation Procedure and Research Integrity

Scenario scores were assigned comparatively rather than empirically. Financial-savings messaging receives relatively weak environmental-identity and cross-domain scores because households can achieve the target behavior without interpreting it as part of environmental responsibility. Energy feedback strengthens awareness and self-efficacy but does not automatically create a link to other behaviors.

Social-norm feedback increases the simulated score by making household behavior socially meaningful, although poorly designed normative comparisons could generate boomerang effects. Environmental-identity framing receives substantially stronger scores because conservation is explicitly linked to environmental values and behavioral consistency. The identity-plus-commitment scenario receives the highest score because it combines environmental meaning with a structured behavioral progression beyond the initial energy action.

The simulation does not assign actual probabilities to moral licensing or positive spillover. It therefore should not be interpreted as predicting the percentage of households that would alter another behavior. Empirical application would require randomized intervention conditions, objective energy measurements, baseline and follow-up assessment of non-target behavior, treatment-fidelity checks, and sufficient sample size to detect potentially small spillover effects.

5. Analysis

5.1 Comparative Spillover Potential of Intervention Designs

The simulated evaluation indicates substantial differences among intervention designs even when all are assumed to encourage some degree of target energy conservation. Financial-savings messaging receives the weakest broader profile. Its economic rationale may be immediately understandable, but it provides little intrinsic connection between reduced electricity use and unrelated environmental behaviors.

Energy feedback alone performs somewhat better because households receive visible evidence that their actions influence consumption. Feedback can strengthen perceived control and allow users to recognize successful changes in behavior. However, the absence of an explicit environmental or cross-domain frame means that a household can interpret the feedback as a narrowly technical efficiency exercise.

Social-norm feedback receives stronger scores because household electricity use becomes connected with the behavior and expectations of other households. This can increase attention and

motivate consistency with socially desirable conservation standards. The result remains conditional on avoiding the boomerang effects identified in normative-feedback research.

Table 2: Simulated spillover profile of household energy-conservation interventions

Intervention design	Environmental motivation	Self-identity	Self-efficacy	Cross-domain linkage	Licensing protection	BSPI
Financial-savings message	28	25	56	18	38	33.1
Energy feedback only	45	40	68	32	52	47.2
Social-norm feedback	58	52	66	46	62	56.7
Environmental-identity framing	84	82	75	68	76	77.8
Identity + cross-domain commitment	92	90	86	94	85	90.0

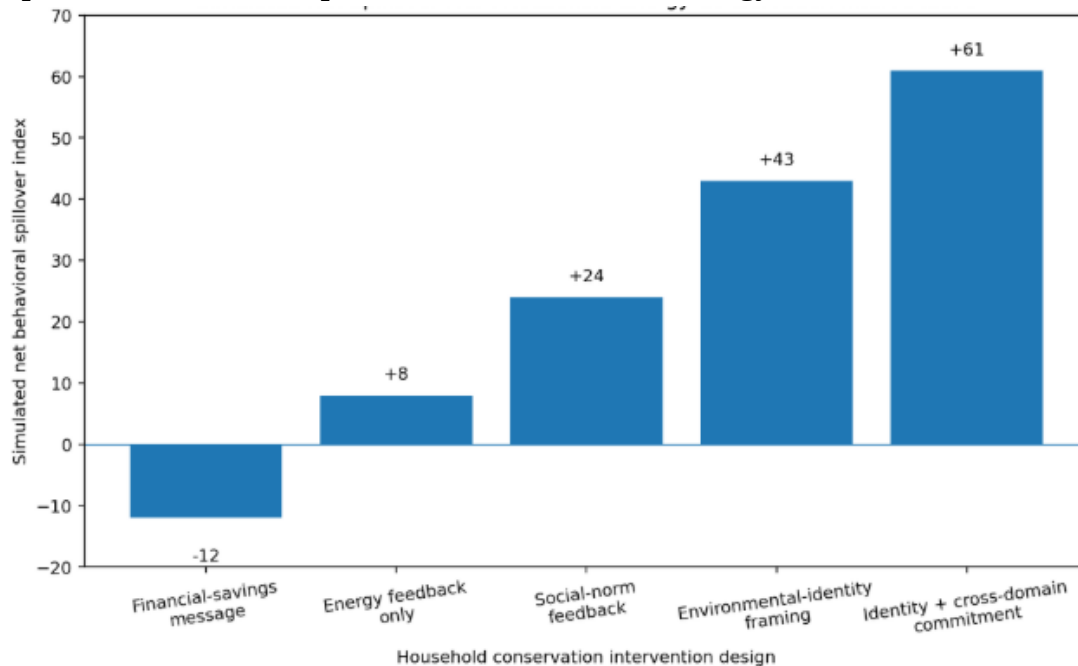
Note: All values are hypothetical simulation scores and do not represent observed household responses. The final two configurations perform substantially more strongly because they reinforce the meaning of the initial action. Environmental identity provides a psychological bridge between otherwise distinct behaviors, while explicit cross-domain commitment converts a general possibility of spillover into a structured next step.

5.2 Net Positive and Negative Spillover Balance

A second simulated indicator represents the net direction of likely spillover mechanisms rather than the broader BSPI criteria. Negative values indicate that compensatory or externally motivated mechanisms dominate the scenario, whereas positive values indicate increasing dominance of identity, consistency, efficacy, and cross-domain continuation.

The financial-savings scenario produces a simulated net spillover index of -12. Energy feedback alone reaches 8, social-norm feedback 24, environmental-identity framing 43, and environmental identity combined with cross-domain commitment 61.

Graph 1: Simulated Net Spillover From Household Energy-Conservation Interventions



The graph should not be interpreted as an empirical effect-size comparison. Its purpose is to visualize how the balance of theoretical spillover mechanisms changes as program design moves from narrow external motivation toward environmental meaning and structured behavioral continuation.

The negative score assigned to financial framing does not imply that financial incentives are inherently counterproductive. Economic motivation can produce substantial direct conservation and may be necessary for costly energy-efficiency investments. The simulated negative net value instead reflects the possibility that financial framing alone provides a weaker psychological basis for generalization to environmental actions that do not deliver comparable personal savings. Evidence from electricity-saving studies similarly indicates that environmental framing can produce stronger broader climate-friendly intentions than a purely monetary appeal.

5.3 Pathways From Energy Conservation to Wider Household Behavior

The analysis suggests that positive spillover can be designed as a behavioral sequence. The initial energy action should first be sufficiently feasible to generate genuine accomplishment. Feedback should then make the successful behavior visible without implying that the environmental task has been completed. Identity-relevant communication can connect this success with a broader environmental self-concept.

A related subsequent behavior can then be introduced. For example, a household successfully reducing standby electricity could next be encouraged to optimize appliance use, reduce hot-water energy demand, or select efficient replacement equipment. After competence and identity are reinforced within the household energy domain, the sequence could extend toward waste reduction, water conservation, sustainable purchasing, or mobility.

This staged model is more defensible than assuming spontaneous transfer between highly dissimilar actions. Research on self-efficacy suggests that successful easier actions can support

progression toward more demanding behavior, while meta-analytic evidence indicates stronger positive spillover when behaviors are relatively similar.

The strategy should nevertheless avoid framing the first behavior as trivial. If households are told that a very minor conservation action represents a major contribution, the communication may encourage premature satisfaction rather than progression. The intervention should instead acknowledge achievement while presenting conservation as part of an ongoing set of household choices.

6. Discussion

6.1 Why Target Energy Savings Are an Incomplete Measure of Program Success

The primary implication of this study is that household conservation programs should not be evaluated exclusively through the energy behavior they directly target. A reduction in electricity use is environmentally valuable, but its net contribution becomes larger or smaller depending on what happens elsewhere in the household's consumption portfolio.

The empirical literature provides evidence for both possibilities. Tiefenbeck and colleagues observed reduced use of one target resource alongside increased electricity consumption, while Carlsson, Jaime, and Villegas found positive electricity spillover for particular households exposed to another resource-conservation intervention. These contrasting findings demonstrate why a program's cross-domain consequences must be measured rather than inferred from its direct effectiveness.

Maki and colleagues' meta-analysis reinforces this caution. Positive spillover was modest for behavioral intentions, while average effects for actual subsequent behaviors were approximately neutral or slightly negative. Programs that report only stated intentions may therefore overestimate wider environmental benefits. Objective indicators should be used wherever practical, including meter data, purchasing records, observable participation, or repeated behavioral measures.

Evaluation boundaries should also extend beyond immediate follow-up. Some spillover effects may emerge gradually as identity and habits develop, whereas other effects may disappear when intervention salience declines. Longitudinal measurement is therefore necessary for determining whether conservation becomes embedded in household routines or remains a temporary response to external communication.

6.2 Identity and Self-Efficacy as Bridges Between Behaviors

Environmental self-identity provides one of the strongest conceptual mechanisms for explaining why an energy-saving behavior might influence another action. When households attribute conservation to environmental values, subsequent choices can become opportunities to preserve consistency with the same self-concept. This interpretation differs from a campaign that treats each environmental behavior as an independent decision requiring a new incentive.

Lacasse's experimental work demonstrates that explicitly connecting past behavior with environmental identity can strengthen positive spillover pathways. Lauren and colleagues similarly show that self-perceptions associated with past environmental behavior can influence later environmental intentions. The present simulation consequently gives environmental-identity framing a substantially stronger spillover profile than financial messaging alone.

However, identity communication should remain credible. Labeling a household as highly environmental after a negligible action may appear manipulative or may produce a sense that enough has

already been accomplished. Identity cues are more likely to be defensible when they accurately acknowledge meaningful effort and connect it with further opportunities for consistent action.

Self-efficacy complements identity by addressing capability rather than values. Households may care about environmental protection but doubt whether their own behavior can make a meaningful difference or whether more demanding conservation measures are feasible. Feedback showing successful reduction can strengthen perceived competence. Lauren and colleagues' findings support the role of self-efficacy in progression from easier toward more difficult environmental actions. Combining identity with efficacy may therefore be more powerful than relying on either mechanism alone.

6.3 Designing Household Energy Programs for Constructive Spillover

Spillover-sensitive energy programs should begin with a clearly specified primary conservation objective but should be designed from the outset to avoid closing the behavioral pathway after that objective is reached. Environmental framing can explain why conservation matters beyond household finances, while personalized feedback can demonstrate that behavior has observable consequences.

Normative information can add social meaning but requires careful construction. Schultz and colleagues demonstrate that households already performing better than the descriptive norm can move in an undesirable direction when they learn that their consumption is below the neighborhood average. An injunctive indication that their lower consumption is socially desirable can reduce this risk. Conservation reports should therefore recognize good performance rather than accidentally communicating that additional consumption remains socially normal.

Program sequencing should also account for behavioral difficulty. Initial behaviors should be achievable enough to establish efficacy, but subsequent stages should progress toward higher-impact actions. An intervention that generates spillover only among many very low-impact actions may produce limited environmental value even when behavioral consistency increases. Thøgersen and Crompton make a similar distinction between easy environmental actions and the more substantial changes required for meaningful sustainability transitions.

Finally, policymakers should distinguish financial support from financial framing. Subsidies and economic incentives may be essential for energy-efficient appliances, insulation, renewable technologies, and other capital-intensive improvements. The behavioral concern is not the existence of financial support but whether the program communicates conservation exclusively as private monetary gain. Combining legitimate economic benefits with environmental purpose, social contribution, and progress toward wider household sustainability may preserve target effectiveness while increasing the possibility of constructive spillover.

7. Conclusion

Behavioral spillovers complicate the conventional evaluation of household energy-conservation programs. An intervention that reduces electricity consumption can influence environmental behavior beyond the targeted action, but the direction of this influence is not predetermined. Positive spillover can occur when conservation strengthens environmental identity, self-efficacy, personal norms, and behavioral consistency. Negative spillover can emerge when an initial action creates perceived moral

credit, reduces the sense of further obligation, or remains psychologically confined to an external financial incentive.

The simulation developed in this study demonstrates how intervention design can alter these underlying conditions. Financial-savings messaging receives the weakest simulated net spillover score, while progressively stronger results are associated with feedback, carefully designed social norms, environmental-identity framing, and explicit cross-domain commitment. The highest-scoring configuration does not merely tell households to use less electricity. It enables them to recognize successful conservation, interpret the action as part of a broader environmental orientation, and transfer that orientation toward another meaningful behavior.

These findings do not imply that environmental framing will always produce positive spillover or that monetary incentives should be abandoned. Empirical research demonstrates substantial heterogeneity, and aggregate spillover effects are often small. The appropriate policy response is therefore measurement rather than assumption. Conservation trials should track non-target behaviors, include sufficiently long follow-up periods, distinguish intentions from actual behavior, and examine whether effects differ among household groups.

Future empirical research should test the proposed Behavioral Spillover Potential Index using randomized household interventions combining smart-meter data with repeated measurement of water use, transportation, sustainable purchasing, waste reduction, energy-efficiency investment, and environmental-policy support. Studies should also examine whether behavioral similarity, intervention duration, income, dwelling type, existing environmental identity, and baseline energy efficiency moderate spillover. Such evidence would allow household energy programs to move from isolated conservation campaigns toward carefully sequenced behavioral strategies in which one successful action becomes a credible foundation for broader and more durable low-carbon lifestyles.

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