

Why Households Adopt Rooftop Solar: An Integrative Review of Economic, Social and Psychological Determinants and its Implications for India's PM-Surya Ghar Programme

Dr. Geetanjali Shrivastava¹ | Vishwa Ahuja^{2*}

¹Professor, Department of Commerce, The Bhopal School of Social Sciences, Bhopal, India.

²Research Scholar, Department of Commerce, The Bhopal School of Social Sciences (Research Centre of Barkatullah University), Bhopal, India.

*Corresponding Author: vishwa.ahuja005@gmail.com

Citation: Shrivastava, G. & Ahuja, V. (2026). Why Households Adopt Rooftop Solar: An Integrative Review of Economic, Social and Psychological Determinants and its Implications for India's PM-Surya Ghar Programme. International Journal of Innovations & Research Analysis, 06(03(II)), 26–30. [https://doi.org/10.62823/IJIRA/06.3\(II\).9495](https://doi.org/10.62823/IJIRA/06.3(II).9495)

Abstract

India has set out to equip ten million households with rooftop solar systems under the PM-Surya Ghar: Muft Bijli Yojana, approved in 2024 with an outlay of ₹75,021 crore. Whether households take up the offer depends not only on subsidies but on how they perceive the technology, the advice they receive and the behaviour of their neighbours. This paper reviews the international research on residential solar photovoltaic adoption to identify which determinants matter most and what they imply for the design of the Indian programme. Drawing on reviews covering several hundred predictors, a meta-analysis of adoption intentions, and causal studies of peer effects, the review organises the determinants into four groups: perceived benefits and economic expectations; perceived behavioural control and barriers; social influence and visibility; and personal values and technical interest. Three conclusions emerge. Perceived benefits, rather than socio-demographic characteristics, are the strongest predictor of the intention to adopt; installed systems in the neighbourhood measurably raise the probability that others will adopt; and informational and transactional barriers can deter adoption even when a system is financially attractive. The paper maps these determinants against the design features of PM-Surya Ghar, identifies where the programme already addresses them and where gaps remain, and proposes an agenda for research on Indian households, including renters, apartment dwellers and rural consumers.

Keywords: Rooftop Solar, Residential Photovoltaics, Technology Adoption, Theory of Planned Behaviour, Peer Effects, Pm-Surya Ghar, India.

Introduction

Rooftop solar brings electricity generation into the home. Unlike utility-scale plants, whose deployment depends on a small number of developers and auctions, residential systems require millions of separate decisions by households that are not energy specialists. The speed at which residential solar spreads therefore depends as much on behaviour as on technology or cost.

India has made this behaviour a matter of national policy. In February 2024 the Union Cabinet approved PM-Surya Ghar: Muft Bijli Yojana, with an outlay of ₹75,021 crore, to install rooftop solar and provide up to 300 units of free electricity a month to ten million households (Government of India, 2024). The programme offers central financial assistance capped at 3 kW, equivalent at the benchmark prices then prevailing to ₹30,000 for a 1 kW system, ₹60,000 for 2 kW and ₹78,000 for systems of 3 kW or more, together with access to collateral-free loans at around 7 per cent and a national portal that helps households choose a system size, estimate benefits and select a rated vendor (Government of India, 2024).

A large international literature has examined why some households adopt residential solar and others do not. It spans economics, marketing, geography and psychology, and has produced a bewildering number of explanatory variables: one systematic review of 173 studies identified 333 distinct predictors (Alipour et al., 2020). For a programme designer, the question is which of these determinants matter most and which can be influenced by policy. This paper addresses that question. It synthesises the evidence into four groups of determinants, distinguishes those that are well supported from those that are not, and maps them against the design of PM-Surya Ghar to identify where the programme is likely to succeed and where it may fall short.

Method

The paper adopts an integrative review design. Studies were identified through keyword searches of academic databases and backward citation tracking, using terms such as residential photovoltaic adoption, rooftop solar, peer effects, theory of planned behaviour and barriers to solar adoption. Priority was given to systematic reviews and meta-analyses, which summarise large bodies of evidence, and to studies with designs capable of identifying causal effects, such as the analysis of installation records over time and space. Qualitative studies were included where they illuminate motives that quantitative work cannot easily capture. The findings were coded by determinant and grouped into four themes. The review is selective and conceptual; it does not attempt a statistical synthesis of its own. The principal studies are summarised in Table 1.

Theoretical Lenses

Two theoretical traditions dominate the literature. The first is the theory of planned behaviour, which holds that a person's intention to perform a behaviour is predicted by their attitude toward it, the subjective norm, meaning their perception of what important others expect, and their perceived behavioural control, meaning their sense of how easy or difficult the behaviour would be; intention, together with perceived control, then predicts behaviour (Ajzen, 1991). Applied to rooftop solar, the theory directs attention to how households evaluate the benefits of a system, whether they believe their neighbours and family approve, and whether they feel able to carry the project through.

The second tradition treats adoption as diffusion through a social system, in which the decision of one household influences others through observation and communication. This perspective gives a central place to peer effects and to the visibility of the technology. The two traditions are complementary: one explains the individual decision, the other its spread across a population, and the empirical studies reviewed below draw on both.

Determinants of Household Adoption

• **Perceived Benefits and Economic Expectations**

The most robust finding in the literature is that households adopt rooftop solar when they perceive it to be beneficial. A meta-analytic structural equation analysis of eight homogeneous studies, with a pooled sample of 1,714 respondents, found that perceived benefits were the strongest predictor of the intention to adopt a residential system, and that adoption intention was jointly predicted by benefits and perceived behavioural control (Schulte et al., 2022). In the same analysis, socio-demographic variables such as income and age were uncorrelated with intention. This implies that programmes should aim to change how households perceive the benefits of solar rather than target particular demographic groups.

Economic expectations are part of these benefits, but their influence is subtler than a simple payback calculation would suggest. In a survey of adopters in northern California, expected financial returns and concerns about operation and maintenance were the main factors determining how households adopted, for instance whether they bought or leased a system (Rai et al., 2016). Interviews with early adopters in Wisconsin found that a narrow calculation of return on investment or payback period was less important than the timing of economic events in the household, such as the availability of savings or an inheritance (Schelly, 2014).

• **Perceived Behavioural Control and Barriers**

Even when the benefits are clear, adoption can be deterred by the effort and uncertainty involved. A systematic review of barriers to photovoltaic adoption found that they persist in both low- and high-income economies and fall into four dimensions: socio-technical, managerial, economic and policy-related (Karakaya & Sriwannawit, 2015). The authors concluded that overcoming them requires the

involvement of adopters, local communities, firms, financial institutions and governments. Rai et al. (2016) emphasised that system cost is not the only barrier: potential adopters also face informational barriers that impose high indirect costs during the search for information, and installers and neighbours play important, often complementary, roles in reducing them.

- **Social Influence and Visibility**

The strongest causal evidence in the literature concerns the influence of neighbours. Using installation data from California and a method designed to avoid the biases of conventional estimates, Bollinger and Gillingham (2012) found that, at the average number of owner-occupied homes in a zip code, one additional installation increased the probability of another adoption in that zip code by 0.78 percentage points. A study of Connecticut found that adoptions cluster spatially in a pattern that does not simply follow income or population, that smaller centres contributed to adoption more than large urban areas, and that the influence of nearby systems diminished with distance and time, consistent with a neighbour effect transmitted through social interaction and visibility (Graziano & Gillingham, 2015).

- **Personal Values and Technical Interest**

Environmental concern is often assumed to drive adoption, but the evidence is mixed. In the meta-analysis of Schulte et al. (2022), environmental concern, novelty seeking and subjective norm explained a large share of the variation in perceived benefits, suggesting that values work through the perception of benefits rather than directly. The qualitative evidence of Schelly (2014) cautions that environmental values alone are neither sufficient nor always necessary to motivate adoption, and identifies an interest in technical innovation and enjoyment of the technical aspects of energy systems as an unexpected motive among early adopters. Comparable patterns appear for other household solar technologies: a review of 100 studies on residential solar water heaters found that certain attitudinal attributes influenced take-up more strongly than some common factors such as the cost of electricity (Ghaboulain Zare et al., 2021).

Table 1: Principal Studies Synthesised in the Review

Study	Design and setting	Principal finding
Alipour et al. (2020)	Systematic review of 173 studies	Identified 333 predictors of residential solar adoption, grouped into a taxonomy
Schulte et al. (2022)	Meta-analytic structural equation model; 8 studies, N = 1,714	Perceived benefits strongest predictor of intention; socio-demographics uncorrelated with intention
Bollinger & Gillingham (2012)	Installation records, California	One additional installation raises local adoption probability by 0.78 percentage points
Graziano & Gillingham (2015)	Spatial panel of installations, Connecticut	Adoption clusters; neighbour effect declines with distance and time
Rai et al. (2016)	Survey of adopters, northern California	Informational barriers matter; installers and neighbours shape the decision and its mode
Karakaya & Sriwannawit (2015)	Systematic review of barriers	Barriers persist in all economies across socio-technical, managerial, economic and policy dimensions
Schelly (2014)	Interviews with 48 early adopters, Wisconsin	Environmental values not sufficient; timing of household finances and technical interest matter

Source: Compiled by the authors from the studies cited.

Implications for the Design of PM-Surya Ghar

Table 2 maps the four groups of determinants against the design of PM-Surya Ghar as described in the Cabinet approval (Government of India, 2024). The programme addresses several determinants directly. The capital subsidy and concessional loans reduce the economic barrier, and the promise of free electricity makes the benefit concrete and easy to grasp, which matters because perceived benefits are the strongest predictor of intention. The national portal, with its benefit calculator and vendor ratings, is in effect an intervention against the informational barriers documented by Rai et al. (2016).

Table 2: Determinants of Adoption Mapped to the Design of PM-Surya Ghar

Determinant (Evidence)	Programme Feature Addressing it	Remaining Gap
Perceived benefits (Schulte et al., 2022)	Up to 300 units of free electricity a month; capital subsidy	Benefits must be communicated in household terms and realised promptly after installation
Economic barriers and timing (Rai et al., 2016; Schelly, 2014)	Central financial assistance up to 3 kW; collateral-free loans at about 7%	Households without savings or credit history may still face upfront costs and paperwork
Informational and transactional barriers (Karakaya & Sriwannawit, 2015; Rai et al., 2016)	National portal with sizing, benefit calculator and vendor ratings	Digital access, local-language support and post-installation service are not guaranteed by a portal
Peer effects and visibility (Bollinger & Gillingham, 2012; Graziano & Gillingham, 2015)	Mass awareness campaign	No explicit mechanism to seed early adopters in each locality or to publicise local installations
Trusted advisers (Rai et al., 2016)	Vendor ratings on the portal	Quality assurance and grievance redress for installers

Source: Compiled by the authors from Government of India (2024) and the studies cited.

The review also points to gaps. The strongest causal evidence concerns peer effects, yet a national awareness campaign is a different instrument from the local, visible demonstration that the evidence suggests drives diffusion. Because the influence of neighbours diminishes with distance (Graziano & Gillingham, 2015), seeding installations in each locality, for instance among community institutions or early adopters, and making them visible may accelerate take-up more than generic advertising. Second, because households rely on installers throughout the decision (Rai et al., 2016), the quality and reliability of local vendors will shape not only individual outcomes but the reputation of the technology in each neighbourhood. Third, the evidence that socio-demographic characteristics do not predict intention (Schulte et al., 2022) suggests that the programme should not assume that lower-income households are uninterested; their constraint is more likely to be perceived behavioural control, such as access to credit, roof ownership and confidence in navigating the process.

Research Agenda

Most of the evidence reviewed comes from the United States and Europe, where adopters are typically owner-occupiers of detached houses. Indian households differ in ways that the literature has barely examined. Research is needed on households in multi-storey apartment buildings, where roof space is shared; on renters, who may benefit little from investing in a building they do not own; and on rural households, whose electricity tariffs and supply reliability differ from those of urban consumers. Studies of the role of women in household energy decisions, of trust in vendors and distribution companies, and of the time taken to obtain net-metering connections would help to explain the gap between interest and adoption. Finally, as PM-Surya Ghar generates administrative data, the spatial spread of installations could be analysed to test whether the neighbour effects documented in California and Connecticut also operate in Indian towns and villages.

Conclusion

The international evidence suggests that households adopt rooftop solar when they perceive clear benefits, when they feel able to manage the process, and when they see neighbours who have already done so. PM-Surya Ghar addresses the first two of these conditions through its subsidy, free electricity, concessional finance and national portal. Its success may depend on whether it can also harness the third, by making local installations visible and by ensuring that the installers on whom households rely deliver reliable systems and service. The review is limited by its selective scope and by the scarcity of Indian evidence, and its conclusions are offered as a basis for empirical testing as the programme unfolds.

Declarations

- *Funding.* This research received no specific grant from any funding agency.
- *Conflict of interest.* The authors declare that they have no conflict of interest.

- **Data availability.** No new data were generated; all sources are cited in the reference list.
- **Author contributions.** Geetanjali Shrivastava: conceptualisation, supervision, review and editing.
- Vishwa Ahuja: conceptualisation, literature search, synthesis, writing of the original draft.

References

1. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
2. Alipour, M., Salim, H., Stewart, R. A., & Sahin, O. (2020). Predictors, taxonomy of predictors, and correlations of predictors with the decision behaviour of residential solar photovoltaics adoption: A review. *Renewable and Sustainable Energy Reviews*, 123, Article 109749. <https://doi.org/10.1016/j.rser.2020.109749>
3. Bollinger, B., & Gillingham, K. (2012). Peer effects in the diffusion of solar photovoltaic panels. *Marketing Science*, 31(6), 900–912. <https://doi.org/10.1287/mksc.1120.0727>
4. Ghaboulian Zare, S., Hafezi, R., Alipour, M., Parsaei Tabar, R., & Stewart, R. A. (2021). Residential solar water heater adoption behaviour: A review of economic and technical predictors and their correlation with the adoption decision. *Energies*, 14(20), Article 6630. <https://doi.org/10.3390/en14206630>
5. Government of India. (2024, February 29). *Cabinet approves PM-Surya Ghar: Muft Bijli Yojana for installing rooftop solar in one crore households* [Press release]. Prime Minister's Office. <https://www.pmindia.gov.in>
6. Graziano, M., & Gillingham, K. (2015). Spatial patterns of solar photovoltaic system adoption: The influence of neighbors and the built environment. *Journal of Economic Geography*, 15(4), 815–839. <https://doi.org/10.1093/jeg/lbu036>
7. Karakaya, E., & Sriwannawit, P. (2015). Barriers to the adoption of photovoltaic systems: The state of the art. *Renewable and Sustainable Energy Reviews*, 49, 60–66. <https://doi.org/10.1016/j.rser.2015.04.058>
8. Rai, V., Reeves, D. C., & Margolis, R. (2016). Overcoming barriers and uncertainties in the adoption of residential solar PV. *Renewable Energy*, 89, 498–505. <https://doi.org/10.1016/j.renene.2015.11.080>
9. Schelly, C. (2014). Residential solar electricity adoption: What motivates, and what matters? A case study of early adopters. *Energy Research & Social Science*, 2, 183–191. <https://doi.org/10.1016/j.erss.2014.01.001>
10. Schulte, E., Scheller, F., Sloom, D., & Bruckner, T. (2022). A meta-analysis of residential PV adoption: The important role of perceived benefits, intentions and antecedents in solar energy acceptance. *Energy Research & Social Science*, 84, Article 102339. <https://doi.org/10.1016/j.erss.2021.102339>

