UNDERSTANDING SOLAR PHOTOVOLTAIC INVESTMENT DECISIONS IN THE RESIDENTIAL SECTOR: OUTCOMES FROM THE HOUSEHOLD SOLAR ENERGY SURVEY

Author & Presenter: N Korsten BBA, PGDip, MPhil – Researcher, Stellenbosch University Centre for Renewable and Sustainable Energy Studies

Co-author: K Kritzinger BCom, BPhil, MPhil – Senior Researcher Stellenbosch University Centre for Renewable and Sustainable Energy Studies

Co-author: L Scholtz BA LLB, MBA, MPhil – Programme Manager, Urban Futures Unit, WWF-SA

1. Introduction

Investments in solar photovoltaic (PV) rooftop installations by households have increased significantly in the past few years. This is true both internationally and in South Africa. This development might be positive in terms of environmental sustainability, but it has consequences for electricity utilities; it impacts grid management and maintenance and affects their financial sustainability.

This paper provides first results of an electronic survey conducted in May to August 2018. The survey aims to provide a deeper understanding of energy transitions at a local level, driven by private household investments in renewable energy (RE) technologies, especially rooftop PV and focussed on the PV investment decisions of survey respondents.

International studies show that PV adoption investment are influenced by financial-, social- and environmental factors. Of these, literature shows that financial factors are the strongest (Fleiß, Hatzl, Seebauer & Posch, 2017; Korcaj, Hahnel & Spada, 2015; Simpson & Clifton, 2017). However, the attitude of peers and influencers also have an effect on drawing people over the line (Jayaraman, Paramasivan & Kiumarsi, 2017; Kastner & Stern, 2015; Korcaj *et al.*, 2015; Palm, 2016, 2017; Rode & Weber, 2016; Wolske, Stern & Dietz, 2017).

There was a total of 2 778 responses to the survey. After the data cleaning, a total of 2 707 responses were left for analysis. Of these, 271 respondents already have PV installed on their homes, 29 whom live in remote off grid areas. As the reasons for PV installations of these respondents are more focussed on necessity and different from the sample group, it was decided not to include these in this paper. This leaves a total of 2 678 survey responses analysed, including 242 households with grid-connected rooftop PV systems.

Of the 2 436 respondents who do not have rooftop PV installed, 2 141 respondents indicated that they might want to invest in the technology in the next 5 years. Only 295 respondents indicated that they are not planning to invest in solar panels at all. See Figure 1.

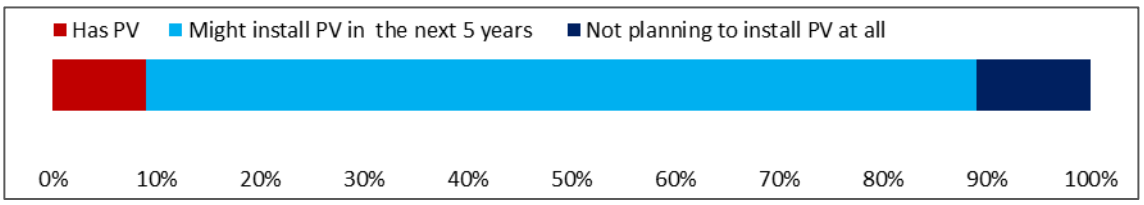

Figure 1: Analysis of survey respondents (cleaned data)

All survey questions were designed in such a way that the answers reveal the reasoning of survey respondents as to why they already invested in rooftop PV or why they might invest in rooftop PV in the future (or why they are not planning it at all). The survey questions were also asked in a similar way to the different groups so that the answers can be compared.

Of the 242 survey respondents who have rooftop PV installed, only 25% indicated that their electricity provider is aware of the installation (thus unregistered). 38% of the respondents said that their electricity provider is not aware of their installation (thus unregistered) and a further 35% said that they do not know whether their electricity provider knows about the installation.

2. Analysis of survey respondents

Survey respondents with PV installations were more likely to have credit meters and pay for electricity on a monthly or yearly basis (57%). These meters can most often spin backwards when PV electricity generation exceeds usage, which results in net-metering. This is not possible with pre-paid meters. 54% of survey respondents who might invest in PV in the coming 5 years have credit meters and 44% have pre-paid meters. See Figure 2.

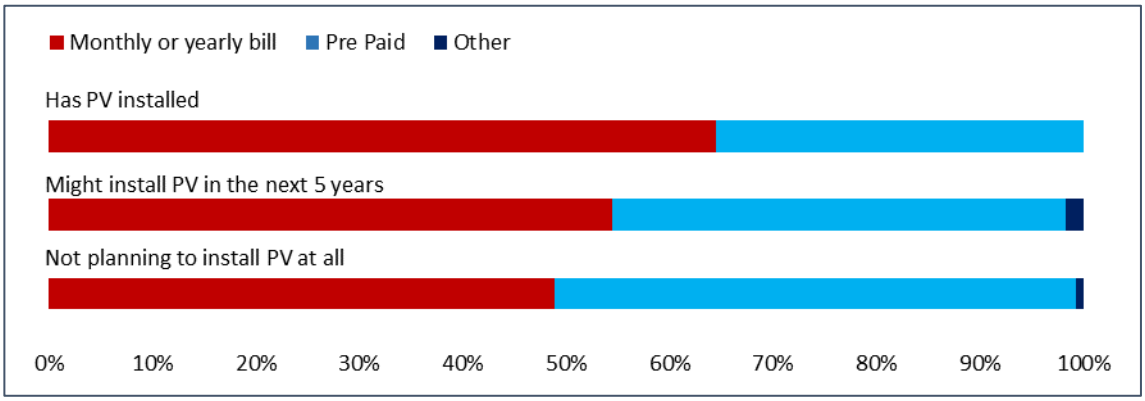

Figure 2: Survey respondents' electricity payments

People who have PV installed are more often home-owners (almost 90%) when compared to survey respondents without PV. 77% of the respondents who might invest in PV in the next 5 years, own the property they are living in. 74% of the people who are not planning to invest in rooftop PV own their houses. It was expected that homeownership would have a stronger influence in the PV investment decision and it is surprising that just over 10% of survey respondents who have rooftop PV installed, do not own their house. See Figure 3.

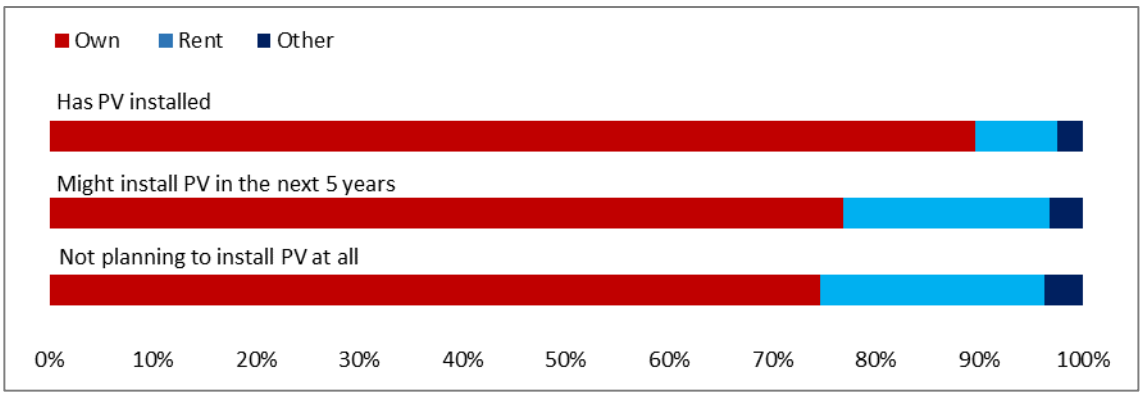

Figure 3: Home ownership of survey respondents

This result correlates well with international studies, indicating a higher likelihood for investing in rooftop solar PV for homeowners (Briguglio & Formosa, 2017; De Groote, Pepermans & Verboven, 2016).

Survey respondents were also asked for the town and suburb they live in. This was done to determine an approximate property value and the correlation of this with the likelihood to invest. This data has not been analysed yet, but will be reported on at a later stage.

Survey respondents were asked about their monthly electricity expenses. There isn't a clear difference between the sample groups. However, the data might indicate that high electricity consumers have brought their bills down by installing PV - compare the respondents who pay more than R2 000 per month for electricity in Figure 4. Respondents who have already invested in rooftop PV are also more likely to have low monthly electricity expenses (more that 15% pay less than R200 per month). See Figure 4.

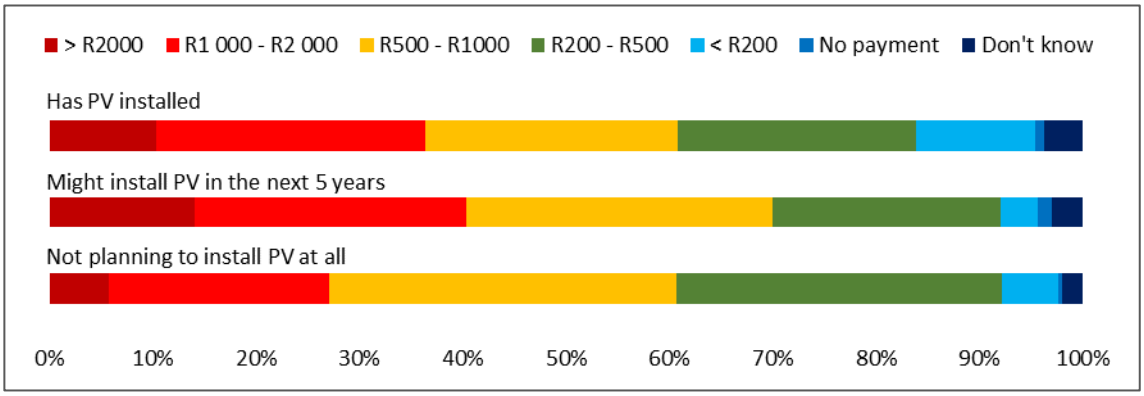

Figure 4: Monthly electricity expenditure

All survey respondents were asked whether they have solar water heaters installed. A significant higher percentage of respondents who already have PV installed also already have solar water heaters installed (65%) than those respondents who don't have PV installed. This shows that solar PV installations are not done in isolation and the same people also invest in other electricity saving technologies, such as solar water heaters. See Figure 5. The survey also included questions about other energy saving devices. However, this data has not been analysed as yet.

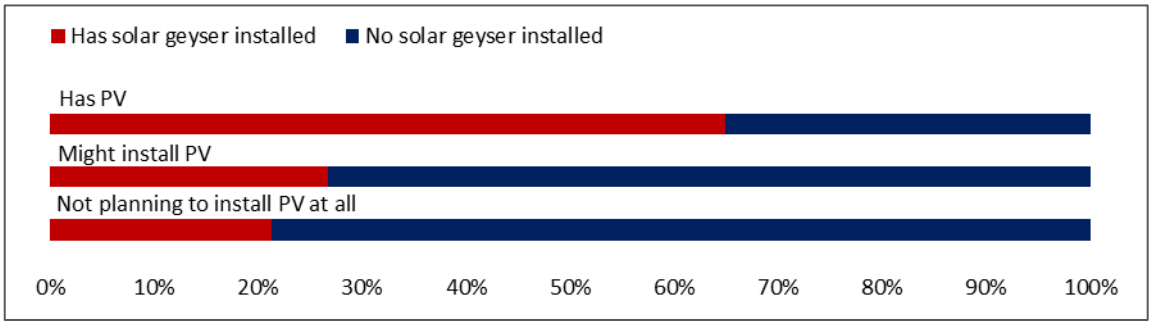

Figure 5: Solar water heater installations of survey respondents

3. Motivating Factors for people to invest in rooftop PV

In this section, three factors that might influence the decision to invest in rooftop PV are discussed, namely; environmental concerns, social influences and financial factors.

3.1 Environmental concerns

The survey tested to what extent environmental concerns influence the decision to invest in rooftop PV installations. The results does not show a significant difference between the sample groups. However, the people who already have rooftop PV installed, indicated a slightly lower significance of environmental concerns in making the investment decision.

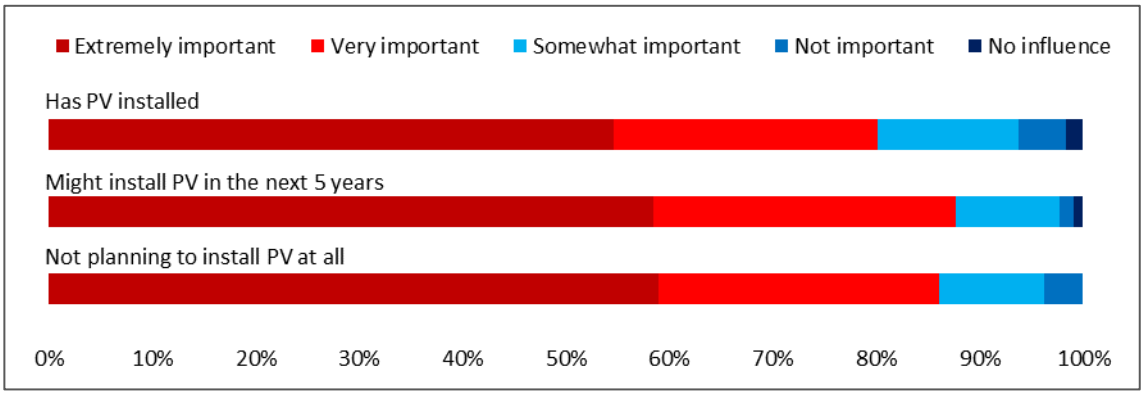

Figure 6: Importance of reducing environmental impact

Survey respondents were asked whether they would like to do more to protect the environment. Yet again, there was an insignificant difference in survey responses with most respondents indicating a high regard for the environment. See Figure 7.

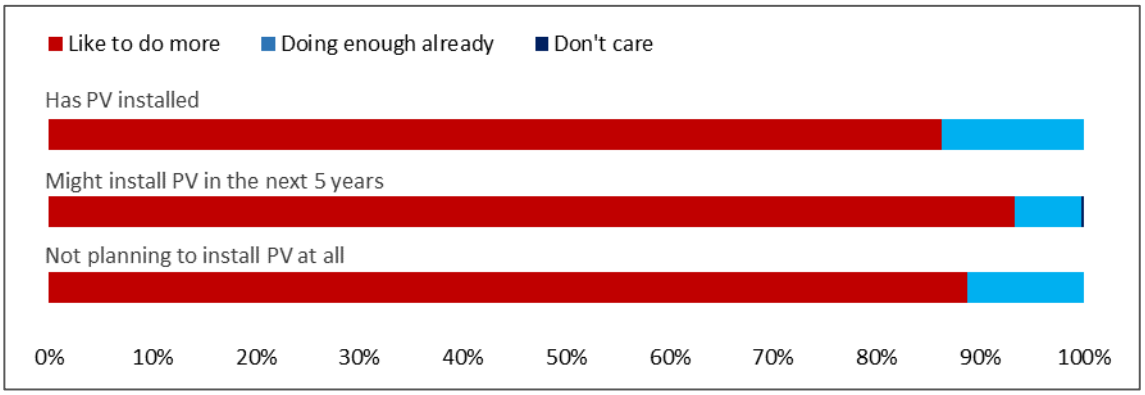

Figure 7: Respondents' view on protection of the environment

Similarly to above, there is no significant difference in survey respondents as to their knowledge of climate change (How informed are you about the issue of climate change)? Survey respondents who already have rooftop PV installed are ever so slightly more likely to be more informed on these issues. See Figure 8.

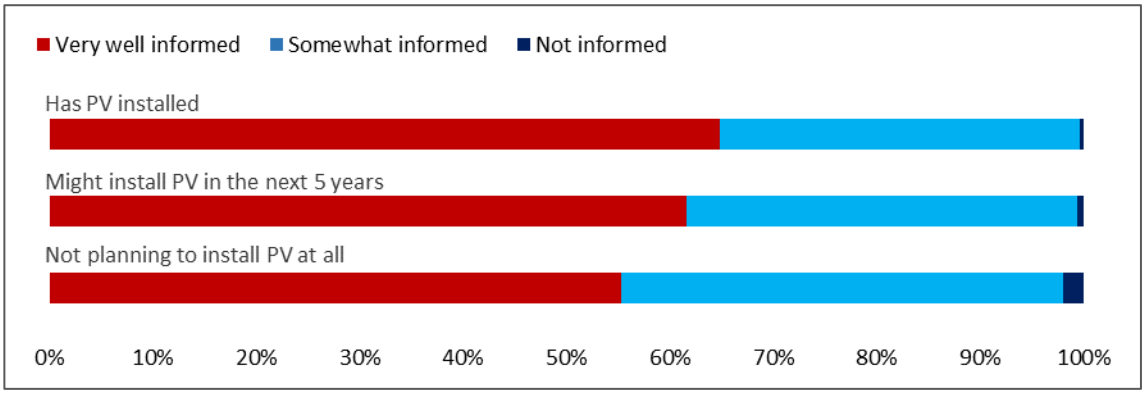

Figure 8: Survey respondents' knowledge of climate change

Most survey respondents agree that electricity generation from coal contributes to climate change. See Figure 9.

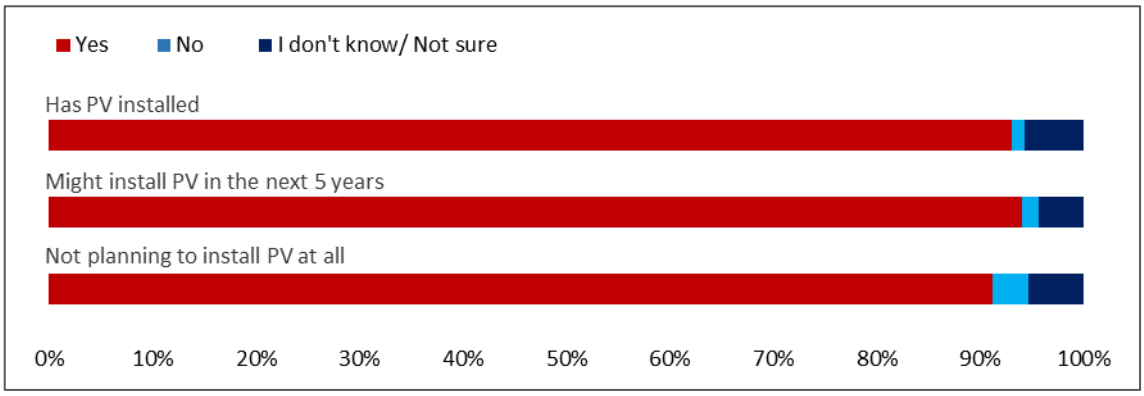

Figure 9: Survey respondents' view on whether electricity from coal contributes to climate change

Survey respondents who already have rooftop PV installed and those who might install PV in the next five years are more inclined to believe that pollution from electricity generation should be taxed. However, this difference is not significant. See Figure 9.

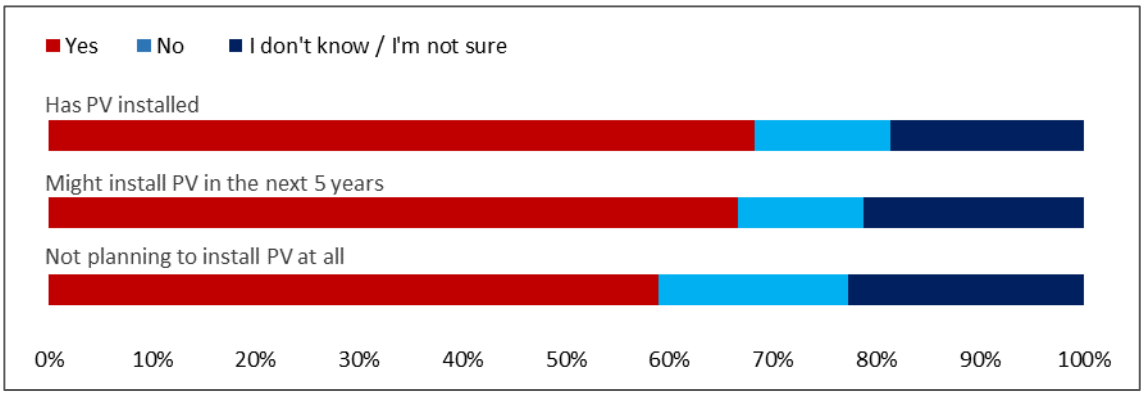

Figure 10: Survey respondents' view on whether electricity generation from coal should be taxed

The recycling habits of survey respondents also do not differ significantly between the sample groups, with most respondents recycling as much as they can. See Figure 10.

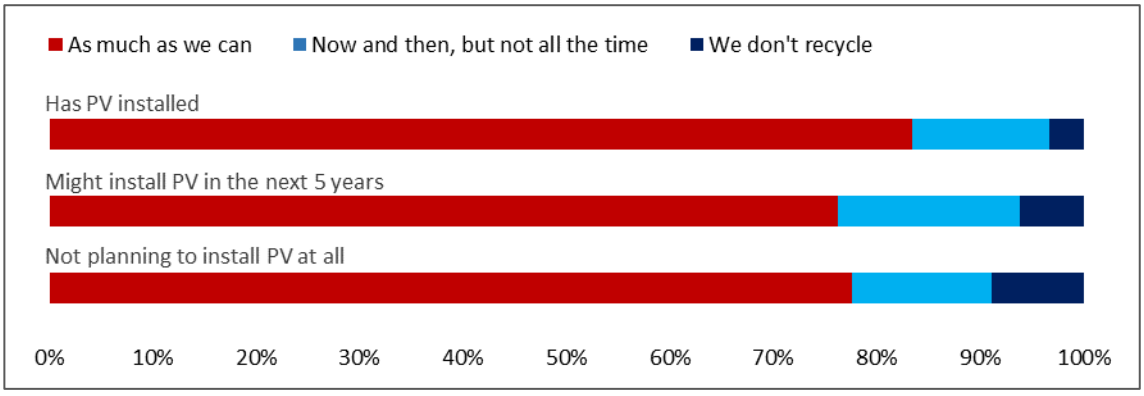

Figure 11: Survey respondents' recycling habits

From the analysis above, it is clear that most respondents care about the environment. No significant difference in environmental attitudes was seen between the sample groups on any of the environmental questions.

3.2 Social influences

International research shows a strong social influence on the decision to invest in rooftop PV. According to Jayaraman *et al.*, (2017), most people that intend to buy a rooftop PV system are influenced by their friends, relatives or close colleagues. A recommendation from a trustworthy source is very important for potential investors (Kastner & Matthies, 2016; Rode & Weber, 2016; Wolske *et al.*, 2017).

In this section, the survey responses on the questions about social influences are analysed.

The survey respondents who already have rooftop solar installations are significantly more likely to know a friend, family member or colleague who also have installations. The survey respondents who are not planning to install rooftop PV at all showed the lowest likelihood of knowing someone with an installation. See Figure 12. This correlates well with international research.

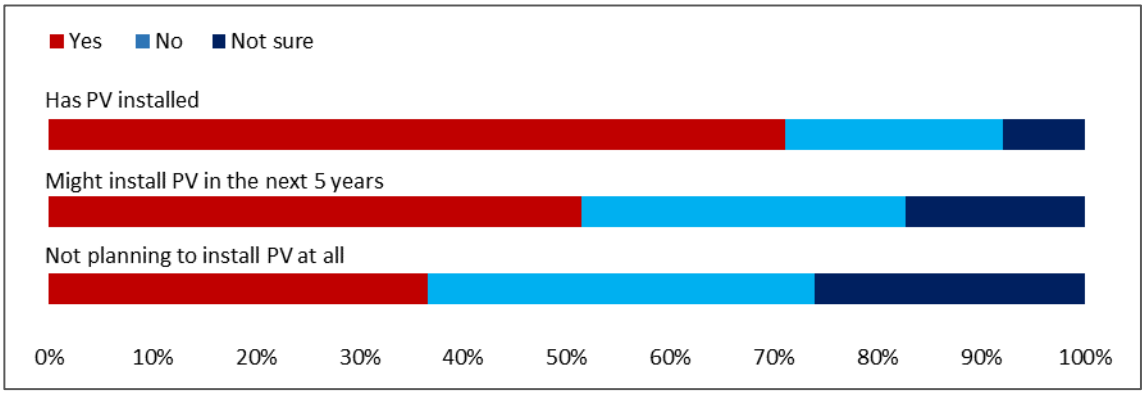

Figure 12: Survey respondents who have family, friends or colleagues who have PV installed

Survey respondents who already have rooftop PV installed, indicated a higher likelihood of other installations in the same neighbourhood. See Figure 13.

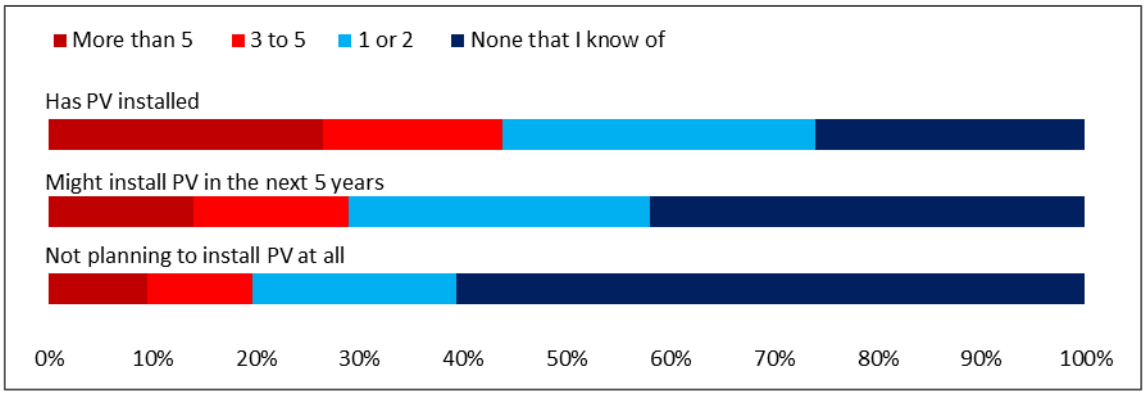

Figure 13: Amount of properties with PV in the neighbourhoods of survey respondents

Survey respondents who indicated that they would invest in solar PV in the next 5 years showed a higher likelihood of; having seen PV installations on other properties; having had conversations about solar PV; have heard or seen advertisements for solar PV and ; have read an article on solar PV. See Figure 14.

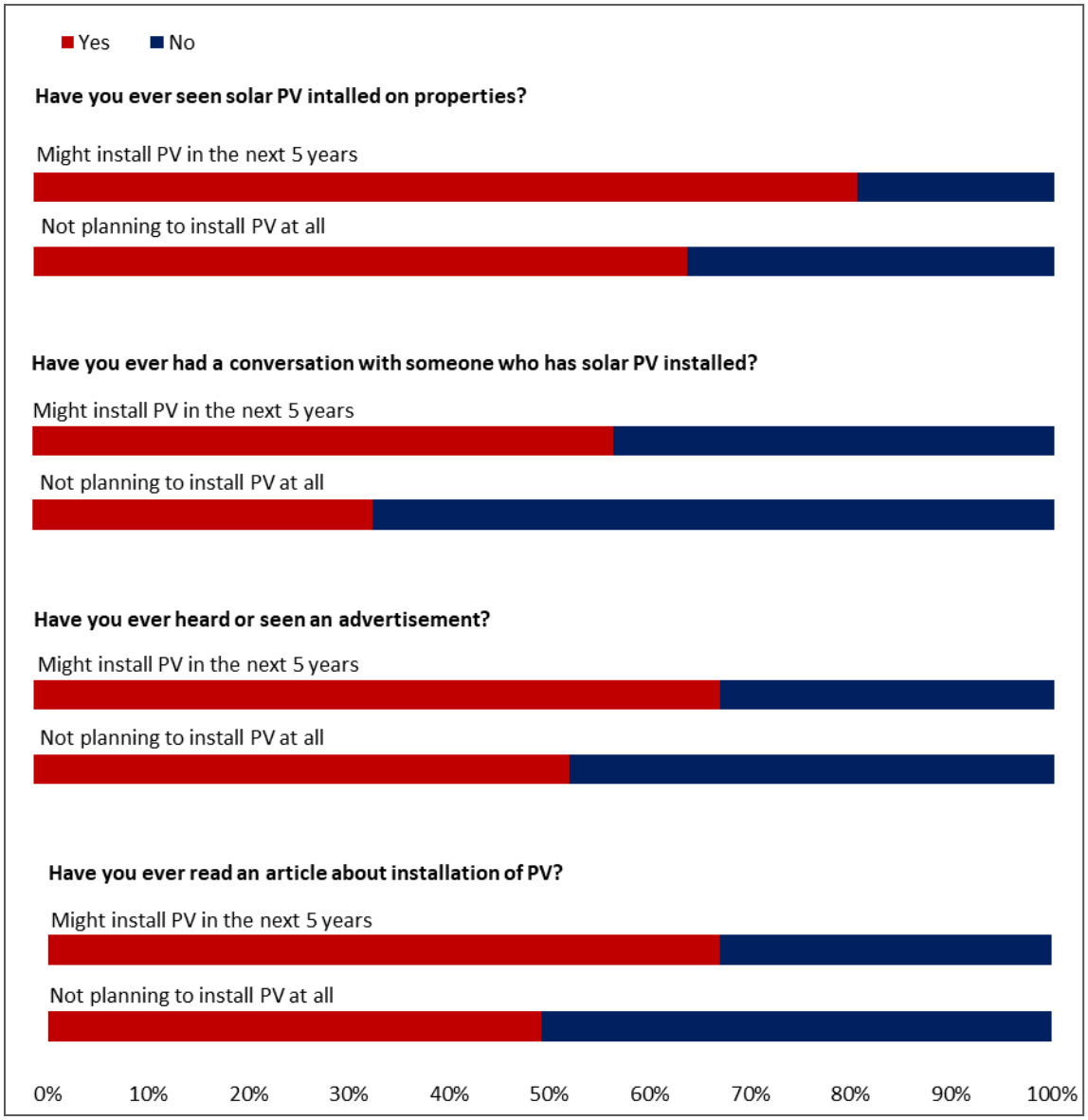

Figure 14: Awareness of PV installations by survey respondents without PV installations

These questions were not asked in the same manner to the survey respondents who already have solar PV installed and those responses are not included here.

It is clear that social influencers play a major role in the decision to install rooftop PV.

3.3 Financial factors

Survey respondents were also queried on whether financial factors influence the decision to install rooftop PV.

Questions were asked about upfront installation costs, reduction of the future electricity bill and the possibility of rising electricity prices to determine how important these are in the investment decision.

Upfront installation costs are considered as a more significant barrier by the survey respondents who don't already have rooftop PV installed than by those who already have. See Figure 15.

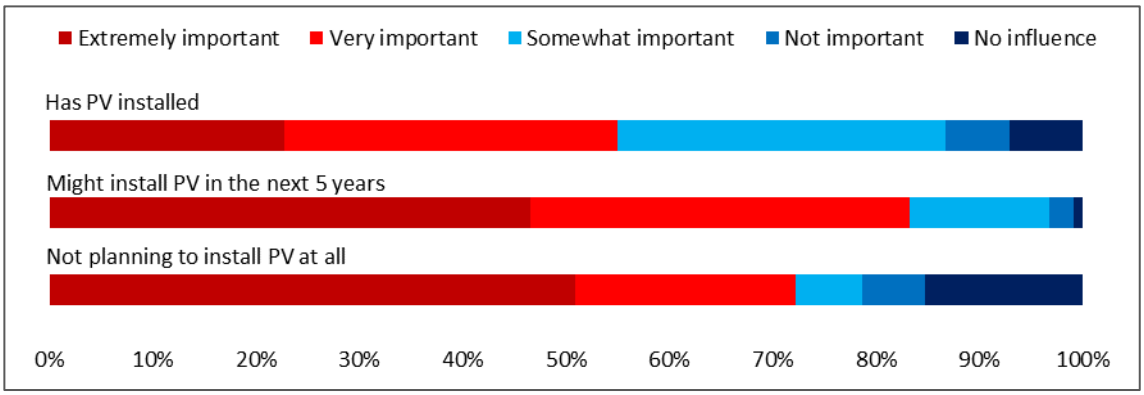

Figure 15: Importance of upfront installation costs of PV in decision to install

There is no significant difference between survey responses on the possible reduction in future electricity bills as an influence to install rooftop PV, with most respondents indicating that it will play a major role. See Figure 16.

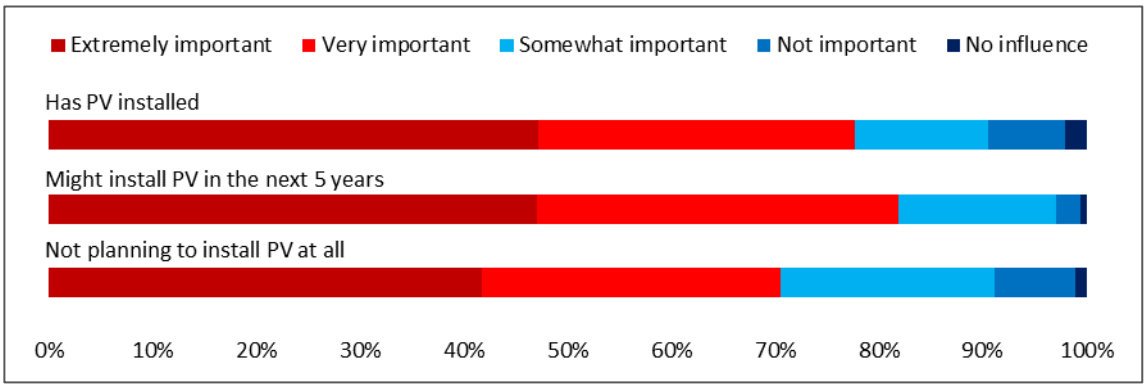

Figure 16: Importance of a reduction of the future electricity bill on the decision to install PV

There is no significant difference between the sample groups on whether rising electricity prices would influence their decision to install rooftop PV. However, survey respondent who already have rooftop PV installed, were more likely to find this factor unimportant. See Figure 17.

This correlates well with international studies where it has been confirmed that the prospect of rising electricity prices is a motivation for people to invest in alternative technologies (Gucciardi Garcez, 2017; Islam & Meade, 2013; Karakaya, Hidalgo & Nuur, 2015).

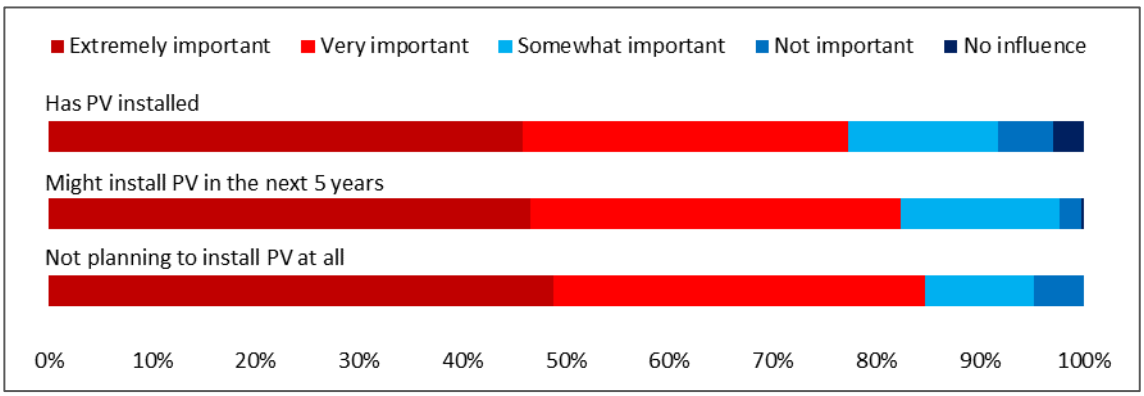

Figure 17: Influence of the possibility of rising electricity prices on the decision to install PV

It can be concluded that in South Africa, the upfront investment costs play a bigger role than the reduction of a household's electricity bill or the possibility of rising electricity prices in future.

International studies have also shown that policy tools to address the upfront investment costs are more impactful than other incentives to stimulate rooftop PV installations (Matisoff & Johnson, 2017).

Other studies have shown that 'saving money' is on top of the list of reasons for people to invest in rooftop PV, but also that saving money on a monthly bill is more important than not having to pay upfront installation costs (AusGrid, 2017; SolarCity, 2015).

4. Conclusion

The results from this survey indicates that the investment decision of households in rooftop PV is mostly influenced by financial and social factors.

No significant difference was found between the sample groups in their environmental concerns and knowledge.

The high upfront cost was indicated as the biggest financial limiting factor for those who have not invested in rooftop PV yet. Survey responses of the sample groups on the possibility of saving on future electricity bills as well as on the rising electricity prices did not show a significant difference. This might indicate that affordability of the high upfront cost plays a bigger role in the investment decision than the possibility of saving in the future.

Knowing someone who already has rooftop PV installed and awareness of PV installations in the neighbourhood was shown as strong influencers to the investment decision.

This paper forms part of an ongoing study funded by WWF-SA and survey responses are being analysed further.

5. References

AusGrid. 2017. *Household Solar Power and Battery Survey*.

Briguglio, M. & Formosa, G. 2017. When households go solar: Determinants of uptake of a Photovoltaic Scheme and policy insights. *Energy Policy*. 108(February):154–162.

Fleiß, E., Hatzl, S., Seebauer, S. & Posch, A. 2017. Money, not morale: The impact of desires and beliefs on private investment in photovoltaic citizen participation initiatives. *Journal of Cleaner Production*. 141:920–927.

De Groote, O., Pepermans, G. & Verboven, F. 2016. Heterogeneity in the adoption of photovoltaic systems in Flanders. *Energy Economics*. 59:45–57.

Gucciardi Garcez, C. 2017. Distributed electricity generation in Brazil: An analysis of policy context, design and impact. *Utilities Policy*.

Islam, T. & Meade, N. 2013. The impact of attribute preferences on adoption timing : The case of photo-voltaic (PV) solar cells for household electricity generation. *Energy Policy*. 55:521–530.

Jayaraman, K., Paramasivan, L. & Kiumarsi, S. 2017. Reasons for low penetration on the purchase of photovoltaic (PV) panel system among Malaysian landed property owners. *Renewable and Sustainable Energy Reviews*. 80(May):562–571.

Karakaya, E., Hidalgo, A. & Nuur, C. 2015. Motivators for adoption of photovoltaic systems at grid parity : A case study from Southern Germany. *Renewable and Sustainable Energy Reviews*. 43:1090–1098.

Kastner, I. & Matthies, E. 2016. Erratum: Corrigendum to ???Investments in renewable energies by German households: A matter of economics, social influences and ecological concern???? (Energy Research and Social Science (2016) 17 (1???9)). *Energy Research and Social Science*. 19:200.

Kastner, I. & Stern, P.C. 2015. Examining the decision-making processes behind household energy investments: A review. *Energy Research and Social Science*. 10:72–89.

Korcaj, L., Hahnel, U.J.J. & Spada, H. 2015. Intentions to adopt photovoltaic systems depend on homeowners '

expected personal gains and behavior of peers. *Renewable Energy*. 75:407–415.

Matisoff, D.C. & Johnson, E.P. 2017. The comparative effectiveness of residential solar incentives. *Energy Policy*. 108(May):44–54.

Palm, A. 2016. Local factors driving the diffusion of solar photovoltaics in Sweden: A case study of five municipalities in an early market. *Energy Research and Social Science*. 14:1–12.

Palm, A. 2017. Peer effects in residential solar photovoltaics adoption—A mixed methods study of Swedish users. *Energy Research and Social Science*. 26:1–10.

Rode, J. & Weber, A. 2016. Does localized imitation drive technology adoption? A case study on rooftop photovoltaic systems in Germany. *Journal of Environmental Economics and Management*. 78:38–48.

Simpson, G. & Clifton, J. 2017. Testing Diffusion of Innovations Theory with data: Financial incentives, early adopters, and distributed solar energy in Australia. *Energy Research and Social Science*. 29(May):12–22.

SolarCity. 2015. *U.S. Homeowners on Clean Energy: A National Survey*.

Wolske, K.S., Stern, P.C. & Dietz, T. 2017. Energy Research & Social Science Explaining interest in adopting residential solar photovoltaic systems in the United States : Toward an integration of behavioral theories. *Chemical Physics Letters*. 25:134–151.