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Local Environment

The International Journal of Justice and Sustainability

ISSN: 1354-9839 (Print) 1469-6711 (Online) Journal homepage: www.tandfonline.com/journals/cloe20

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To cite this article: Genevieve Simpson (2018) Looking beyond incentives: the role of champions in the social acceptance of residential solar energy in regional Australian communities, Local Environment, 23:2, 127-143, DOI: 10.1080/13549839.2017.1391187

To link to this article: https://doi.org/10.1080/13549839.2017.1391187

LOCAL ENVIRONMENT, 2018
VOL. 23, NO. 2, 127–143
https://doi.org/10.1080/13549839.2017.1391187

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Looking beyond incentives: the role of champions in the social acceptance of residential solar energy in regional Australian communities

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ABSTRACT

Research into renewable energy adoption is increasingly identifying that the successful implementation of renewable energy projects is influenced by a combination of market, community and socio-political acceptance of renewable energy technology. This research uses case studies in two regional Australian communities to examine the social acceptance of residential solar energy, in particular under the influence of financial incentives and social interactions. Fifty-five semi-structured interviews with members of the local community, industry and government were undertaken between May and October 2015. Respondents were asked about their perceptions and knowledge of solar energy and incentives to support its adoption, and their interactions with actors important in the diffusion process. Responses indicated that financial incentives motivated solar adoption; however, social interactions in the communities also contributed to decision-making. In one case study, a local "solar champion" built a private solar farm to demonstrate the technical feasibility of solar, assisted community members with physically installing their own systems and helped community members to maximise the financial benefits of their solar installations. This solar champion contributed to this community having an earlier and more rapid rate of small-scale solar adoption compared with the second case study community. The second case study community included two individuals interested in promoting solar energy; however, they were less integrated with the community's process of adopting solar, resulting in community members experiencing substandard installations and consequent distrust of the solar industry. This research concludes that local context influences solar adoption through complex interactions among market, community and socio-political acceptance.

ARTICLE HISTORY
Received 28 July 2016
Accepted 25 September 2017

KEYWORDS
Renewable energy; solar champion; residential solar; diffusion of innovation; social acceptance

1. Introduction

Approximately 33% of Australia's greenhouse gas emissions come from the electricity sector (Australian Government, 2016), with coal generation providing 61% of Australia's electricity needs (Australian Government, 2015b). In order for Australia to meet its international commitment of a 26–28% reduction in emissions from 2005 levels by 2030 (Australian Government, 2015a), Australia will need to reduce emissions associated with electricity use. While increasing energy efficiency has a role to play in reducing demand for electricity, the use of renewable energy to reduce the carbon intensity of electricity has been prioritised in Australian policy. Australia's longest-running policy

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for promoting renewable energy investment, the Renewable Energy Target, provides funding for small-scale systems (less than 100 kW) and utility-scale renewable energy (Clean Energy Regulator, 2016b). Additionally, most Australian states and territories have made net feed-in tariffs available to householders installing small-scale solar systems, in order to further promote the adoption of renewable-based distributed generation (Climate Change Authority, 2012). Finally, some local governments have also provided upfront discounts or reimbursements for the installation of residential solar systems.

The academic literature has shown that the rate of adoption of residential solar energy is not solely reliant on the availability of financial incentives (Jager, 2006), levels of solar irradiation (Noll *et al*., 2014) or patterns of income (Graziano and Gillingham, 2015). Instead, adoption levels appear to vary depending on a mix of these factors combined with the influence of social characteristics, including the presence of local champions to promote community-level interest in renewable energy. Rogers' (2003) seminal book on the diffusion of innovations highlights that the first to adopt technologies are referred to as "innovators"; however, it is those with ties to social networks who have the greatest potential to communicate the benefits of a technology and "spread" it. Rogers (2003) refers to these individuals as "opinion leaders"; however, the community renewable energy literature variously refers to them as "local level actors" (Nygren *et al*., 2015), "front runners" (Hufen and Koppenjan, 2015), "community renewable energy champions" (Allen *et al*., 2012) and "local champions" (Ruggiero *et al*., 2014). The literature identifies that in order to be successful, local champions must be trusted by the community and have a history of commitment to community interests (Noll *et al*., 2014).

In spite of government support for residential solar energy, the facilitated adoption of residential solar energy by a local champion may face similar challenges to those experienced by all renewable energy ventures. Wüstenhagen *et al*. (2007) conceptualise these challenges under the banner of "social acceptance of renewable energy", separated into three overlapping dimensions. Firstly, renewable energy projects require market acceptance, where consumers and investors generate demand for renewable energy resources. This relates to both electricity consumers having an awareness of the availability of renewable-based electricity supplies and being amenable to pay for it, and investors both perceiving sufficient demand for renewable-based electricity and having sufficient trust in renewable technology to support its adoption. Furthermore, intra-firm market acceptance, where incumbent energy market players transition from providing/accepting fossil fuel-based generation to renewable-based generation, is vital. A barrier to market acceptance of renewable energy is a lack of information on the technical and financial realities of renewable energy investment. In particular, community-initiated renewable energy projects are reliant on technical knowledge for the deployment of projects, with some project participants claiming that they found it difficult to access reliable and unbiased advice (Leaney *et al*., 2001, Rogers *et al*., 2008, Allen *et al*., 2012, Park, 2012, Ruggiero *et al*., 2014, Adams and Bell, 2015).

The second dimension of social acceptance of renewable energy is community acceptance and refers to the extent to which community members will support or oppose renewable energy projects. The literature largely frames this support or opposition in terms of distributional justice (Devine-Wright, 2005, Gross, 2007, Jones and Richard Eiser, 2010, Cowell *et al*., 2011, Baxter *et al*., 2013, Simpson and Clifton, 2016), the extent to which the "goods" and "bads" of renewable energy projects are distributed between community members. Community-based projects, including those developed by local champions, are generally expected to achieve higher levels of community acceptance than conventional large-scale renewable energy projects given the inclusive nature of their development; however, this is dependent on the extent to which the project is truly representative of the local community. Community acceptance also includes trust in renewable energy, not only in terms of its technical capacity but in terms of the ways in which renewable energy projects can benefit the environment and society.

Finally, socio-political acceptance relates to the policies, regulations and institutions that not only support renewable energy but provide a foundation for its integration with existing energy frameworks. For example, limitations in socio-political acceptance have been identified in the adoption of renewable energy at the local level, where success has been stymied as a result of renewable energy policy instability (Allen *et al*., 2012, Ruggiero *et al*., 2014, Adams and Bell, 2015). Alternatively, incentive schemes, including loans, have been identified as important in helping communities overcome financial barriers when installing renewable energy systems (Park, 2012, Dóci and Vasileiadou, 2015, Klein and Coffey, 2016). Additionally, socio-political acceptance includes the general public developing a level of awareness of the potential benefits of renewable energy technologies in order to support political initiatives for its promotion. Wüstenhagen *et al*. (2007) indicate that the socio-political dimension may be the most important in promoting the social acceptance of renewable energy, given it is the development of policies that will create "the institutionalisation of frameworks that effectively foster and enhance market and community acceptance" (p. 2685).

Further to the difficulties faced by all community-initiated renewable energy projects, regional communities experience additional challenges. Rogers' (2003) diffusion of innovations theory suggests that innovators key to the adoption of new technologies have higher levels of "cosmopoliteness" than the general population, exhibited through varied communication networks. The potential for community members in regional areas to exhibit "cosmopoliteness" is restricted considering access to varied communication networks is limited. Related to this, geographic remoteness in regional communities also inhibits access to technical experts to assist with the planning of renewable energy projects and has the potential to limit competition between technology providers.

This paper is part of a larger project examining the social acceptance of renewable energy in Western Australia. Part of the larger research project identified that financial incentives contributed significantly to the adoption of residential solar energy (Simpson and Clifton, 2017), and were therefore useful in promoting market acceptance of renewable energy. Another found, conversely, that socio-political barriers existed in the form of network operator practices leading to "push back" on increasing penetrations of solar energy, and therefore limited residential solar energy adoption in some areas (Simpson, 2017). In spite of communities being exposed to similar financial incentives and limitations on solar system adoption by networks, different communities experience different rates of solar system adoption.

It was hypothesised that the presence of local renewable energy champions could influence the social acceptance of renewable energy, explaining some of the variation in adoption experienced between communities. This research therefore sought to examine two communities in detail to better understand the community-level experiences that can influence the social acceptance of renewable energy. In particular, the research considered the ways in which renewable energy champions can influence the different dimensions of social acceptance of small-scale solar energy and challenges to social acceptance in the presence of local renewable energy champions. This is the first paper to take a multi-dimensional social acceptance of renewable energy approach to considering residential-scale solar adoption in regional areas. The complex interplay between the three different dimensions of social acceptance, in addition to the potential interactions and unpredictable influence of stakeholders, means that case study research is best used to investigate multi-dimensional social acceptance.

Two regional communities were selected for case study analysis based on their experiences with small-scale solar energy systems and their community profiles. The first community, Carnarvon, was chosen given it has a highly publicised reputation as a self-started "solar town". Carnarvon had one of the first privately owned solar farms in Western Australia (Carpenter, 2005), and has seen a further large-scale installation (Energy Made Clean, 2016) and a large number of small-scale systems connected to the grid (Mercer, 2011). This was in large part due to an active "solar champion" who built the privately owned solar farm and was featured in media descriptions of Carnarvon as a solar adoption hotspot (Pownall, 2011, Sustainable Energy Association, 2012, Martin, 2012, ABC

7:30, 2012). The town of Narrogin was selected as an alternative community, based on its similar population size, number of free-standing dwellings, median household wage and proportion of rental accommodation (Australian Bureau of Statistics, 2013a). Prior to undertaking this research, no local renewable energy champions were identified in Narrogin. The rate of adoption of residential solar systems differed markedly between the two regional communities (Figures 1 and 2).

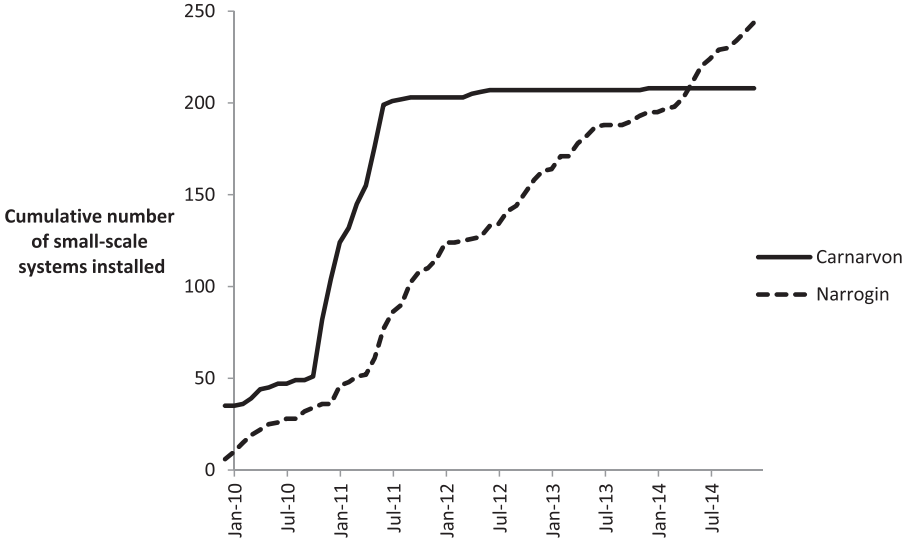

Figure 1. Cumulative installation of small-scale solar systems (less than 100 kW) in the postcode regions of Carnarvon and Narrogin (Clean Energy Regulator, 2016a). Network operator restrictions prevented small-scale solar adoption in Carnarvon after 2011 (Simpson, 2017). This graph demonstrates that it took Narrogin almost three years to "catch up" to the number of small-scale solar systems installed in Carnarvon.

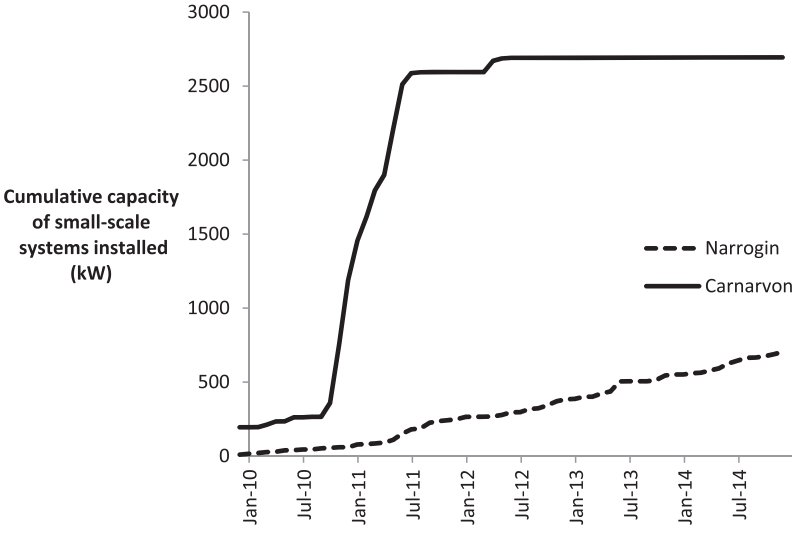

Figure 2. Cumulative capacity of small-scale solar systems (less than 100 kW) in the postcode regions of Carnarvon and Narrogin (Clean Energy Regulator, 2016a). Even though the network operator in Carnarvon restricted additional solar installations from 2011 Carnarvon continues to exceed Narrogin's cumulative installed capacity.

The results section of this paper highlights the key processes, interactions and experiences involved with the adoption of small-scale solar energy in the two regional communities. The discussion section considers these two case studies as examples of the adoption of residential solar energy systems and implications for the social acceptance of renewable energy in regional areas. The findings suggest that local renewable energy champions can be effective in promoting community and market acceptance of renewable energy. Additionally, the findings highlight issues with community acceptance of renewable energy, with unequal access to solar energy adoption, grid connection and therefore the financial benefits of solar energy. Finally, in spite of the generous financial incentives available through federal, state and even local governments, adoption was hampered by issues in the socio-political dimension, including regulations for installers and limited access to the network. The conclusion section briefly summarises the research findings.

2. Methods

Semi-structured interviews with stakeholders of interest to each of the three dimensions of social acceptance were undertaken to analyse the social acceptance of small-scale renewable energy in regional communities. In order to gain an understanding of issues around the market acceptance of residential solar energy in these regional communities, 15 representatives from the electricity and solar energy industry were interviewed (Table 1). Representatives could provide feedback on the ways in which demand for small-scale solar was unfolding in the region and the ways in which solar systems were supplied. Additionally, they could provide feedback on the effectiveness of socio-political strategies for small-scale solar adoption and associated barriers. Representatives were purposively selected based on their role in the local energy sector, their presence in media articles and searches of solar energy suppliers/electricians in the regional communities. The "solar champion" in Carnarvon was approached for an interview. During interviews with government representatives in Narrogin, one individual with an interest in renewable energy was repeatedly mentioned, with stakeholders recommending the author speak to them to better understand the local context around solar energy adoption. Therefore, although no "champion" was previously identified in the lead up to the interviews, an interview with this individual was conducted during which he self-identified as a Clean Energy Advocate.

Community members were interviewed to gain an understanding of community acceptance of renewable energy in the two regional communities. In the case of small-scale renewable energy, community members are not only relevant in terms of understanding the perceptions of distributional justice associated with solar but are also relevant in terms of understanding the drivers for investment in the solar energy market. Community members interviewed were accessed after

Table 1. Summary of stakeholders interviewed during the research, separated according to relevant dimension of social acceptance of renewable energy.

Dimension	Stakeholders	Carnarvon	Narrogin	State-based
Market acceptance	Solar champion/Clean Energy Advocate	1	1	
	Local electrician	1	1	
	Solar industry member		2 (Neighbouring community)	2
	Network operators	1	2	2
	Renewable energy industry advocate			2
Community acceptance	Residential householder with a solar system	8	8	
	Residential householder without a solar system	4	3	
Socio-political acceptance	Town council representative	2	2	
	Regional/Shire area representative	1	1	
	State government energy policy specialist			6
	Member of Parliament	1	1	2
	Consumer protection agency			1

completing one of two mail-out surveys, for two other parts of this research project (Simpson and Clifton, 2015, Simpson and Clifton, 2016). At the opening of each survey, respondents were asked to self-identify if they would be interested in being interviewed for further research. All respondents who self-selected for further research were approached for an interview (42 in total), with 23 interviews completed, for a response rate of 55% (Table 1).

In order to gain an understanding of the socio-political aspects of renewable energy adoption in Carnarvon and Narrogin, 17 representatives from 3 levels of government were interviewed during the research (Table 1). These representatives could provide information on government support for renewable energy and issues experienced while delivering policies aimed at increasing the penetration of small-scale renewable energy in Western Australia.

The research process followed that of Allen *et al*. (2012), who examined local drivers, enablers, barriers and solutions to community renewable projects in the Lake District National Park, UK. Consistent with the methodology used in Allen *et al*. (2012), key themes were identified in a background study and literature review prior to undertaking interviews. Respondents were asked about their personal opinions of residential solar energy, their own experiences with solar energy, their understanding of incentives available for, and connection processes relevant to, the installation of systems and any challenges associated with their implementation. Finally, respondents were asked about their interactions with members of community, industry and government regarding renewable energy. Responses to the set of questions relating to interactions with stakeholders were used to develop a "communication map" for each regional area (Figures 3 and 4) to determine the extent to which those promoting renewable energy were able to act as "cosmopolites" spreading ideas and information across community networks.

This research complied with The University of Western Australia ethics approval processes. Respondents were notified that all information gathered would be recorded, transcribed and analysed in such a way that maintained their anonymity; however, some individuals may be identifiable given the small population size of the communities and particular characteristics of interview subjects. In all cases, representatives were responding to the interviewer's questions based on their own experiences, with their comments not necessarily reflecting the opinions or intentions of the agency they were representing, or the experiences of all representatives within that agency. Interviews took place between May and October 2015, with a sole researcher conducting all interviews. NVivo Version 11 (QSR International Pty Ltd, 2015) was used to code survey responses according to the previously identified research themes (market, community and socio-political dimensions) with an iterative process for defining sub-categories of themes.

3. Results

The results section summarises the experiences of solar adoption in each community, starting with an overview of the large-scale renewable energy adoption and network settings in each community, followed by a summary of the position of local renewable energy champions in communication networks, then examining in detail the interactions between local champions and dimensions of social acceptance.

3.1. Carnarvon

Carnarvon is a small coastal community approximately 900 km north of Perth, the capital of Western Australia, which had a population of 5350 at the 2011 census (Australian Bureau of Statistics, 2013b). Carnarvon is powered by a regional electricity grid, with approximately 200 km of lines but only an average summer load of 6800 kW (APVA/CEEM, 2012). The total rated capacity of all small-scale systems in Carnarvon is 1025 kW, which means that these systems have the potential to contribute up to 15% of the generation required to meet the average summer peak load. Carnarvon's solar experience began with the opening of the Solex Project in 2005 (Carpenter, 2005). The high cost

of solar systems limited adoption in 2005; however, with the increase in subsidies and reduction in capital cost of systems over time, Carnarvon experienced a rapid and early rate of solar adoption (APVA/CEEM, 2012). The owner/operator of the Solex project was featured in mass media publications promoting not only the Solex project but community support for solar in Carnarvon (Sustainable Energy Association, 2012, ABC 7:30, 2012). Based on this media presence, the owner/operator was identified by the researcher as Carnarvon's solar champion.

The solar champion made use of connections with members of industry, local, state and federal government, network operators and members of the community to increase the adoption of small-scale solar energy in Carnarvon. Additionally, according to all stakeholder groups interviewed, the solar champion sought to assist people with physically installing their own system under the proviso that the person installing a system then helped someone else mount/install their system. The solar champion became known as the "go to" person in Carnarvon regarding solar, with all but one of the community members (including those who had not installed systems) engaging in conversation with him about solar energy. Figure 3 demonstrates the extent to which the solar champion was a "cosmopolite" embedded within a network of stakeholders.

3.1.1. Local champion and market acceptance of renewable energy

Interviews with community members identified that access to financial incentives was critical both as motivation for installing solar systems and in order to make solar systems affordable. The majority of people installing were residential consumers and therefore accessed the generous state-based feed-in tariff. For those installing large systems (up to 30 kW), this represented a significant financial windfall:

> I mean basically we get free power plus three thousand dollars a year in round terms, which is absolutely wonderful. (Community member)

The role of the solar champion in accessing these rebates should not be overlooked. According to community members, he was valuable in being able to explain the federal and state incentive

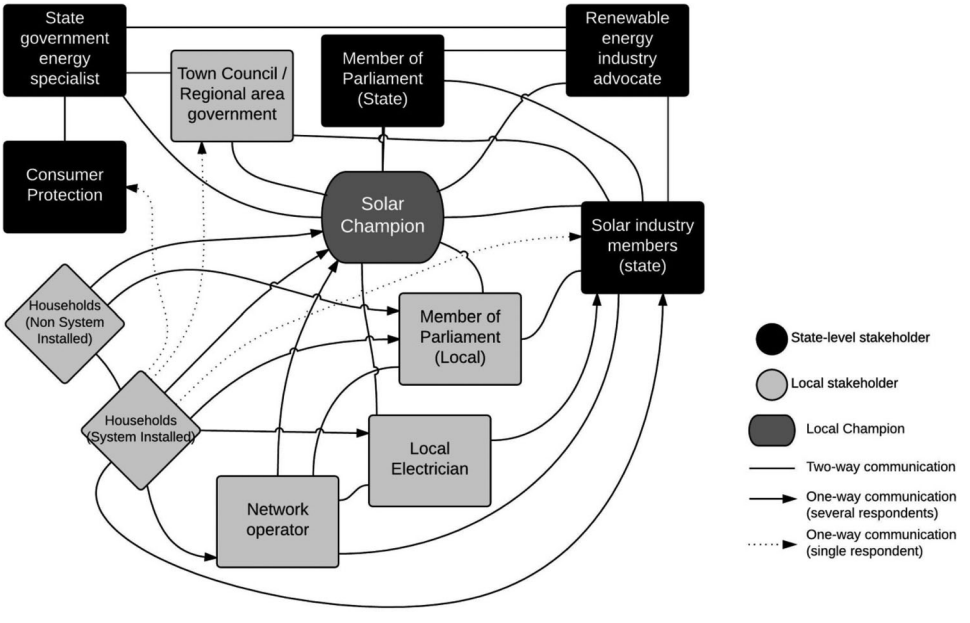

Figure 3. Communication network between state and Carnarvon-based solar stakeholders, government and community members. Interactions were identified during interviews with stakeholders. A solid line (no arrows) indicates that the interview respondents on both ends of the communication link identified interactions with the other stakeholder.

schemes. Additionally, according to both community members and public sector workers, he engaged with the regional area representatives to make additional local government-based financial incentives available to the community. He was also able to use his skills as an accountant to learn about the incentive scheme process and maximise community members' financial returns. The solar champion also utilised contacts made during the development of the Solex project to import solar panels and inverters to Carnarvon, selling them to community members at wholesale prices:

> And we sold wholesale in there, and then their group of people did the install … The systems were very affordable. In terms of under a one year payback. (State-based solar industry member)

This, combined with the reduction in system costs associated with community members installing their own systems, resulted in substantially reduced prices for systems, allowing community members to install solar systems of a larger capacity than they would otherwise have been able to afford. By providing systems at wholesale costs, reducing installation costs and maximising financial returns the solar champion was able to provide a "better deal" to those installing a system.

3.1.2. Local champion and community acceptance of renewable energy

The solar champion noted that he took advantage of links with media representatives developed while working in real estate to generate media interest in the opening of the Solex farm. Four community members and four government representatives (from the local and state level) indicated during interviews that information available in the media and the accessibility of the Solex site increased the awareness of solar energy in the community. In particular, the physical manifestation of the Solex farm was instrumental in forming perceptions of the potential of solar systems as a reliable form of electricity generation:

> He built it. You could actually physically see what he had built, and he was able to physically show how it worked. It's better than looking at paper. You can see it work. You can understand it. (Member of Parliament)

The solar champion had also invested significantly in his own system, which was seen as "putting his money where his mouth is" and increased community members' trust in the technology:

> For [the solar champion] to put out a fairly large investment on something like that, it really piqued my interest. (Community member)

During the interview with the solar champion, it was noted that all installations he was involved with met compliance standards and regulations. He, alongside the local electrician, completed solar installation qualifications and was therefore appropriately skilled to install solar systems. He also became an inverter service partner, enabling him to fix inverters within the town as opposed to having them sent back to the manufacturer. According to interviews with community members, Carnarvon benefitted technically from having a local inverter technician, and also placed greater faith in the reliability of the systems given the salesman/installer was always easily located:

> We stayed with [the solar champion] because if something went wrong we could whinge to him, because at least there would be someone to whinge to. (Community member)

> Oh, we all knew where he lived so there would have been a picket line and torches if something went wrong! (Community member)

While several community members suggested that the solar champion's word was not always reliable, his investment, demonstration and training in solar energy developed trust in the technology in the community.

Furthermore, Carnarvon householders' involvement in the installation process led to an apparently high level of interaction with the technical aspects of solar systems, with three Carnarvon residents describing how they recorded the generation of electricity from their systems on a daily basis.

Further benefits included that some vulnerable members of the community, including the elderly, had their systems installed by more able-bodied community members, thereby ensuring equitable access to solar systems:

> I mean, that's like Joan, she couldn't do it herself. So that's why I put it up. And her son came over, he was here, I had to do all the frames and stuff like that, and he was here to take all the panels up. (Community member)

Community members indicated during interviews that discussions about solar were taking place within large social circles, suggesting "the people at the [salt] mine", "the plantation owners" and "all the people at work" discussed the financial benefits of solar energy. Furthermore, the rapid uptake of solar in Carnarvon was described in interviews as being the result of social cues, with respondents referring to the spread as "infectious", "snowballing" and indicating that "people were jumping on the bandwagon".

3.1.3. Local champion and socio-political acceptance of renewable energy

While the solar champion-initiated model of residential solar adoption proved successful in promoting a rapid rate of solar adoption and considerable cost savings for consumers, it was not without its disadvantages. The primary disadvantage was that the high capacity of solar as a proportion of the network load led to a decision by the network operator to place a moratorium on new solar systems connecting to the grid, starting in 2011 (Mercer, 2011). It was two years before the moratorium was lifted, and then only installations with costly generation management systems were allowed on to the network (Western Australian Parliamentary Debates, 2013).

The solar champion acting as a primary vehicle for generating the installation of systems in Carnarvon resulted in those who were well embedded in his community network finding out about solar and installing it preferentially to those with looser ties to the community. While it was certainly never the solar champion's intention to exclude community members from accessing solar, the "first come first served" basis of allocation of a "spot" on the network prioritised his social network. Furthermore, by maximising access to financial incentives, the solar champion encouraged the adoption of larger capacity systems. While this was important in terms of an objective of maximising the installed capacity of solar on the Carnarvon network it had issues for the "hosting capacity" of the regional network, contributing to the moratorium on systems, which prevented other community members from having the opportunity to install their own systems. Several of the community members mentioned an awareness of people perceiving this inability to install systems as "unfair":

> I hear them going crook [getting upset] about how they're not allowed to put [solar] on. It's their own stupid fault. They should have jumped in when they had the chance. Some of them get real upset about it … they go "oh … you know … people have got too much" but, well, the offer was there. And, OK, maybe they should have restricted it when the offer was first up, but they didn't. (Community member)

The solar champion noted during his interview that prior to the moratorium Carnarvon was experiencing a pause in solar installations as there was a backlog of documentation to complete. The regulatory environment in Western Australia contributed to the solar champion's excessive workload. During his interview, the electrician noted that, while technically capable of installing systems and completing paperwork, he could not fulfil these requirements as he had let his solar installation qualification accreditation lapse. Maintaining the accreditation requires completion of "case studies" and continuing education points, which proved to be difficult to maintain in regional areas where the number of installations is low and access to continuing education programs is limited.

3.2. Narrogin

Narrogin, situated 200 km south-east of Perth, had a population of 4730 at the 2011 census (Australian Bureau of Statistics, 2013c). Narrogin houses a large transformer station and associated depot for Western Australia's largest electricity network. The installation of the majority of Narrogin's solar systems occurred since 2010, with a total small-scale installed capacity of 1200 kW across 339 solar

systems (Clean Energy Regulator, 2016a). The local government chose to install solar on government buildings (Infinite Energy, 2013), but no larger-scale solar facility exists.

During interviews with Narrogin stakeholders, two individuals with an interest in promoting solar were identified. The first was the Clean Energy Advocate identified during interviews with local government representatives and the city-based installation firm that installed solar systems on government buildings. The second was the local electrician, who also installed solar systems. During the interview, it became apparent that the local electrician had significant business interests in renewable energy (primarily biofuels).

During interviews with community members, only one householder in Narrogin mentioned the local Clean Energy Advocate and one other mentioned the solar installer/electrician. This was surprising given the Clean Energy Advocate had explained during his interview that he had attempted to promote solar in the region, including by hosting a community forum with his preferred city-based solar firm explaining the benefits of solar:

> We got about fifty people there, maybe a few more, but it was not as good as I expected. But the information that that group received has been disseminated in the community and now the uptake is increasing … Because [the city-based firm] were providing the technical information people would always go back to that point of information. (Clean Energy Advocate)

Interviews did not reflect this outcome, although this may be a consequence of the small sample number and time lag between surveys and interviews. Interestingly, one of the Narrogin stakeholders was aware of the solar champion in Carnarvon, demonstrating his considerable impact in promoting solar energy in regional Western Australian communities. From the interviews it was apparent that, although two individuals in Narrogin identified themselves as interested in promoting solar, they were not successful local renewable energy champions within the community. A full summary of interactions between stakeholders is available in Figure 4.

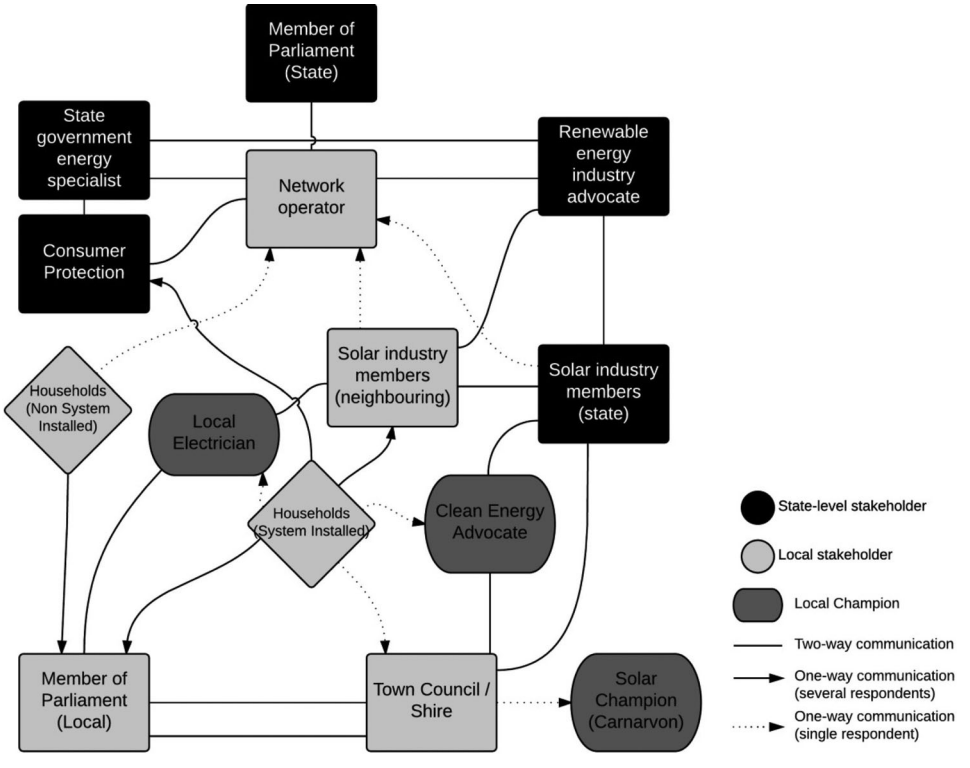

Figure 4. Communication network between state and Narrogin-based solar stakeholders, government and community members.

3.2.1. Lack of local renewable energy champion and market acceptance of renewable energy

According to interviews with the Clean Energy Advocate and local government members, the Clean Energy Advocate person lacked the technical skills to install solar but was able to influence local government through his connections as a former member of the town council. As a result of his introduction, the city-based firm was contracted to install systems on town council buildings. He subsequently developed an ongoing relationship with this Perth-based solar installation company, which provides him with a small commission for systems installed in the region. During the interview with the local electrician, the electrician noted that he was technically qualified and experienced in solar installation but did not have a strong local presence as a solar installer and was not socially connected with local government members. This separation of capacities between the Clean Energy Advocate and the electrician resulted in both the local council and members of the community purchasing solar systems from Perth-based firms instead of the local electrician, causing money from within the local community to be diverted towards external solar firms, with coincident higher installation costs associated with imported labour. This has contributed to Narrogin continuing to have smaller capacity systems than those installed in Carnarvon (Figure 2), and not yet reaching the network operator's "hosting capacity".

Two of the regionally based solar industry players noted dissatisfaction with local governments choosing to support city-based firms, for example:

> It hurts me to find out that the job has been lost to a city-based company when the income can stay in the community. (Solar industry member in neighbouring community)

Householders with solar systems in Narrogin cited financial benefits as the biggest motivation for installing systems, although many also reflected an interest in environmental benefits. The availability of financial incentives, in particular the premium net feed-in tariff that allowed electricity customers to accrue a credit on their utility bill, was important in decision-making. However, in the absence of sound information provided by a local renewable energy champion, some householders did not appear to recognise the benefits of solar, including avoided energy costs, in the absence of incentives:

> Well if you didn't have the [premium feed-in tariff] it would be no gain to you. See because what it is now is, [the premium feed-in tariff] is paying off the winter time … Without the [premium feed-in tariff] it wouldn't be bloody worthwhile. (Community member)

Narrogin community members also expressed a lack of understanding of where to turn when a system performed poorly, with one householder attracting the attention of a visiting installer's car to ask questions, and another indicating she would "not know where to go" if her system failed.

3.2.2. Lack of local renewable energy champion and community acceptance of renewable energy

The lack of a local renewable energy champion to promote solar apparently left Narrogin susceptible to "travelling salesmen". The Narrogin electrician, solar installers in the neighbouring community of Bunbury and the city-based installer employed by the town council all expressed concern around the vulnerable nature of regional communities to these forms of "fly-by-night" operators:

> It's something I get quite protective about, the rural towns, because [solar installers] just treat us like we're idiots. That we don't know any better. They're going to charge us $20,000 for a system that's not worth $5,000, and they'll hope that it never gets back to [people] in the city. (Solar industry member in neighbouring community)

The public sector workers, nearby installers and many householders were aware of stories of substandard installations in Narrogin, reporting experiences with systems that were substantially overpriced, faulty, poorly installed or experienced delays in system installation:

> There was a flier that came out through the fax machine and when I saw it I thought "oh that sounds alright" and it ended up being a hell of a hassle and I took them to court over the whole thing. (Community member)

> The installation was a disaster. [The solar company] sent this bunch of fly-by-night operators in and the wiring in the ceiling … the annoying thing was that I didn't look at it myself, I didn't go up into the ceiling until twelve months later and I saw bare wires up there and all kinds of nasty stuff. (Community member)

This was reflected in that two householders had engaged the state consumer protection agency, with a formal complaint made against one of the out-of-town installation companies frequently mentioned by community members (Department of Commerce, 2014). Furthermore, even householders who had not installed systems perceived the large, city-based solar firms as untrustworthy.

The local electrician noted that these issues were exacerbated by inadequate policing of the solar safety regulations, with network operators only looking at the contents of the meter box and solar systems from ground level:

> The local [network operator] inspector comes out and do you know what they check? They're not allowed on the roof, and they check the labels, and that's it … He's literally told me that's all that [network operator] inspects. (Local electrician)

The Clean Energy Advocate acknowledged that negative experiences with solar electricity adoption in the town had damaged perceptions of solar, with an associated reduction in community confidence:

> Some people have had bad experiences, and sometimes that's just because of a certain salesman, because everything is determined based on the deliverer of the information and the deliveree. You do get those problems. So I wouldn't say there aren't issues. (Clean Energy Advocate)

In the absence of a local renewable energy champion, social engagement around solar energy was based on peer-to-peer interactions. Where householders in Narrogin discussed solar with other community members it was generally within small groups, for example one only spoke with a small group of friends who all installed solar together, another with direct work colleagues and three respondents only talked about solar with family members. Passive effects also contributed to increased awareness of solar in Narrogin, with householders mentioning that the visibility of systems themselves were useful in raising awareness about solar, and started discussions about solar systems:

> You would start to see solar panels appearing on people's house roofs and you'd think "oh well, I wonder if that's any good". (Community member)

4. Discussion

The results provide evidence of the ways in which local renewable energy champions, incentive schemes, renewable energy industry players and the incumbent energy systems interact with, and influence, the social acceptance of renewable energy in regional communities. The discussion section draws on findings from the results and links these with similar findings from the literature. However, this research differs from that available in the literature by demonstrating that regional case studies can be used to show that even residential solar energy system adoption takes place within a complex network of market, community and socio-political interactions.

4.1. Market acceptance dimension

The market acceptance dimension relates to potential investors' awareness of renewable energy and their willingness to pay for it. It also relates to existing members of the energy industry adapting to renewable energy. A typical barrier to market acceptance is a lack of information for stakeholders. Consistent with the findings by Palm (2016), the results of this research suggest that, in spite of the promotion of innovations through mass media channels and the availability of financial

incentives, the local context, in particular the role of local renewable energy champions, plays a vital role in influencing attitudes towards solar energy and adoption decision-making.

In the case of this research, the greatest barrier to adoption appeared to be access to a trusted installer. The solar champion of Carnarvon was instrumental in promoting adoption, whereas community members in Narrogin were aware of negative solar adoption experiences (limiting their willingness to pay for it), were not aware of the local electrician installing systems (the existing energy industry adapting to renewable energy) and would not know who to talk to if their system failed (displayed a lack of information). This demonstrates that a lack of access to trusted market players has the potential to limit solar adoption in regional communities, with some community members in Narrogin choosing not to install solar, explaining the three-year delay in Narrogin "catching up" to the installations in Carnarvon (Figure 1). This provides evidence to support Wolsink's (2013) theory that the prevailing focus on the "ABC" of adoption (attitude, behaviour, choice) overlooks the influence of locally relevant social practices and institutions on the market acceptance of renewable energy technologies.

Compared with Narrogin, the Carnarvon example provided a useful model of adoption that led to market acceptance of solar in line with Rogers' (2003) theory on the innovation-decision process. The solar champion in Carnarvon developed community members' *knowledge* of the technology by promoting solar technology in the local media. His private solar farm was available for community members to access, which led to the potential to *persuade* them of the validity of the technology. The peer-to-peer community interactions discussing the benefits of solar helped *reinforce the decision* to adopt. The solar champion would then be available to assist with the installation of solar systems, and thereby *implement the adoption*. The solar champion was then available for discussion about systems and to address issues, resulting in *positive confirmation* of the technology. Therefore, the rapid and early rate of adoption of solar in Carnarvon was partly based on the opportunity for potential adopters to be able to engage with the technology in a meaningful way.

4.2. Community acceptance dimension

Community acceptance relates to the extent to which the community supports or opposes renewable energy and is particularly related to distributional justice and levels of trust in renewable energy. The results section highlighted the benefits of a solar champion to improving community acceptance of renewable energy, in particular through developing trust in solar technology. However, the moratorium on systems, and subsequent exclusion of community members from accessing solar generation, resulted in negative distributional justice outcomes.

Policies and initiatives to promote renewable energy should be mindful of the extent to which they may result in distributional injustices, providing benefits to a select few at the expense of others. The solar champion in Carnarvon intended to minimise the distributional injustice associated with a lack of financial capital restricting community members from adopting solar energy. He did this by purchasing system components at wholesale prices, helping community members to undertake their own installation and using accounting skills to maximise their financial benefits. Alternatively, the Carnarvon community members' installation of larger capacity solar systems led to the unintended consequence of accelerating the point at which the "hosting capacity" of the network was reached. Once the moratorium was in place other members of the community were prevented from installing a system, leading to distributional injustices within the community. Interview respondents indicated that they thought it was "unfair" that some community members received generous financial compensation for the electricity fed into the grid from their solar systems, while others were excluded from participating in the scheme. The distributional injustices in this case illustrate the theory proposed by Wolsink (2013) that energy networks can be viewed as common pool resources and therefore vulnerable to "subtractability", which Ostrom *et al*. (1999) describe as where "exploitation by one user reduces resource availability for others" (p. 278).

Maximising engagement with local community members and stakeholders has the potential to build trust in renewable energy itself, increasing community acceptance of renewable energy. Compared with Narrogin, the Carnarvon case study demonstrated elements of "thick trust", where trust in a system is embedded in existing interpersonal relationships (Walker *et al*. (2010) referencing Williams (1988)). The results clearly highlight that the Carnarvon solar champion was an effective "cosmopolite". He made connections with city-based solar wholesalers, engaged with the nationally based solar accreditation agency, advocated for solar with state Members of Parliament and promoted the benefits of solar through various media channels. The solar champion was also trusted considering his role in the community, his personal investment in solar energy, his availability to anyone needing assistance, his experience as a tax accountant and his position on the local council. Previous research has found that community renewable energy projects that take advantage of existing social networks within a community are likely to benefit from "thick trust" above those that employ outside stakeholders to act as primary agents of change. Park (2012) illustrated this, showing that external professionals are perceived as driving top-down agendas within communities, creating the impression of a lack of control over their own circumstances. This was emphasised in the Narrogin case study, with the city-based installation company engaged with the local government not trusted by community members despite their endorsement from the local elites.

4.3. Socio-political acceptance dimension

Socio-political acceptance relates to the policies, regulations and institutions that promote the integration of renewable energy with the existing energy regime. The case study results provide evidence that socio-political mechanisms, in particular the availability of financial incentives, promoted the adoption of small-scale solar systems. However, the results also suggest that, consistent with the assertion by Wüstenhagen *et al*. (2007), socio-political features have the potential to act as barriers to further adoption by preventing consumers from understanding the true costs and benefits of solar, restricting the availability of regionally based solar installers and limiting access to the electricity network.

The most effective government policy for promoting adoption of small-scale solar systems was the provision of financial incentives, with financial incentives prioritised in the decision-making of solar adopters in both communities. However, there was evidence to suggest that community members did not understand the true costs and benefits of solar technology, with respondents indicating that solar systems would not be worth adopting in the absence of financial incentives. This provides support for Sovacool's (2009) assertion that "intentional market distortions (such as subsidies) … prevent consumers from becoming fully invested in their electricity choices" (p. 4500). In the case of solar adoption, the provision of generous financial incentives without associated education of consumers on their costs and benefits, such as was the case in Narrogin, could result in consumers choosing not to re-adopt solar in the absence of financial incentives, referred to as a "disenchantment discontinuance" by Rogers (2003).

The research highlighted that regulations were both restricting local industry and allowing substandard installations, with implications for community members' trust in solar technology. The requirement for installers to undertake continuing development and complete a minimum number of installation "case studies" in excess of opportunities in regional areas prevented regional installers from maintaining their installation accreditation. The continuing education system is therefore acting as an impediment to the maintenance of the local industry, meaning regional community members may not have access to a locally available, trusted installer. Alternatively, the interviews highlighted that regional areas lack policing of the extent to which systems are meeting regulations, which has enabled substandard installations to proliferate. This appeared to be of particular concern in Narrogin, where the lack of locally based installers and increasing number of faulty systems was leading to reduced levels of trust in solar technologies. This is an example of a socio-political system that has been established to maintain high standards in the renewable energy industry, but has counterintuitive outcomes in regional areas.

Energy utilities have a role to play in small-scale solar adoption, with Carnarvon's adoption profile stalled by the network provider placing a moratorium on new systems. While the community renewable energy project literature has indicated that network interactions can influence renewable energy project outcomes (Ruggiero *et al*., 2014), this was the first identified case where a utility has placed a blanket moratorium on connecting small-scale solar systems to a network. While the network operator indicates that reasons for this moratorium were technical, the decision is influenced by the larger socio-technical system energy decisions take place within (Sovacool, 2009, Simpson, 2017). That is, social decisions around risk, prioritisation of access to the network by incumbent generation sources and financial decisions associated with the cost of connection of renewable energy would all have contributed to the implementation of the moratorium.

5. Conclusion

This research has used a "social acceptance of renewable energy" framework to consider the contribution local renewable energy champions can make towards market, community and socio-political acceptance of small-scale solar energy. The research finds that variations in the rate and total capacity of residential-scale solar energy adoption can be explained, in part, by local conditions and the interactions between stakeholders at the community level, including the presence of local renewable energy champions. While the research confirms earlier findings around the importance of incentives in adoption decision-making (Simpson and Clifton, 2017) and the role networks play in restricting access to solar energy (Simpson, 2017), the research also found that solar champions can promote rapid and early adoption of residential solar energy.

The contribution this research makes to the literature is not based around simply asserting that local champions matter, as this has been done comprehensively elsewhere (Allen *et al*., 2012, Ruggiero *et al*., 2014, Noll *et al*., 2014, Nygren *et al*., 2015). Instead, this research sought to provide an example of the influence of social interactions on the complex interplay between the different dimensions of social acceptance. This research emphasised that while a local renewable energy champion, in the form of Carnarvon's solar champion, can increase trust in renewable energy (community acceptance) and reduce installation costs for householders (market acceptance), interactions with the incumbent energy system can unexpectedly exacerbate distributional justice issues (community acceptance), for example in terms of "push back" from networks in the socio-political dimension. Similarly, community members with an interest in promoting solar energy are not sufficient to actively promote local drive for adoption – instead, as was the case in Narrogin, local renewable energy champions not effectively integrated with the community network (i.e. lacking "cosmopoliteness") can lead to a reduction in benefits for local communities, with external industry members employed. This research therefore highlights that renewable energy researchers should be cautious about attempting to generalise experiences within any of the dimensions of social acceptance – doing so risks overlooking potential opportunities and challenges for the social acceptance of renewable energy.

Acknowledgements

The author thanks her supervisor, Julian Clifton, for his support during this research. The author acknowledges the Australian Government's support, through the provision of an Australian Postgraduate Award. The researcher thanks Chunbo Ma and Michael Burton, of the School of Agricultural and Resource Economics, University of Western Australia and the Australian Research Council for partial funding of this research. The researcher also thanks Lex and Julie Fullarton, members of the solar industry, government officials and the residents of Carnarvon and Narrogin who gave their time for this project. The author thanks the two anonymous peer reviewers for their insightful comments, which helped improve the quality of this paper.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The author acknowledges the Australian Government's support, through the provision of an Australian Postgraduate Award. The researcher thanks Chunbo Ma and Michael Burton, of the School of Agricultural and Resource Economics, University of Western Australia and the Australian Research Council for partial funding of this research.

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