BEHAVIOUR CHANGE VIA SOCIAL SANCTIONS AND SHARED ELECTRICITY

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Abstract: *Applying behaviour change methods to reduce home energy consumption has resulted in varying outcomes and also conservation effects that were short-lived. Some of the more promising treatments included In Home Energy Displays (IHDs) and home energy bills with comparisons to unknown others (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007) - for individual homes. In contrast, so-called collective "energy communities" reduce individual energy consumption (Bauwens & Eyre, 2017) and report other benefits such as group cohesion and community building. A question arises as to whether conservation norms would emerge in ad-hoc urban groups if they we able to co-own and operate a Distributed Renewable Energy (DRE) asset. Secondly, can an economical DRE size for a small group be arrived at via demand aggregation and conservation together? The aim of this paper is to propose a methodology that will test this hypothesis. The approach is to deploy an IHD to display home energy consumption against the fictitious electricity available from a shared solar and battery system, as if it were installed. The IHD will also prompt group members among 6 neighbours to sanction or reward specific (but not identified) group members based on how they use the "shared energy". A multiple baseline approach will be used and correlation of time series (energy consumption against user actions on the IHD) will be performed in R. We expect to observe a sustainable reduction in overall energy due to the effect of an IHD on occupant behaviour. The outcome of the study will help the community to scale the solar and battery storage combination that works best for them based on their usage and their willingness to invest and participate. The proposed system could provide an optimum net zero energy district tailored for the community based on the local parameters and their behaviour.*

Keywords: *Electricity conservation, Applied Behaviour Analysis, Home Energy Display, Group Dynamics, Net Zero Energy Community*

1 Introduction

Tackling the problem of greenhouse gas emissions in Australia should require concerted effort to curb electricity demand since electricity generation is a very large emitter. However, energy efficiency measures which save consumers money may result in savings being spent on energy-derived goods and services in the greater economy. Approaches to this complex problem require more than single interventions. The current study proposes testing a both a technical means to make home solar and battery systems more efficient and cost-effective along with a behaviour change mechanism to suppress demand.

Home solar electricity generation, particularly with energy storage batteries is expected to be a large contributor to Australia's energy system - up to 50% of all electricity (Brinsmead, Graham, & Qiu, 2017). At present the average home solar system supplies about 30% of electricity for the home. A correctly sized battery could double this rate of self-consumption. At present, battery cost and lifespan are serious constraints to broad residential adoption and it has previously been stated that battery cost would have to fall to about a tenth of the current value for there to be widespread domestic adoption as there has been for solar panels (Palmer, 2014). Since 2014, retail electricity prices have nearly doubled and battery costs have almost halved but this does not yet meet Palmer's criteria. Even when they are met, it will take more time again for the formation of a critical mass of home storage large enough to significantly offset centralised generation at any time of day or night.

There are possibly many ways to increase battery uptake, and subsequent grid independence and emissions reductions. For a single home, simply reducing demand would mean that a smaller (cheaper) battery could provide acceptable energy independence to the household. Home energy batteries are typically used to charge from solar energy and discharge to reduce the evening peak demand (which is aligned with peak tariffs in many Australian states). Moving loads (such as clothes drying or ironing) to draw on the system during the day when available solar energy is at its peak will thus reduce the evening energy demand and the battery capacity needed. This is called "load shifting" and is already an anticipated behaviour change to accompany new demand-based tariffs being deployed in Australia to reduce stress on the electricity system. With renewable generation this is even more desirable because peak supply also varies (see for example peak consumption controls on the Isle of Eigg in Scotland (Gardiner, 2017).

Behaviour change is considered a fast and inexpensive means to reduce emissions, potentially more economical than any new technology (Kelly, 2010). Load shifting will join a long list of government stimulated consumption behaviours including energy efficient purchasing, use of devices that sleep, turning off lights, turning down thermostats and many building insulation and envelope changes. However, despite many campaigns for energy efficiency to reduce energy demand, along with a carbon price, closures of large industry consumers in Australia, and a very high electricity price, demand has grown with population and is predicted to keep growing to 2050 (Brinsmead et al., 2017; BREE, 2014).

Home electricity demand accounts for more than 28% of national electricity consumption (BREE, 2012) and households consume more secondary energy (via the products and services consumed) than any other sector (ABS, 2011). However, home occupants tend to consistently underestimate the consumption of devices (Attari, DeKay, Davidson, & Bruine de Bruin, 2010) and indeed consumption itself is felt to be price inelastic (Hobman, Frederiks, Stenner, & Meikle, 2015). It seems that consumers are unable to reduce their demand, even when residential electricity in Australia is the most expensive in the world.

However, the UNDP (2004) identifies examples of other countries which have high living standards (via its Human Development Index) that consume less than half of the energy of Australian households. In addition, a number of organisations promoting “zero carbon” rely on reducing electricity demand, usually by at least 50% (Ison & Lyons, 2013; Wright & Hearps, 2011). Finally, due to the use of brown coal in electricity generation, most Victorians (home to a quarter of Australia’s population) are not aware that they are the worst per-capita emitters of CO2 in the world. Home energy consumption in Australia is thus an important and a potentially fruitful target for redoubled conservation efforts.

To this end, there is a broad literature base around feedback to home occupants on their energy use. The details of this inform our experimental design below but it is sobering to consider that in reviews of up to 194 studies (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Delmas, Fischlein, & Asensio, 2013) many have reported highly varying results, with methodological problems or observed short lived outcomes and even increased consumption during conservation programmes. It is likely that home energy conservation is difficult and that changed behaviours are hard to validate.

Setting up potential strangers to share electricity of course raises many questions concerning technical design, privacy, governance and many others which we attempt to address but the benefits may be substantial for consumers, the environment and also the utilities. The next section expands on our literature findings. This is followed by a methodology section explaining the experimental design. A conclusions section discusses implications and provides suggestions for future research.

2 Energy use, feedback and social mechanisms

Successful behaviour change in home electricity consumption has taken two main forms. Since electricity is measured in at least two units (confusingly kWh and kW or “energy” and “power”) it can be difficult to quantify consumption for specific appliances (rated in Watts or Amps). A home display than can report electricity consumption along with actual costs makes it easier for consumers to understand the final bill and also to isolate devices consuming large amounts of electricity. Studies of these devices began around 1980. With each solar panel installation in Australia, an IHD showing solar productivity has also been installed and so the homeowner has information to hand concerning both their consumption and the availability of solar energy they can consume for free. These devices have been typically information-only with no normative cues such as an assessment of how well the household has performed.

2.1 Feedback and norms

A friendly assessment of household conservation (or high consumption) was first reported as beneficial for conservation by (Schultz et al., 2007) when home energy bills were accompanied by a hand-written comment and an “emoticon” to clearly indicate good, bad or average performance relative to other houses in the study. Relative reporting, as it is called, has resulted in sustained electricity conservation of 2.5-7% (Allcott, 2011) and has been a legal requirement for home energy bills in Australia since 2013 (AER, 2017). In this form of customisation the comparisons to others include examples like "average of 100 homes near you", "similar others", "conserving others" but the others are not known or identified in any way. It has also been reported that when a low-consuming home is shown to be below "others", their consumption is likely to increase. Comparison to others establishes a norm, which the consumer then moves to conform to.

Social norms are even more effective when energy consumption is compared among known others, for example a small study in Sydney installed energy reporting placards on the facades of 6 houses in a busy street (Moere et al., 2011) which was reported to cause a competitive game to emerge as to who could consume less. This went further to a form of cheating where loads were shifted to known consumption reporting gaps. In a related study at the University of California Los Angeles, residential students were given energy saving advice but also had their consumption reported against their names on a bulletin board (Delmas & Lessem, 2014). The energy advice led to reduced consumption but the public reporting had a much greater effect which persisted. A preliminary study combining real-time consumption (a phone-based IHD) with comparative information about one's consenting social network connections finally connects IHD information with relative reporting (Petkov, Medland, & Krcmar, 2011) like the Sydney study, finding people fell into competition to conserve but preferred only to compete with people they knew.

These effects are due to social norms but the interventions are aimed at the individual or individual home with normative effects only as the antecedent. Treating the group as the consumer (the utility framing the challenge as a "community challenge") was found to be effective in home water conservation in the face of the Victorian drought of 2001-09 (Liubinas & Harrison, 2012) but this was not compared to historic water conservation programmes. A tendency for people to group together in times of civil or environmental stresses is well documented in history (for example, see Victory gardens for food (USDA, 2015) as well as post-soviet Cuba's response to supply crises (Quinn, 2006)). Appealing further to group effects in energy consumption, particularly groups of people who know each other, should lead to greater conservation. However, without a WWII or other crisis, what can bind the group together has not been explored.

2.2 Conservation and community

Self-selecting groups already form large "energy communities" which may share a common Distributed Renewable Energy system (DRE) such as windmills, or an entire off-grid energy system, but such groups may also be concerned with lobbying, supply-side changes and energy efficiency (Ison, 2017). Energy collectives are more common in Europe where not-for-profit retailers have been established for distributing renewable energy - but such communities have been found to attract more large consumers who have the most to gain from conservation campaigns within the collective (Bauwens & Eyre, 2017). Nonetheless such groups in Victoria have reported social benefits of community cohesion and self-direction (Dumais, 2016), social cohesion of community cooperation (Essential Services Commission, 2016, p. 65), and that they "stimulate community relations" (Smith, 2016, p. 2). The social value of energy for these groups is encouraging.

Whether climate change is perceived as a sufficient emergency to stimulate arbitrary groups of neighbours to cooperate is debatable and a recent study for Melbourne found only 41% of neighbours report they would pull together in an emergency and only 39% trust each other (City of Melbourne, 2016, p. 40). This suggests there is not likely an automatic transfer of energy community cohesion to arbitrary sets of neighbours. However, this has not been tested and so it is not clear whether the community precedes the shared energy system or vice versa. It may well be the case that if neighbours co-owned a renewable energy system, they may cooperate to conserve energy from that system at least because this saves them more money (than owning separate systems, or not conserving).

2.3 Conservation and common resources

A binding force between energy communities and their renewable energy assets is probably related to sharing benefits. In Daylesford Victoria, a large commercial wind-farm development was challenged as it was forced on the community with no direct benefit to them. Once the community gained some ownership of the windmills, and accessed shared benefits, the project was accepted (Hepburnwind, 2011). With a large system like Hepburn Wind, energy sharing can only take the form of profit sharing from the windmill energy sales to the greater market. So the conservation effects would not be a direct result of sharing a limited resource, which is quite a different form of community.

In contrast, historic village commons with real resource limits required active governance - committees to distribute benefits and resolve conflicts. This governance successfully managed (among other things) deviant behaviours like free riding (taking too much) and shirking (not working enough) by enacting sanctions, usually fines (McKean, 1986). A desire for fairness and for appropriate consequences for deviant behaviour are reliable findings in group studies and sanctions have been found to reinforce group cohesion (Dentler & Erikson, 1959). This in turn is beneficial for normative behaviour. It is thus desirable for the group to enforce limits - in return there may be even tighter group binding:

> “The deviant supplies a group with a problem that the group needs to solve. The members can unite against this problem as they try to do something about it. They will attempt to bring about conformity in the deviant. Their attempt can serve as a "rallying point" for coordinated group activity. Thus, the presence of a dissenter allows the members to express and nurture group cohesion” (Pavitt, 1998:202).

Of course there are limits to how complex sharing rules can be and how punitive or encouraging reinforcement can be. The field of APEX games has explored how limited resources are shared under varying rules and constraints, but also that there can be retribution (Oliver, 1984, p. 124). In an environment where conflict between neighbours may be possible, it is desirable to design group governance so that sanctions do not escalate or that subjects quit the study. One way to do this is to anonymise both the giver and receiver of sanctions. Although this would seem to diminish group bindings based on identity, in a small group it is still clear that it is the group that is acting on the group deviant. This of course is not certain and our final question asks to what extent this simplified social reinforcement will actually be effective.

This diverse literature provides some emergent themes:

1. Feeding back more and more regular information about electricity consumption to home occupants results in significant conservation outcomes (for example Gans et al 2013)

2. Comparison of home electricity consumption to the consumption of unknown others results in moderate reductions in consumption (for example oPower.com 2015)
3. Comparison to the consumption of *known* others leads to additional conservation outcomes (Moere et al 2011)
4. Treating consumers as a group (a community) and framing conservation problems as a community concern has resulted in improved conservation efforts (for example in water conservation (Liubinas & Harrison 2012). More generally in the environmental movement, individuals who assemble in groups report much greater collective agency against larger challenges (drought, climate change).

To which we add

5. Sharing renewable energy goals in a group ("energy community") reinforces group cohesion and leads to energy conservation (Bauwens & Eyre 2017)
6. Sharing a renewable energy asset or generator purportedly reinforces group cohesion, identity and community (Essential Services Commission 2016, p.65)
7. Sharing from a limited commons (a "limited pool resource") brings about consumption awareness in individuals (for example Gardiner 2017)
8. Social sanctions (positive and negative reinforcement, as a form of governance) are part of many historical shared common resources and this reinforces group cohesion and effective sharing while preventing conflict (for example Ostom 1990)

Taken together, these findings suggest potential for a socio-technical intervention for energy conservation to be effective at the group level, but also a potential for collective behaviours over isolated behaviour change within the home. To what extent any group can be artificially assembled and then cooperate around a conservation goal will be tested.

3 Method

It is difficult to align cause and effect in home energy consumption because it occurs in a non-experimental environment and energy consumers have complex motivations, varying understanding of their consumption and experience varying costs and benefits of energy use. Households interact with the economy to the extent that savings from curtailing energy consumption are often spent on either more energy (direct rebound) or on more devices that consume energy (indirect rebound).

Conventionally, behaviour change in energy consumption is measured by establishing treatment households and control households. Because households differ greatly in their composition, many studies have attempted to pair controls with treatment homes on a range of characteristics. Because energy use for the household is effectively an aggregate of all demands from all devices, it is impossible to control for many confounding effects (Delmas et al., 2013) and likewise to pair for all possible categories (for example: issues with Propensity Score Matching (King & Nielsen, 2016)). This problem is likely present in many of the studies with methodological problems and invalid outcomes. For example, one pledge-based conservation study even paired households on the independent variable (Hannah & Murphy, 2013). Because this study will measure consumption of a collective of energy users (aggregating proximate causes even further), it seems appropriate to consider another approach than separate controls and matching.

Fortunately, the problem of so many unknown variables in a naturalistic setting has been tackled in medical science using multiple baseline intervention - advised for complex, confounding or small treatment groups (Sanson-Fisher, D'Este, Carey, Noble, & Paul, 2014). This approach is used to stabilise a patient with a high blood temperature due to an undiagnosed affliction based only on frequent temperature measurements and a set of treatments applied iteratively. That is, there is one reliable measurement, and total control over how the treatments are tried. A certain medicine is then given in a certain concentration and the patient's temperature before and after is compared for a set period. If the temperature remains high, another treatment is attempted. If the patient's temperature drops, the treatment can be halted to see if the temperature has stabilised, or whether in the absence of the medicine, the temperature then rises. It should be noted that this last condition provides the strongest evidence of the causal relationship between the intervention and the effect.

This has strong parallels to home energy use. For one, the data are the kilowatt-hour consumption values which can be obtained continuously and which are accurate to the watt-hour. Second, we have the house group's historic consumption for any arbitrary period, establishing the house group as its own control. We can then apply a range of treatments, even different treatments with different parameters to different house groups and use home energy consumption measurements to find significant effects, or not, as the case may be. This can form a cycle: in the case of the medical patient it ends when the treatment that stabilises temperature is found (or temperature stabilises itself). In our case, it can continue until a repeatable intervention suppresses demand. Ideally, our treatments cause demand to remain low, so it may not be possible to rely on the above observation of the negative effect of removing the medicine. Instead, the validity of the energy consumption finding has to be determined by running "successful" interventions over multiple groups and measuring regression.

3.1 Participants

The experimental design and recruiting approach is presently under consideration for approval by the University of Melbourne Central Human Research Ethics Committee.

Participants are being recruited via Moreland, Port Phillip and Melbourne City councils which are partners on the broader research project. To counter self-selection effects somewhat, the participants will consist of 5 groups of 6 adjacent inner urban homes. Adjacency also would be a requirement of a shared energy system installation. One set of homes will be made up of apartments (all within one apartment block) which would interconnect via the shared wiring of the site.

Figure 1. A modified image showing a group owned solar system at left, and potential local network with central battery storage to distribute and share generated electricity at right.

Participants that already have home solar installed will have their solar generation measurements obtained from their solar MODBUS meter. Self-consumed solar will be added to imported electricity as if the existing solar system was not present.

3.2 Apparatus

An in-home display (IHD) has been designed and created and occupants are instructed to refer to it at least twice a day (Figure 2). The IHD remains on and continuously lit and will be put in a high traffic area such as a kitchen bench. The study will run for six months over the Australian summer, a peak demand period. Nonetheless occupants are told not to forgo basic electricity needs such as air conditioning on a hot day for the sake of energy conservation the study asks for. Occupants will be instructed not to interact with their neighbours on what their IHD conveyed to them.

Occupants are instructed to read and understand any of five treatment features of the IHD which are introduced at certain times. They are

1. Home energy use and home energy use goal - this is a graph showing home energy use against shared system generation. A gap indicates grid import, which should be minimised.
2. Group energy use and group energy use goal - this is the same for the whole group with the home shown relative to it.
3. System pay down graph - shows how the group as a whole adhere to the goal of "fitting" within the capability of the shared system and so can realise positive net present value (NPV) in the predicted time period
4. Deviant reporting and social sanctions - occasional prompts about over- and under- achievers in the group (de-identified) and the option to increment or decrement that group member with a fiat currency called Sparks. Sparks are used as an alternative to both money and kWh for simplicity (Anderson & White, 2009).
5. A passive mode of the social sanctions feature merely displays deviant consumption (again anonymously) but occupants cannot interact (this is similar to

the Petkov et al (2011) study where the performance of known others cues conservation).

6. Informational pop ups - energy saving tips that are weather-aware such as closing blinds on a hot day or wearing a jumper on a cold day. These are taken from a state government energy saving guide (DELWP, 2014)

These treatments are turned off and on via a central server accessed over the Internet by each IHD.

Social sanctions are provided using the following algorithm

1. The consumption trends of each household against their historic consumption will be calculated regularly and adjusted for temperature and precipitation. A household trend will be weighted against the performance of the other households.
2. The system will determine if the occupants are home by the presence of demand aligned with daytime and night-time.
3. A sustained 5-day rising trend is detected as an overconsumption event. Likewise, a conservation event is detected for the converse of this except if the occupants are determined to be not home. This home will be called the deviant group member.
4. A selection of 3 other group members will be made at random by the IHDs.
5. Each of the 3 group members will be solicited with a statement to the effect that a certain group member (who was not identified) can have their energy savings incremented or decremented. The solicitation could be refused.
6. The total of accepted solicitations then resulted in a deviant home being informed its savings due to conservation had increased or dropped due to the collective action of the group.
7. The system introduced delays to make it difficult to align the arrival of a sanction with other group members being home, for example.

As above, study households will be informed not to share the details of their IHD displays. Any occupant asked if they had caused or received a sanction will be advised to respond that they did not know. The social sanctions are thus a minimal, semi-transparent reinforcing system with the usual risks of retribution seen in APEX games (Oliver, 1984) diminished due to de-identification and plausible deniability. Nonetheless, the presence of social sanctions is expected to reinforce group norms for both the giver and the receiver (Caldwell, 1976).

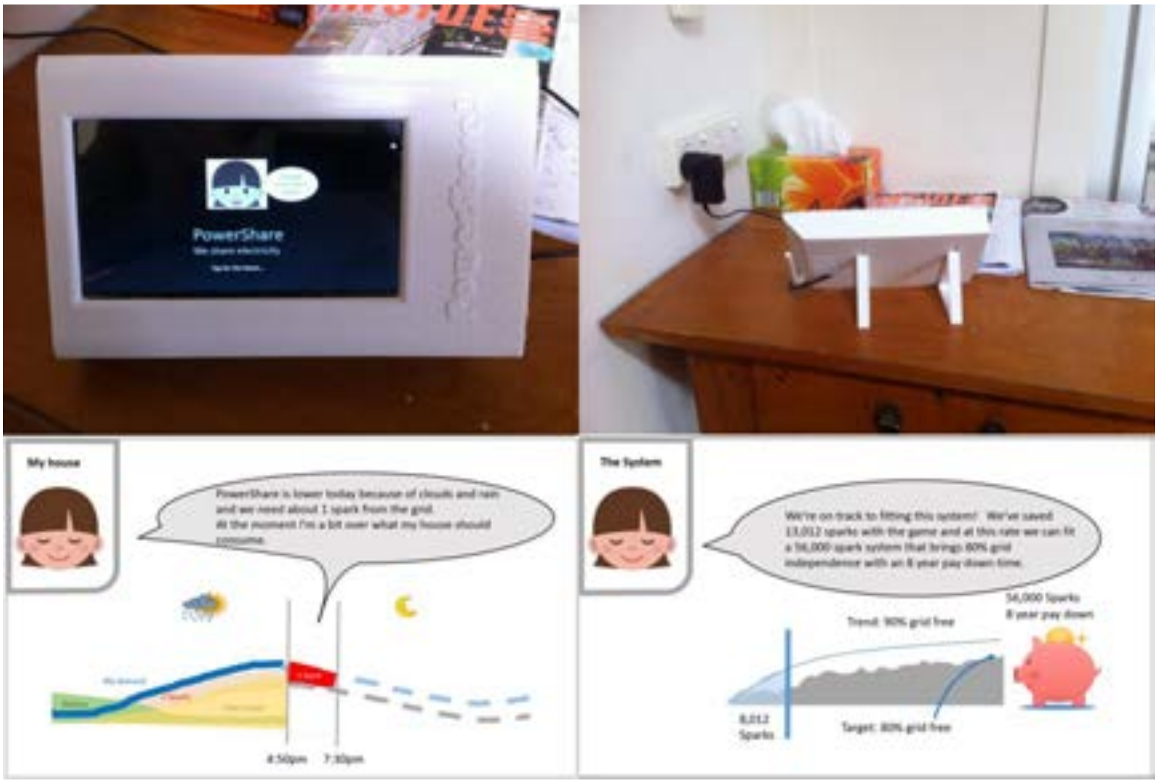

Figure 2. Top left: experiment in-home energy display. Top right: in-home energy display rear view with LoRA radio antenna visible. Bottom left: Performance, generation and goal for participant home. Bottom right: final goal for the group. The display communicates with the home smart meter and with a central server via an internal 3G dongle. The IHD does not interact with conventional electricity billing at all.

The IHD produces a number of prompts which require the occupants to touch the screen. This in turn results in time series of events being recorded (Figure 3). This time series is aggregated centrally at the server. If the IHD goes offline or occupants cannot or are not using the IHD this can be detected centrally and the affected home can be contacted.

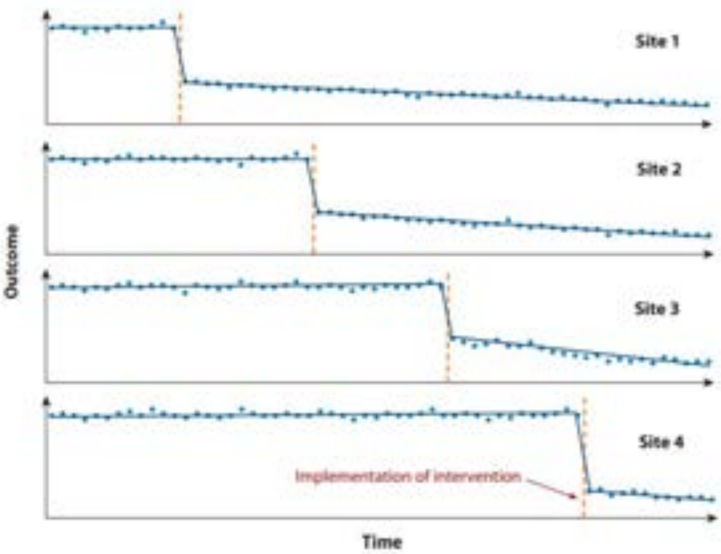

Figure 3. The interventions will be deployed per group and group energy consumption recorded as above. The correlation strength and significance of consumption and timed interventions will be determined. If the intervention is significant it will then be tried on another group remotely via the IHD. Taken with permission from (Sanson-Fisher et al., 2014:20).

The time periods over which to run a treatment and then observe for effects have not been determined at this stage. When the experiment runs, it will first be deployed to only one house group for a month in order to calibrate the system. This includes establishing the reinforcement schedule. Once the multiple baseline process emits significant data, then the remaining four groups will be set up.

3.3 Risks

The study requires that occupants can provide reinforcement to other (anonymous) group members who are adjacent homeowners, via the IHD. A group member who uses a lot of energy may receive negative reinforcement from the others causing annoyance. This may cause the participant to quit the study, to complain to the University, and/or to fall out with one- or all- of the other neighbours. To address this participants are told that if they are a habitual large energy consumer that they will not be unfairly treated and that all standing energy profiles are simply based on the participant's 2016 energy consumption as a starting point. The system does not identify reinforcement opportunities from one-off events and instead identifies over- or under- consumption as the 5-day trend (adjusted for weather) of the household over- or under- their 2016 energy use records (respectively). This means that a household having guests, or trades work done, or using an energy intensive device for a day will not receive negative reinforcement. Likewise, a household that goes away for a few days will not receive positive reinforcement for low energy consumption (in fact the system detects when no one is home and such periods are discounted from the analysis). Reinforcement events impose a cost on the issuer. This cost has been observed to reduce the risk of retribution in other social games.

4 Conclusion

The study will attempt to determine if ad-hoc groups of urban neighbours can be coordinated to share a co-owned solar and battery system. An In Home Display will be deployed to both display home energy use as well as the fictitious production of the shared system, and to solicit group sanctions to head off common limited pool resource conflicts.

The outcomes of this study, if found to be valid and consistent may be important for new efforts in the Australian energy transition. If groups of neighbours can share such systems then the technology will be far more affordable than if neighbours had to all buy separate systems. Such collective groups could enjoy high levels of energy independence and consume less large scale generated energy through more efficient self-consumption of generated solar power. In turn, less solar power exported to the utility would reduce stress on the grid.

A group that can share may also enjoy the additional benefits reported by energy communities more widely, namely group cohesion, and community forming. Perhaps more importantly, emergent energy groups that learn to conserve may be more open to the concept of final energy consumption, lifetime carbon cost and even sharing other utilities such as water, waste and transport.

If a group can share a renewable energy generator on a supplementary (that is, a private) network, then the group has a redundant supply and so can enjoy more reliable power, islanding power, or poor quality grid power, (reducing the imperative, cross-subsidies and overall great cost of 99.998% power for all domestic consumers).

In future, it would be desirable to run this study at a greater scale. This could allow varying the neighbour group sizes, or adding and removing group members to determine shared system designs that are robust to change. In the current study, renters are not catered for and they may not benefit from the projected long term savings once a system is collectively paid down. Instead, future studies might consider how owners enjoy improved property values with DRE systems and could be incentivised to subsidise their tenants or even join a sharing scheme as a virtual member contributing directly to the pay down curve of the system (which may also be tax-deductible).

In future it would be valuable to follow up on the groups tested in this study and to this end, participants' permission is being requested for future recruitments and data access. It would be desirable that a sharing group can continue to conserve without the requirement of social sanctioning features since these are intended to change behaviours. Of perhaps greatest interest in future is the potential for neighbours to cooperate to shift or aggregate demand through personal interactions (such as to spread solar day loads). In this study interaction was limited to only those social cues served via the IHD.

Acknowledgements

Burton would like to thank his supervisors / co-authors along with his supervisory panel A/Prof Sven Feldmann, Hon Fellow Terry Jones and Dr. Janet Stanley together with Prof Robert Sanson-Fisher of the University of Newcastle Medical Faculty and Mr Lee Honan. The authors greatly acknowledge the support of Moreland, Melbourne and Port Phillip City Councils who provided valuable staff and contacts, and the Cooperative Research Centre for Low Carbon Living that funds the research programme.

References

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291.

ABS. (2011). 4604.0 - Energy Account, Australia, 2008-09. Retrieved March 22, 2017, from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4604.0Main+Features42008-09

AER. (2017). How to read your electricity bill. Retrieved March 21, 2017, from https://www.energymadeeasy.gov.au/helpG/electricity-bill

Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*(9–10), 1082–1095.

Anderson, W., & White, V. (2009). *Exploring consumer preferences for home energy display functionality* . Centre for Sustainable Energy.

Attari, S. Z., DeKay, M. L., Davidson, C. I., & Bruine de Bruin, W. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(37), 16054–16059.

Bauwens, T., & Eyre, N. (2017). Exploring the links between community-based governance and sustainable energy use: Quantitative evidence from Flanders. *Ecological Economics: The Journal of the International Society for Ecological Economics*, *137*, 163–172.

BREE. (2012). 2012 Australian energy statistics data. Retrieved July 19, 2017, from https://web.archive.org/web/20130425193450/http://www.bree.gov.au/publications/aes-

2012.html
BREE. (2014). *Australian Energy Projection to 2049-50*. bree.gov.au.
Brinsmead, T., Graham, P., & Qiu, J. (2017). *Economic benefits of the Electricity Network Transformation Roadmap: Technical report*. CSIRO.
Caldwell, M. D. (1976). Communication and sex effects in a five-person Prisoner's Dilemma Game. *Journal of Personality and Social Psychology*, *33*(3), 273.
City of Melbourne. (2016). *Resilient Melbourne Strategy*. 100 Resilient Cities.
Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. *Energy Policy*, *61*, 729–739.
Delmas, M. A., & Lessem, N. (2014). Saving power to conserve your reputation? The effectiveness of private versus public information. *Journal of Environmental Economics and Management*, *67*(3), 353–370.
DELWP. (2014). Top 10 ways to save energy. Retrieved July 19, 2017, from https://www.victorianenergysaver.vic.gov.au/more-ways-to-save/top-10-ways-to-save-energy
Dentler, R. A., & Erikson, K. T. (1959). The Functions of Deviance in Groups. *Social Problems*, *7*(2), 98–107.
Dumais, M. (2016). *Submission 97 Victorian Parliament Inquiry Community Energy Projects* . Australian Fabians Vic Branch.
Essential Services Commission. (2016). *Distributed Generation Inquiry Final Report - Energy Value*. Essential Services Commission.
Gans, W., Alberini, A. & Longo, A. (2013). *Smart Meter Devices and the Effect of Feedback on Residential Electricity Consumption: Evidence from a Natural Experiment in Northern Ireland*. Energy Economics 36. Elsevier: 729–43.
Gardiner, K. (2017). The small Scottish isle leading the world in electricity. Retrieved July 18, 2017, from http://www.bbc.com/future/story/20170329-the-extraordinary-electricity-of-the-scottish-island-of-eigg
Hannah, D., & Murphy, C. (2013). *We Energies - Community Education Pilot Program Final Evaluation*. Itron Inc.
Hepburnwind. (2011). *Hepburn wind - Submission to the Clean Energy Finance Corporation Expert Review* . Hepburn Wind.
Hobman, E. V., Frederiks, E. R., Stenner, K., & Meikle, S. (2015). Uptake and usage of cost-reflective electricity pricing - Insights from psychology and behavioural economics. *Renewable and Sustainable Energy Reviews*, *57*(C), 455–467.
Ison, N. (2017). Community Power Agency. Retrieved March 19, 2017, from http://cpagency.org.au/
Ison, N., & Lyons, M. (2013). *Homegrown Power Plan Summary*. GetUp and SolarCitizens.
Kelly, M. J. (2010). Future Energy Needs and Engineering Reality. Retrieved from http://www.nscj.co.uk/JECM/issues/JECM-1-3.pdf
King, G., & Nielsen, R. (2016). *Why propensity scores should not be used for matching*. Harvard University. Retrieved from https://gking.harvard.edu/files/gking/files/psnot.pdf
Liubinas, A., & Harrison, P. (2012). Saving a Scarce Resource: A Case Study of Behavioural Change. In *Academy of Marketing Conference*.
McKean, M. A. (1986). *Success on the commons: a comparative examination of institutions for common property resource management* . Duke University.
Moere, A. V., Tomitsch, M., Hoinkis, M., Trefz, E., Johansen, S., & Jones, A. (2011). Comparative Feedback in the Street: Exposing Residential Energy Consumption on House Façades. In *Human-Computer Interaction – INTERACT 2011* (pp. 470–488). Springer, Berlin, Heidelberg.
Oliver, P. (1984). Rewards and Punishments as Selective Incentives an APEX game. *JOURNAL OF CONFLICT RESOLUTION*, *28*(1), 123–148.
opower.com, 2015. Moments that Matter: A customer-centric approach to experience management, oPower.
Ostrom, E., (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. J. E. Alt & N. D. C., eds., The Edinburgh Building, Cambridge, CB2 2RU, UKK: University of Cambridge Press.
Palmer, G. (2014). *Energy in Australia: Peak Oil, Solar Power, and Asia's Economic Growth*. Springer International Publishing.

Pavitt, C. (1994). *Small group communication - a theoretical approach* Gorsuch Scarisbrick.
Petkov, P., Medland, R., & Krcmar, H. (2011). Engaging Energy Saving through Motivation-Specific Social Comparison. In *Proceedings of Human Factors in Computing Systems (CHI)* (p. 7). New York, USA: ACM.
Quinn, M. (2006). The power of community: How Cuba survived peak oil. Retrieved March 18, 2017, from http://www2.energybulletin.net/node/13171
Sanson-Fisher, R. W., D'Este, C. A., Carey, M. L., Noble, N., & Paul, C. L. (2014). Evaluation of systems-oriented public health interventions: alternative research designs. *Annual Review of Public Health*, *35*, 9–27.
Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, *18*(5), 429–434.
Smith, G. (2016). *Submission 93 Victorian Parliament Inquiry Community Energy Projects* . Indigo Shire Council.
USDA. (2015). The facts about 1945 Victory Gardens. Retrieved July 20, 2017, from https://web.archive.org/web/20150702085451/http://www.victorygardenfoundation.org/VGhistory/Facts%20about%201945%20VGs.pdf
Wright, M., & Hearps, P. (2011). *Zero Carbon Australia Stationary Energy Plan*. Beyond Zero Emissions. Retrieved from http://media.bze.org.au/ZCA2020_Stationary_Energy_Report_v1.pdf