CSIRO Intelligent Grid Cluster

Progress Report

Project P6: The Intelligent Grid in a New Housing Development

Period: March – June 2009

Milestone 3 and 4

Authors

Prof. Wasim Saman
Dr. Jane Edwards
Mr. Lachlan Mudge
Dr. Edward Halawa

August 2009

Disclaimer

This report is confidential and was prepared exclusively for the client named above. It is not intended for, nor do we accept any responsibility for its use by any third party.

Acknowledgements

Table of Contents

EXECUTIVE SUMMARY

This report outlines the work undertaken during the past 6 months (January – June 2009) on the iGrid Project P6: The Intelligent Grid in a New Housing Development. The report covers 2 milestones (Ms) of the project, namely M3: Design and finalisation of the first household questionnaire, and M4: (a) Selection of energy monitoring system for housing cluster (electricity and gas) and (b) Selection of households for individual monitoring and completing household consent and ethics approval.

All the components of the M3 have been accomplished. The survey instrument has been designed and developed. In addition, an analysis of the preliminary household survey has been conducted. Despite some uncertainty in the data gathering process, the analysis of the collected data define the Lochiel Park residents demographic characteristics and attitudes towards sustainability and sustainable practices. The ethics protocol proposed by UniSA has been approved by the University of South Australia's Human Research Ethics Committee (HREC).

Work on the first component of M4 (Selection of energy monitoring system for housing cluster - electricity and gas -) is almost complete. However, there are still some unresolved issues with gas metering and monitoring.

In total, 16 houses have had some monitoring equipment installed at this time. By the end of June 2009, homes have been completed and occupied and 1 has its detailed monitoring equipment completely installed. Two more homes will have their detailed monitoring equipment installed by the end of August.

The difficulty of some builders complying with the sustainability guidelines has resulted in the delay of construction of some homes. Therefore the list of the homes included in the detailed monitoring had to be revised. Currently there are 35 houses under construction. It is expected that over the next 6 months a further 25 – 30 homes will be handed over.

UniSA and LMC are still negotiating with EcoVision on the best option for storage and access of the collected data from individual houses and housing cluster. A temporary solution, whereby the data are stored on a server at Lochiel Park, is currently being finalised by LMC and EcoVision to allow the project to progress.

Overall, the implementation of the components of the projects are within the schedule of the original plan. However, a number of circumstances have resulted in some delay in the commencement of the remote data monitoring which was originally scheduled to start in July 2009 as stated in Annual Performance Goal of P6 work plan (P6WP, 2009). It should be noted however that data are already being collected locally at several sites.

Abbreviations

ETSA - The Electricity Trust of South Australia

HREC – Human Research Ethics Committee

LMC – Land Management Corporation

ONU - Optical Network Unit

VPN – Virtual Private Network

Key Words

Sustainable housing, green village, energy rating, star rating, greenhouse gas emissions, smart metering, distributed generation, distributed energy resources, grid connected solar

1   INTRODUCTION

This report outlines the work accomplished and highlights some issues encountered during the implementation of the P6 Project - The Intelligent Grid in a New Housing Development during the past six month period, January – June 2009. The accomplished components of work include: analysis of the results of preliminary survey of intending residents of Lochiel Park Green Village, development of the first qualitative survey instrument and selection of new homes included in the detailed monitoring program. Some issues highlighted are: delay in the monitoring of the homes, still unresolved issues of gas metering and monitoring for housing cluster, problems in installation and programming of electricity meters and wiring of existing EcoVision display systems.

2   SURVEY OF INTENDING RESIDENTS OF LOCHIEL PARK GREEN VILLAGE

2.1 SUMMARY

The Land Management Corporation conducted an online survey of intending residents of Lochiel Park. This report summarizes the results of that survey.

Socio-demographic profile

The majority of the study population are:
- Middle aged
- Employed in professional and semi-professional occupations
- Financially well-off
- Living in one and two person households

Transport

The study population has:
- High levels of car ownership
- Preference for small vehicles
- Near universal use of petrol to fuel cars
- Wide variation in the kilometres travelled to work

Energy and water use

The study population:
- Exhibits wide variation in reported use of gas, electricity and water
- Rates themselves as more rather than less efficient in their use of energy and water

Waste

The study population:
- Composts kitchen and garden waste at slightly below the national averages
- Rates themselves as more rather than less efficient in the management of household waste

Impact of living in Lochiel Park

The study population:

- Expects residing in Lochiel Park will significantly influence the sustainability of their lives
- Expresses interest in being involved in community projects

2.2 INTRODUCTION

This section presents the findings from an online survey conducted by the Land Management Corporation (LMC) of South Australia during 2006. The survey respondents were, for the most part, people intending to reside in Lochiel Park. The development of Lochiel Park was announced by the state government of South Australia in 2004 and is focused on the building of ecologically sustainable houses and on fostering lifestyles that have a reduced carbon footprint. When complete, the development will contain approximately 100 houses in a location only 8 kilometres from Adelaide's CBD. The housing stock will be mixed; some packages will cost more than the average Adelaide house price, but there will be with some mews style dwellings to provide lower cost housing and approximately one quarter of the development will devoted to social housing. Houses will employ passive design features and will have energy efficient appliances installed, and houses will utilize distributed energy. There will be detailed monitoring of household energy consumption and householders will be able to monitor and regulate their energy use through load management devices. It will be mandatory for houses to have photovoltaic cells and gas boosted hot water systems, as well as to have rainwater tanks. In addition, the Lochiel Park development will increase the use of recycled water; it also aims to reduce household and community waste and develop community initiatives that lead to lower green house gas emissions. The intention is that houses in Lochiel Park should have 66% lower energy consumption and 74% reduction in greenhouse gas emissions compared to the average for South Australian households in 2004. It is anticipated that Lochiel Park will be a showcase for sustainable housing and community development.

Residents of Lochiel Park will be encouraged to actively engage with the household technology that monitors and regulates household energy consumption and to be active in reducing their water use and waste production. Because of the innovative nature of the Lochiel Park development, it is desirable that there be some data on the demographic characteristics of intending residents and that information is collected about their current attitudes and behaviours related to sustainable living. This will provide benchmark data that will allow some assessment of the way living in Lochiel Park shapes attitudes and behaviours related to sustainable living. In view of this, the LMC surveyed intending residents about their socio-demographic characteristics, their current energy and water use, recycling behaviour, car ownership and travel patterns. In addition, intending residents were asked about how they rated the sustainability of their lifestyles and the impact they anticipated living in Lochiel Park would have on the sustainability of their way of life. Surveys were completed online by people who had been accepted as members of an online Lochiel Park community; thirty-six people responded. Data were entered into an Excel spreadsheet and were analysed using SPSS 15.

2.3 SOCIO-DEMOGRAPHIC PROFILE

Table 1 indicates that intending residents are predominantly middle aged; the mean age is 45.5 years.

Table 1: Respondent's age

Age brackets	n	%
0-10	5	11
11-20	3	6
21-30	6	13
31-40	3	6
41-50	5	11
51-60	15	32
61-70	10	21
71-80	0	0
Total	47	100

The most common age bracket is the 51-60 age group, followed by the 61-70 age group. It is likely that the 61-70 age group will be actively retired or be transitioning into retirement or, at least, to have less intensive labour market participation. This is likely to have significant impacts on the way people behave in relation to household technology and in other behaviours relevant to energy and water use, and waste reduction.

On the other hand, 17 % of the potential population are under twenty years of age, which will yield important information about the impacts of young children and teenagers on household practices related to the intelligent grid and other 'green' features of housing in Lochiel Park. Furthermore, 30% of the population are aged between 21 and 50 years. This is the age group that we would expect would be juggling the demands of family and work and they will therefore be an interesting sub-population for examining the impact of work and household division of labour on the behaviours relevant to monitoring and adjusting energy and water use.

Data on respondents' income levels were not collected using mutually exclusive categories, allowing only limited commentary on the income status of the study population. However, as Table 3 demonstrates, 55% of the study population earns $75,000 or over per annum, making this a population that is comfortably off. Some evidence suggests that it is households that are well off that make the most onerous contributions to energy consumption because they have the economic wherewithal to buy and run appliances that consume energy and other resources. Income of over $80,000 per annum is also predictive of being less likely to use less household heating and cooling (State of Victoria 2008). The study of Lochiel Park residents will therefore provide important information about a key target group for producing more sustainable lifestyles.

Table 2: Household income brackets

Income	n	%
45-60	4	20
60-75	5	25
75-100	3	15
100-150	5	25
150+	3	15
Total	20	100

Missing 16 households

Data on occupation were collected using very broad categories which do not permit much detailed interpretation about respondents' employment patterns. However, it is evident that the majority of the study population are in professional and semi-professional occupations. This also makes this population worthy of investigation. Available evidence suggests it is middle class professionals who feel time poor and who are more likely to have jobs that entail significant degrees of travelling. The impact of demanding jobs and of time spent travelling on household behaviours related to sustainability have been largely ignored, obscuring insight into factors that are likely to be important contributors to the way households use technology and resources.

Table 3: Occupation

Employment	n	%
Other	8	26.7
Engineering	2	6.7
Other professional	7	23.4
Manufacturing	1	3.3
Education	9	30.0
Finance	1	3.3
Housing	1	3.3
Other administration	1	3.3
Total	30	100

Missing 6 households

Table 4: Number at address

Number of people living at address	n	%
1	2	5.9
2	20	58.8
3	7	20.6
4	4	11.8
5	1	2.9
Total	34	100

Missing 2 households

Not surprisingly, given the age brackets of the population, one and two person households predominate, as table 4 indicates. Two person households are the dominant household type (accounting for almost 59% of households) and two thirds of the study population are in one and two person households. Given the ageing of the Australian population and the rising rate of single person households, these will be an important demographic group to monitor. Approximately one-third of the study population are in households that include children. The study population mirrors the wider Australian population. The mean number of householders in the study population is 2.47, which compares with a mean of 2.5 in the wider Australian population in 2005-6 (Australian Bureau of Statistics 2008).

Table 5: Number of bedrooms

Number bedrooms	n	%
1	1	3
2	5	15
3	18	53
4	9	26
5	1	3
Total	106	100

Most householders are in homes of three bedrooms (53%), while only 18% have 1 or 2 bedroom dwellings. Just under 30% of respondents have dwellings with four bedrooms or more. The mean number of bedrooms per dwelling is 3.1.

This population therefore mirrors the wider Australian population. Data collected by the Australian Bureau of Statistics (ABS) reveals that nationally 28% of dwellings had four or more bedrooms and there was an average of 3.1 bedrooms per dwelling. Hence these respondents fit the national averages (Australian Bureau of Statistics 2008). In 2005-6, the average was 3.1 bedrooms per dwelling (Australian Bureau of Statistics 2007).

For the most part, the homes in Lochiel Park will be an important site of energy and other resource consumption because only under 30% of households will have no person at home during the day. This means that almost three-quarters will have people in them at all times during the day, making them significant sites of consumption. One third of households will have two or more people in them at all times during the day.

Table 6: Number at home

Number persons at home during day	n	%
0	9	27.3
1	13	39.4
2	10	30.3
3	1	3.0
Total	33	100.0

Missing 3 households

2.4 TRANSPORT

The study population has high levels of car ownership, as table 7 demonstrates:

Table 7: Number Cars

Cars per household	n	%
0	1	3
1	10	30
2	20	61
3	2	6
Number	33	100

Missing 3 households

Almost all of the study population have cars (97%) and of the households with cars 61% have two or more; the mean was 1.69 cars per household. The Australian Bureau of Statistics (ABS) revealed that 90% of people had at least one registered car at their dwelling or garage and 51% had 2 or more vehicles (Australian Bureau Statistics 2008). This study population therefore has a greater number of cars per household than the national average, suggesting that they are more affluent.

The study population, however, makes greater use of smaller cars than larger ones, as table 8 shows. The preponderance of small vehicles is even more pronounced for the second vehicle in the household, as indicated in table 9; more than 80% of second vehicles are 4 cylinder cars. It may be, given the high percentage of one and two person households in this population, that people feel they do not need bigger cars. The preference for small vehicles may reflect 'green' attitudes. However, the Australian Bureau of Statistics reported in 2003 that only 4% of households purchased cars on the basis of environmental concerns (Australian Bureau of Statistics 2003).

Table 8: Size first car

Size first car in household	n	%
4 cylinder	15	60
6 cylinder	10	40
Total	25	100

Missing 11 households

Table 9: Size second car

Size second car in household	n	%
4 cylinder	13	81
6 cylinder	3	19
Total	16	100

Missing 20 households

Petrol overwhelmingly remains the fuel used for cars among the study population, as tables 10 and 11 reveal.

Table 10: First car fuel

Fuel type first car	n	%
Petrol	24	96
Other (not specified)	1	4
Total	25	100

Missing 11 households

Table 11: Second car fuel

Fuel type car 2	n	%
Petrol	13	81
Diesel	2	13
LPG	1	6
Total	16	100

Missing 20 households

The number of cars owned by the study population outnumbered the number of bikes owned by a ratio of approximately 3: 2. Bikes appear to be most favoured by those in one and two person households.

Table 12: Bikes per household

Number bikes per household	n	%
0	0	19
1	7	27
2	13	50
3	0	0
4	0	0
5	1	4
Total	21	100

Missing 15

The mean number of bikes per household was 1.46. Of those people who had bikes, just under one-third identified that they used their bike for commuting, while over two-thirds (68%) indicated that their bikes were for casual use. Levels of public transport use were relatively low, as were the level of people walking or cycling to work. Private cars are the form of transport most favoured as a way of travelling to work. Respondents were asked about the ways in which they travelled to work; many respondents offered more than one response, indicating that their mode of travel varied:

- 25% travel to work on their bicycle
- 31% walk to work
- 33% travel to work on the bus
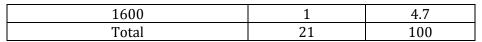- 58% drive their car to work.
-

The level of car use for travel to work is much lower than that for the Australian population as a whole. It was estimated in 2006 that roughly 80% of Australians used a private car for travel to work (Garnaut).

The distance travelled to work by members of the household varied markedly. The kilometres travelled to work per week by person one in the household ranged from zero to 1600. This degree of variation may reflect actual travel patterns or it may reflect different interpretations of the question. The mean number of kilometres travelled to work in a week by person one was 148. Approximately half of the study sample travelled less than 35 kilometres per week and approximately 61% of the sample of person one in the household travelled 100 kilometres or less per week.

Table 13: Travel to work Person 1

Kilometres travelled to work per week (person one)	n	%
0-35	10	47.6
60-100	3	23.8
101-235	4	19.2
300	1	4.7

| 1600 | 1 | 4.7 |
| Total | 21 | 100 |

Missing 15 households

The distances travelled to work per week by person two in the household were markedly lower than those travelled by person one. The mean number of kilometres travelled to work per week by person two was 82.6. The range of kilometres travelled by person two was also significantly lower than that for person one: 6 – 200 kilometres. However, the percentage of person two people travelling 100 kilometres or less per week was also 60%, as table 14 shows.

Table 14: Travel to work Person 2

Kilometres travelled to work per week (person two)	n	%
0-30	5	33.3
40-100	4	26.7
101-150	5	33.3
200	1	6.7
Total	15	100

Missing 21 households

The data on the number of people who on average travel in the car are hard to interpret. Almost one-third of respondents said there were no persons in their car in the journey to work. It is plausible that people interpreted this question to mean the number of passengers they carried on their journey to work. If those who indicated '0' meant they had no passengers in their car, it would indicate that approximately 65% of car journeys to work had only one person in the car.
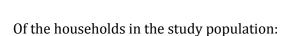
Table 15: Number in car

Number in car	n	%
0	7	30.43
1	8	34.79
2	7	30.43
3	1	4.35
Total	23	100

Missing 13 households

2.5 WATER

Data on household water use by the study population should be interpreted with caution. The variation in stated use is wide (zero through to 400 kl consumption in the last quarter). This may reflect actual consumption patterns or it may reflect divergent interpretations of the question. In 2000-01, the average annual household consumption per capita in South Australia was 123kL (Australian Bureau of Statistics 2005). By 2007-08, the South Australian government reported that the average metropolitan household consumed 191 kL water in 2007-08 (South Australian Government 2008). The mean water use reported by the study population is 89.6 kL per quarter which suggests that their mean annual consumption is approximately 258 kL water, making it higher than the metropolitan average. Two thirds of the study population have an annual consumption in excess of the 191 kL average and almost 30% have approximately double the average level of water consumption.

Of the households in the study population:

- 33% used under 50kL water in the last quarter
- 42% used between 51 and 100kL water in the last quarter
- 24% used over 100kL water in the last quarter

Table 16: kL water use previous quarter

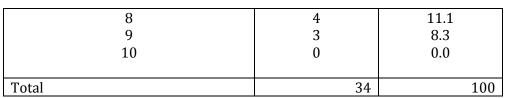| kL water use per household last quarter	n	%
.00	2	8.3
10.00	1	4.2
22.00	1	4.2
33.00	1	4.2
35.00	1	4.2
37.00	1	4.2
45.00	1	4.2
54.00	1	4.2
57.00	1	4.2
59.00	1	4.2
62.00	1	4.2
92.00	2	8.3
100.00	4	16.7
104.00	1	4.2
135.00	1	4.2
150.00	1	4.2
174.00	1	4.2
191.00	1	4.2
400.00	1	4.2
Total	24	100

Missing 12 households

The study population have mixed estimates about how efficient they were in their use of water. Survey participants were asked to rate the efficiency of their water use on a scale from 0 to 10; 0 represents least efficient and 10 represents most efficient. As table 17 shows, approximately 27% rated themselves as less than 5 on the scale, 17% rated themselves at 5, while approximately 56% rate themselves as more efficient rather than less efficient in their use of water.

Table 17: Self rated efficiency water use

Self Rating 0 to 10 (0 least efficient, 10 most efficient)	n	%
0	0	0.0
1	0	0.0
2	2	5.6
3	4	11.1
4	3	8.3
5	6	16.7
6	4	11.1
7	8	22.2

8	4	11.1
9	3	8.3
10	0	0.0
Total	34	100

Missing 2 households

The number of people in the household does not appear to have a relationship with levels of water consumption. However, the sample size is insufficient to confidently describe any trends.

Table 18: Water consumption and number in household

Water consumption (kL)	Number in household				
	1	2	3	4	Total
0	0	0	1	0	1
22	0	1	0	0	1
33	0	1	0	0	1
35	1	0	0	0	1
59	0	0	1	0	1
92	1	0	0	0	1
100	0	1	0	0	1
104	0	0	1	1	2
135	0	1	0	1	1
150	0	1	0	0	1
174	0	1	0	0	1
191	0	1	0	0	1
Total	2	7	3	2	14

In relation to water efficient actions, of the study population:
- 33% has a rainwater tank
- 53% had a water efficient shower head
- 53% had a water efficient garden

Of respondents with a rainwater tank:
- 6.7% had it plumbed to the toilet
- 6.7% did not use it
- 13. 3% had it plumbed to the laundry
- 13.3% had it plumbed to the hot water service
- 69% used it for outdoor use only

However, according to ABS data, 48% of South Australian households had a rainwater tank in 2004 (ABS 2005). Hence, the study population has a lower rate of use of rainwater tanks than the state average. However, only 44% of Australian households had water efficient shower heads, so the study population performs better on this indicator than the national average (Australian Bureau of Statistics 2008).

There was no consistent relationship between people's rating of the efficiency of their water use and having an efficient shower head. Nor was there any relationship between possessing a rainwater tank and self-rating for efficient use of water. However, people who rated themselves as more than five on the self rating efficiency scale were more than twice as likely to have a water efficient garden.

2.6 ENERGY CONSUMPTION

2.6.1 Gas

As Table 19 reveals, there is marked variation in the reported gas consumption by the study population in the last quarter (15-4250 MJ). This variation means these data should be interpreted with great caution. The mean quarterly gas consumption was 1843 MJ. The small sample size does not allow any assessment to be made of the relationship between gas use and the number of people in a household.

Table 19: Gas use previous quarter

Gas Use Previous Quarter (MJ)	n	%
15	1	6.25
80	1	6.25
100	1	6.25
539	1	6.25
543	1	6.25
1000	1	6.25
1325	1	6.25
1578	1	6.25
1654	1	6.25
1727	1	6.25
2448	1	6.25
2500	1	6.25
3750	1	6.25
3753	1	6.25
3952	1	6.25
4250	1	6.25
Total	16	100

Missing 20 Households

2.6.2 Electricity

As is the case for water and gas usage, there is significant variation in the reported consumption of electricity for the previous quarter by the study population (range 6-3037 kWh). Accordingly, these results should be treated with caution. The mean electricity consumption in the past quarter was 1068kWh.

Table 20: Energy use previous quarter kWh

Electricity Use last quarter (kWh)	n	%
6	1	4

15	1	4
30	1	4
451	1	4
100	1	4
300	1	4
375	1	4
380	1	4
406	1	4
512	1	4
891	1	4
898	1	4
980	1	4
1284	1	4
1310	2	8
1437	1	4
1600	1	4
1773	1	4
2100	1	4
2200	1	4
2291	1	4
2352	1	4
3037	1	4
	24	100

Missing 12 households

There is no relationship between the level of electricity consumption and the number of people in the household. However the small sample size makes establishing trends difficult.

Table 21: Self rating energy use

Self rating energy (0 to 10) (0 least efficient, 10 most efficient)	n	%
0	0	0.0
1	0	0.0
2	2	6.1
3	3	9.1
4	5	15.1
5	9	27.3
6	7	21.1
7	3	9.1
8	2	6.1
9	2	6.1
10	0	0.0
Total	33	100

Missing 3 households

Within the study population:

- 5.5% had Photovoltaic cells or other forms of solar power
- 20% purchased green power

Survey respondents were asked about their sources of hot water, air-conditioning, heating, and lighting. Not all respondents replied to all questions and some respondents offered multiple responses to the same questions:

Household sources of hot water:

- 13.9% had gas hot water storage
- 16.7 had solar or other sources of heating water
- 19.4% had gas instantaneous hot water
- 25% had electric storage hot water

Sources of air conditioning

- 5.6%---Reverse cycle multi head split
- 5.6%---Other form of air conditioning
- 8.3%--- No air conditioner
- 13.9% ---Reverse cycle ducted
- 19.4%--- Evaporative
- 27.8%--- Reverse cycle

Types of heating

- 3% indicated they had no form of heating
- 6% have gas ducted heating
- 8% have gas heating
- 11% use wood for heating
- 17% indicated that they used other forms of heating
- 42% have reverse cycle heating

Types of lighting

- 17% low voltage halogen
- 25% incandescent globes
- 36% compact fluorescent

It is difficult to compare the kinds of lighting used by the respondents in this study with data on national averages. The Australian Bureau of Statistics (2008) reports on the kinds of lighting used by households in both 'at least one room' of the house and it also reports data on the kinds of lighting used for 'all rooms' in the house. This survey, however, asked people about the kinds of lighting they used in a 'majority' of rooms in the house. Hence, no comparisons can be meaningfully made between ABS data and the results of this survey.

2.7 WASTE

Only 15% of the study population considered they were less rather than more efficient in their management of waste. Twelve percent considered they were neither particularly efficient of particularly inefficient in their management of waste, while a clear majority (73%) considered they were more rather than less efficient in the way they managed waste. The mean for the self-rating of efficient waste management was 6.6.

Table 22: Self Rated efficiency waste

Self Rating Waste	n	%
0	0	0.0
1	1	3.0
2	0	0.0
3	1	3.0
4	3	9.2
5	4	12.1
6	3	9.2
7	8	24.2
8	8	24.2
9	4	12.1
10	1	3.0
Total	33	100

Missing 3 households

The study population reports having high levels of access to recycling facilities, with 97% saying they had access. However, 31% said that their council did not provide triple bins. While the study population ranks itself as more efficient in relation to waste than to use of water and electricity, the majority of this population does not compost its kitchen or garden waste, as tables 22 and 23 demonstrate. Those composting kitchen waste were more likely to identify themselves as more efficient (self-rating over 5) in their management of waste. However, composting garden waste was not associated with self-rating of efficient management of waste.

Table 23: Households composting kitchen waste

Behaviour	n	%
Households composting kitchen waste	16	47
Households not composting kitchen waste	18	53
Total	33	100

Missing 3 households

Table 24: Households composting garden waste

Behaviour	n	%
Households composting garden waste	15	47
Households not garden composting waste	17	53
Total	32	100

Missing 4 households

ABS data reveal that by 2006, 99% of Australian households engaged in recycling / reusing household materials. However, kitchen and garden waste were the items that were least recycled and re-used. In 2006, approximately 50% of households recycled or reused kitchen / food waste, while almost 70% recycled garden waste (Australian Bureau of Statistics 2008). This means that the survey respondents are slightly below national averages for kitchen waste and much lower than national averages for recycling garden waste.

2.8 EXPECTED OUTCOMES OF LIVING IN LOCHIEL PARK

Only a very small percentage of respondents considered that living in LP would make a minor difference to the way in which they lived. An overwhelming majority considered it would impact

on their lifestyle, with 50% suggesting it will have a significant impact on their lifestyle. Subsequent phases of the project will explore the ways in which people expect living in Lochiel Park will significantly influence the ways in which they live. As indicated below, the expected impact of living in Lochiel Park may relate to involvement in community facilities and activities as much as it does to behaviours related to sustainable living.

Table 25: Impact of living in Lochiel Park

Impact	N	%
Minor	2	7
Somewhat	12	40
significant	15	50
Major	1	3
Total	30	100%

Missing 6 Households

The survey population was asked to indicate whether they would be interested in community based transport and recreation activities. Relatively high levels of interest were expressed in being involved in these things. A community bus and a walking group generated the highest levels of interest, followed by having a community garden and a cycling group. It is interesting that the lowest levels of interest were expressed for having a community car and in having a car pool; this may indicate that people have an ongoing preference for the use of private cars.

Of those who responded to these questions (respondents could nominate multiple responses):
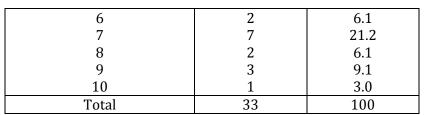
- 22% expressed an interest in having a car pool
- 25% expressed interest in having a community car
- 36% expressed interest in having a community garden
- 36% expressed an interest in being involved in a community based cycling group
- 42% expressed an interest in having a community bus
- 42% expressed an interest in being involved in a community based walking group

The study population were asked to rank their lifestyles on a scale from 1-10, with 0 indicating less sustainable patterns of living and 10 indicating the most sustainable ways of living; the average rating was 5.8. The majority of respondents (30%) rated themselves as 5, suggesting they regard their lifestyles as neither particularly unsustainable nor particularly sustainable. Approximately a quarter rated themselves under 5 on the scale, suggesting that they regarded their lives as not particularly sustainable. Roughly 45% of the study population rated themselves as higher than 5, suggesting they consider their lifestyles are more rather than less sustainable.

Table 26: Self Rating Sustainability

Self Rating Sustainability	n	%
0	0	0.0
1	0	0.0
2	1	3.0
3	2	6.1
4	5	15.1
5	10	30.3

6	2	6.1
7	7	21.2
8	2	6.1
9	3	9.1
10	1	3.0
Total	33	100

Missing 3 households

Survey respondents were asked to rate themselves on a scale of 0 to 10 (0 equals less efficient and 10 equals most efficient) in relation to water and energy use and management of household waster. They report themselves to be more efficient in their waste management than they report their efficiency in either water or energy use. The means for self rating of efficiency are:

- Energy 5.3
- Water 5.7
- Waste 6.6

This suggests that people find it easier to efficiently manage their waste. This may relate to the services provided to facilitate management of waste; it may take less time and/ or be less disruptive to household routines to efficiently manage waste than it does to efficiently manage the use of water and energy. Energy and water use may also be more closely linked to personal comfort than is the efficient management of waste and people may be less willing to engage in practices they regard as compromising their comfort. The reasons for the differences in self-rating of efficiency in these domains will examined in subsequent phases of the research.

There was no relationship between respondent's self-rating of their sustainability with the distance travelled to work per week by Person one. Those who rated themselves as more rather than less efficient in their use of energy were more likely to rate their lifestyles as more rather than less sustainable. Similarly, there was a relationship between the self-rating people gave regarding their use of water and their rating of the sustainability of their lifestyle; people who rated themselves as less efficient in their use of water also rated their way of life as less sustainable. In a similar vein, people who rated themselves as more efficient users of water were also more likely to rate their way of life as more sustainable. There was no apparent association in the way people rated their efficiency in waste management with the rating they made of the sustainability of their lives. There did not appear to be any association between the self-rating of sustainability and the number of people living in the household. However, the sample size impedes establishing trends within the data with any confidence.

3 DESIGN AND FINALISATION OF FIRST HOUSEHOLD SURVEY QUESTIONNAIRE (QUALITATIVE INSTRUMENT PHASE ONE)

This section describes the qualitative instrument to be used in phase one. It will be an exploratory, pilot study that analyses people's attitudes and behaviours in relation to 'green' behaviour, the interface of householders with the metering technology utilised in Lochiel Park houses and it will also identify the social and demographic influences on green behaviour and use of household metering technology. The qualitative phase will help inform the development of a survey instrument which will collect quantitative data on the use of technology and the things which influence it. It is developed as an instrument for a survey to be conducted on the Green Village household. The phase one qualitative questions will explore the following

questions: What did you know about distributed energy before you started living here? What prompted you to move to Lochiel Park?

Do you currently take any actions to reduce energy and water consumption? What do you do? Who initiates these activities and takes responsibility for them? What helps these activities? What hinders undertaking these activities?

Is there any conflict for the household between practicing 'green behaviour' and

> The time such activities take?
>
> The smooth operation of your household?
>
> The cost of 'green behaviour' ?

- What impact do you think living in Lochiel Park will have on your energy and water consumption and on your carbon footprint generally? How do you living in Lochiel Park will influence these things?
- How do you think monitoring your energy consumption and limiting your load will change the way the household operates?
- How will the household decide what its limit would be and how will it decide what appliances would be switched off if the load limit was exceeded? What will influence these decisions?

4 DATA MONITORING, STORAGE AND ACCESS

The location and type of data storage system and route of access to the monitoring data from homes is still being discussed between the research team, LMC and EcoVision. A number of long-term options are being considered, including a local server at Lochiel Park, a virtual server at UniSA and a server at EcoVision office in Queensland. A number of issues have been raised by UniSA and LMC with EcoVision and OptiComm, i.e.: ensuring accessibility for UniSA staff, preferred data format (a relatively raw format with information about the rates / units / time intervals, data security, data transfer rates, requirement for data backup and a guarantee of the data availability. Currently, LMC are proposing a temporary solution where data are stored on a server at Lochiel Park, which would utilise a Virtual Private Network for communicating with EcoVision systems in each household and would allow remote access to project stakeholders over the internet. This is currently being finalised by LMC and EcoVision to hasten the achievement of project milestones.

EcoVision has advised that it is in the process of developing its own server for projects generally which can host a number of projects, however a number of factors have delayed the implementation of this system.

The monitoring data for Lot 51 was collected manually, onsite, on two separate occasions. One such data file has been sent to the UniSA and undergone preliminary analysis .

It was discovered that, due to an error in the installation and programming of electricity meters installed by ETSA, the pulses generated by the meters were for net electricity only. This means that when the meters are in export mode, i.e. when surplus energy is being generated, no

corresponding pulse occurs. This is not a problem for the 'detailed monitoring' houses, since all information required still exists in the data stream. However this is not the case for the 'basic monitoring' houses. ETSA is rectifying this error through re-programming and rewiring of the billing meter, to avoid the need for complicated rewiring of the PV solar feed, that would otherwise have arisen. Ecovision are also currently working on software amendments required by EcoVision systems to accommodate these changes.

EcoVision screens on some houses were not properly wired back to the Optical Network Unit - ONU – (which converts light pulses from a fiber optic line to an electrical/digital signal), via Hills Home Hubs. This will require the supply and installation of an adaptor at the ONU to provide a separate data connection for the touch screens, where required. All future jobs are to be wired with separate data cable to port 4 on the ONU. This is to facilitate the EcoVision VPN (Virtual Private Network – the network that will be used to send data from households to the server for storage and later access by UniSA) to be setup.

EcoVision will prepare diagrams of the proposed VPN architecture for discussion with OptiComm in the near future.

OptiCom will provide specifications and recommendations for a 'high end' PC to be purchased by LMC as the interim/ back-up server previously mentioned. This is to be located in the Sustainability Centre at lot 29 (the project office). This is a priority for LMC as it will ensure data access and security. OptiCom will also provide details on the database software, license and consider additional uses including *citrix* connection to the LMC office.

The load management hardware and software was finally installed and configured in several households; however, a number of issues were identified in these houses. Due to incorrect wiring of sub-metering boards, those appliances to be controlled (e.g. dishwashers, ovens, laundries etc.) were not all placed on separate circuits. Furthermore in Lot 53, the contactor for air-conditioner control needs to be upgraded, given that the A/C circuit breaker was 32A but the allocated contactor was only 25A. OptiCom will investigate and advise 'The Butler Did It' of the requirements, who will then install when available.

5 SELECTION OF ENERGY MONITORING SYSTEM FOR HOUSING CLUSTER (ELECTRICITY AND GAS)

This Section should be considered as correction to Section 6.4 of the previous report (Saman et al., 2009). Section 6.4 of that Report should be part of the Section 6.3.

The electrical energy monitoring system for housing cluster has been selected as previously detailed. However, there are still some unresolved issues with gas metering and monitoring.

6 SELECTION OF HOUSEHOLDS FOR INDIVIDUAL MONITORING

In the previous report (Saman et al., 2009) the houses selected for the detailed monitoring program were lots 19, 26, 42, 47, 48, 49, 51, 55, 68, 77, 81. Due to the circumstances described in Section 1, the houses included in the detailed monitoring program are lots 10, 36, 37, 51, 57,

58, 60, 62, 67 and 77 (10 houses). A consideration is being given to a Housing SA apartment. However, it would take another year before the construction of this apartment commences.

7   COMPLETING HOUSEHOLD CONSENT AND ETHICS APPROVALS

On February 26th, the University of South Australia's Human Research Ethics Committee (HREC) approved the ethics protocol proposed by the project (Saman et al., 2009). The HREC approval and conditions can be found in the Appendix. The nature of qualitative survey to be carried out does not necessitate householders' consent; however the Ethics Committee requires that the survey questionnaire be sighted by the Committee.

8   Publications

None within this period. However, the preparation for the paper titled: *The impact of passive design and solar energy use in a housing development on the electrical grid* to be presented at the ISES Solar World Congress 2009 to be held in Johannesburg, South Africa, from 11 – 14 October 2009 was carried out during this period.

9   Meetings

- Wasim Saman attended IGrid meeting in Brisbane 4 Feb 09
- IGrid Project members meeting 23 March 09 Adelaide to discuss the project progress and implementation details.

10 REFERENCES

- Australian Bureau of Statistics (2003) 'Environmental Issues: People's views and practices' Cat No 4602.0
- Australian Bureau of Statistics (2005) 'Australia's economic indicators, 2005' Cat. No. 1350.0
- Australian Bureau of Statistics (2007) 'Australia's Environment: Issues and trends' Cat. No. 4613.
- Australian Bureau of Statistics (2008) 'Yearbook Australia 2008', Cat no 1301.0).
- Garnaut R (nd) Issues paper-Forum 5 'Transport, planning and the built environment'
- Intelligent Grid Cluster Project Plan - P6: The Intelligent Grid in a New Housing Development.
- Saman, W., Halawa, E., Mudge, L., and Edwards, J., 2009: iGrid P6 Literature Review and Progress To Date – submitted to iGrid Cluster, March,2009.
- South Australian government 2008 'New prices for water 2009-2010'
- State of Victoria (2008) 'Green Light Report: Victorians and the Environment 2008
- www.garnautreview.org.au (accessed June 19th 2009)
- www.sawater.com.au/NR/rdonlyres/54912A48-5401-43EA-971B-5AB7C81B7273/0/MedRelPricingDec 08.pdf (accessed June 14th 2009)
- www.sustainability.vic.gov.au (accessed 29th June 2009).

Appendix: Household Consent, Ethics Approval and Conditions

From: Alice Granger
Sent: Thursday, 26 February 2009 2:36 PM
To: Jane Edwards – CMR
Cc: Barbara Pocock; Edward Halawa; Wasim Saman
Subject: Ethics protocol P027/09 "The intelligent grid in a new housing development - Lochiel Park; factors influencing household response to distributed energy and load limits"

Dear Jane,

Re: **Ethics protocol P027/09 "The intelligent grid in a new housing development – Lochiel Park; factors influencing household response to distributed energy and load limits"**

Thank you for submitting your ethics protocol for consideration. The Chairperson of the University's Human Research Ethics Committee (HREC) considered your protocol on behalf of the Committee.

I am pleased to advise that your protocol has been granted ethics approval and meets the requirements of the *National Statement on Ethical Conduct in Human Research*. Please note that the Chairperson's decision will be reported to the next meeting of the Human Research Ethics Committee for endorsement.

Please regard this email as formal notification of approval.

Ethics approval is always made on the basis of a number of conditions detailed in the attachment; it is important that you are familiar with, and abide by, these conditions. It is also essential that you conduct all research according to UniSA guidelines, which can be found at http://www.unisa.edu.au/res/ethics/default.asp

Please note, if your project is a clinical trial you are required to register it in a publicly accessible trials registry prior to enrolment of the first participant (eg Australian New Zealand Clinical Trials Registry http://www.anzctr.org.au/Survey/UserQuestion.aspx) as a condition of ethics approval.

Best wishes for your research.

Alice

Alice Granger
Compliance Officer
Research and Innovation Services
University of South Australia
Mawson Lakes Campus
Tel: 08 8302 3523
email: alice.granger@unisa.edu.au

UNIVERSITY OF SOUTH AUSTRALIA

Human Research Ethics Committee approval is always made on the basis of a number of important conditions:

- Your research MUST NOT commence until the University's Human Research Ethics Committee has granted full and final ethics approval.
- Any serious or unexpected adverse effects on research participants must be reported immediately to the Ethics and Compliance Officer.
- Any unforseen events that might affect the continued ethical acceptability of the research project must be reported immediately to the Ethics and Compliance Officer.
- The Human Research Ethics Committee must be notified of, and approve, any changes to the original protocol.
- The Human Research Ethics Committee must be notified of any changes in membership of the research team.
- In Australia there is a legal obligation for raw data arising from human research to be held securely.   The University requires that research data be retained for a period of five years.   If your school does not store your data, the school must be aware of its location.
- Information for participants should include the name of the Executive Officer of the UniSA Human Research Ethics Committee as a person who is able to discuss any ethical concerns about the research project.   These details should read:
  - "This project has been approved by the University of South Australia's Human Research Ethics Committee. If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 3118; Email: Vicki.allen@unisa.edu.au".
- Approval is for a period of twelve months only.
  Researchers, including Masters by Research and PhD students, must make annual requests for extension using the Application for Extension form available at
      http://www.unisa.edu.au/res/ethics/human.asp#forms

- A project completion report must be submitted to the Executive Officer, Human Research Ethics Committee or Divisional Ethics Committee (whichever granted the original approval) within three months of the project's completion. The Project Completion form is available at
      http://www.unisa.edu.au/res/ethics/human.asp#forms

- Clinical Trials The *National Statement on Ethical Conduct in Human Research* defines a clinical trial as a form of human research designed to find out the effects of an intervention. Health-related interventions can include drugs, surgical procedures, devices, behavioural treatments, dietary interventions or process-of-care changes. If your project is a clinical trial you are required to register it in a publicly accessible trials registry prior to enrolment of the first participant (eg Australian New Zealand Clinical Trials Registry http://www.anzctr.org.au/Survey/UserQuestion.aspx) as a condition of ethics approval.

September 2008