# PERTH SOLAR CITY

## ANNUAL REPORT

2009 **2010** **2011** 2012 2013

PERTH SOLAR CITY

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**"SINCE ITS LAUNCH IN NOVEMBER 2009, THE PROGRAM HAS BECOME THE MOST COMPREHENSIVE ENERGY EFFICIENCY INITIATIVE IN WESTERN AUSTRALIA"**

**PROJECT IMPLEMENTATION MANAGER, ANDREW BLAVER**


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Australian Government
Solar Cities

# TO TRIAL INNOVATIVE SOLUTIONS THAT HELP RESIDENTS USE LESS ENERGY AND GENERATE THEIR ENERGY RENEWABLY, WITH STRONG ECONOMIC AND SOCIAL BENEFITS

# EXECUTIVE SUMMARY

Perth Solar City is Australia's newest and largest solar city. Since its launch in November 2009, the Program has become the most comprehensive energy efficiency initiative in Western Australia.

Perth Solar City has developed and implemented more than 30 energy efficiency and renewable energy projects for households within Perth's Eastern Region. Now at its midway point, 13,764 households have participated in the Program by taking up one or more of the different energy efficiency products, services or trials offered by a Consortium of industry leaders.

As lead Consortium member, Western Power is accountable for the delivery of the Program on behalf of the Federal Department of Climate Change and Energy Efficiency. On behalf of Western Power, I would like to acknowledge each of the Consortium members - Botanic Gardens and Parks Authority, Eastern Metropolitan Regional Council, Mojarra, Prospero Productions, Solahart, SunPower and Synergy, and the tremendous contributions they are making to the success of the Program.

The 2011 Annual Results Report is the first such report for the Perth Solar City program. For each of the energy efficiency products, services and trials, this report:

- provides an overview of activity
- accounts for progress against milestones
- presents key results including preliminary data analysis of the effects of the intervention on electricity use
- divulges transferrable lessons
- comments on the key focus for 2012

## FUNDING

After securing $13.9 million in seed funding from the Australian Government's Solar Cities program, a further $33.3 million of cash and in-kind support was contributed by the Perth Solar City Consortium.

As at 30 September 2011, Perth Solar City had expended 75% of the allocated Australian Government funding, and is on target to expend over 90% by 30 June 2012. The final year of the Program, concluding 30 June 2013, will focus on in depth data analysis of the individual and combined effects of the energy efficiency products, services and trials on household energy consumption.

The following milestones and results have been achieved by the Perth Solar City Consortium to date.

## SMART GRID TRIAL

Smart grid, and the resulting smart metering infrastructure, is new technology shown to both help reduce peak demand, facilitate increased network efficiencies and provide customers with the opportunity to reduce their electricity consumption.

The Smart Grid Trial has installed over 8,700 smart meters in four specific locations within Perth's Eastern Region - the suburbs of Bassendean, Darlington, Forrestfield and Midland. As a result of the Trial, Western Power has proven the end-to-end smart grid technology including the establishment of the home area network as an open platform for delivering additional services to customers. Western Power has begun to understand the customer response to smart grid technology, and has developed a robust cost benefit analysis for a wider roll-out.

## AIR-CONDITIONER TRIAL

Western Power and Synergy are undertaking an opt-in trial of the Direct Load Control (DLC) of residential air-conditioners over the summers of 2010/2011 (Year 1) and 2011/2012 (Year 2). The trial is researching the technical feasibility and cost-effectiveness of DLC as a demand side management tool for reducing electricity consumption at times of peak demand.

The Air-Conditioner Trial is the first of its kind in Australia to utilise smart grid infrastructure, and participants reduced their energy consumption at peak time by 20% during the first year.

## IN HOME DISPLAY TRIAL

Perth Solar City provides a Western Australia-first trial, to test In Home Display (IHD) technology and its impact on residential energy use. Householders were provided an IHD by Synergy that shows their electricity consumption in real-time. An average 6.82% reduction in electricity use is evident for trial participants thus far. While preliminary, there is evidence to suggest that IHDs can lead to a reduction in household energy consumption.

## TIME-OF-USE TARIFF TRIAL

PowerShift is a three-part time-of-use tariff developed by Synergy for Perth Solar City. It is the first tariff in Western Australia that seeks to more closely align electricity consumption blocks with time based costs of generation. To date 427 participants have been recruited to the Trial. Preliminary analysis shows a 10.9% reduction in electricity consumption during the 'super peak' period.

## SOLAR PHOTOVOLTAIC SATURATION TRIAL

The Solar Photovoltaic (PV) Saturation Trial is investigating the effects of a high penetration of solar PV systems on Western Power's existing low voltage distribution networks. This is an important trial given the significant recent increase in the connection of small scale renewable energy systems to Western Power's electricity network.

## RESIDENTIAL SOLAR PHOTOVOLTAIC SYSTEMS

The Perth Solar City program and SunPower are assisting households in Perth's Eastern Region to generate their own electricity by providing a discount on SunPower residential solar PV systems. SunPower is the premium brand in the solar PV system market place, with the highest efficiency panel (19%). To date, SunPower has installed 429 solar PV systems at an average size of 2.27kW.

Preliminary analysis shows a 57.9% reduction in the average daily electricity use of participant households, or 11.36kWh per day.

## RESIDENTIAL SOLAR HOT WATER SYSTEMS

The Perth Solar City program and Solahart provide an $1,100 discount (inc. GST) on family-sized Solahart solar hot water systems to residents in Perth's Eastern Region. To date, Solahart had installed 610 systems.

Preliminary analysis of households who had replaced an electric storage or electric instantaneous hot water system with an electric-boosted solar hot water system shows an average 15% reduction in average daily electricity use.

## MARKETING

To support the Perth Solar City program, a broad-reach marketing strategy was developed, utilising community-based social marketing concepts to create a shift in community energy perceptions and attitudes, and to assist in enabling behaviour change. As a result, the campaign 'Collective Impact' was established, positioning Perth Solar City as the educator and enabler for households on their energy efficiency journey. The campaign has included cinema advertising, local art installations, local newspaper advertisements, billboards in high traffic areas, adshels and attendance and sponsorship at local festivals. A community awareness rate of 51% was achieved in the first year of operation.

## BEHAVIOUR CHANGE

The Living Smart Households program (Living Smart) is the intensive behaviour change program, delivered by the Western Australian Department of Transport (in partnership with the Eastern Metropolitan Regional Council), for Perth Solar City. Living Smart uses eco-coaching to help participants reduce their electricity, water and transport costs. Eco-coaches provide the right information at the right time, and set simple and measureable targets for the household through the establishment of 'social contracts'.

Preliminary analysis for 4,768 Living Smart participants shows an average 8.5% reduction in electricity use.

## HOME ECO-CONSULTATIONS

The Perth Solar City program and Mojarra provide Home Eco-Consultations (HECs) to help participants understand what is contributing to their energy consumption. A follow up report provides participants with information on what changes to make to reduce energy use. To date, Mojarra had completed 2,497 HECs.

Preliminary analysis shows a 7.8% reduction in the average daily electricity use of participant households.

## ICONIC PROJECTS

To support the engagement objectives of Perth Solar City, and to promote the Australian Government's Solar Cities program, five iconic Perth locations were selected for prominent solar photovoltaic (PV) installations. The selected locations are the Midland Atelier, the Central Institute of Technology, Kings Park and Botanic Garden, Perth Zoo and Perth Arena, and will provide nearly 500kW of grid connected renewable energy. To date, Perth Solar City has completed installations at Midland Atelier (60kW), the Central Institute of Technology (49kW) and Perth Zoo stage I (91kW of 231kW).

## DEMONSTRATION PROJECTS

To engage the local community within Perth's Eastern Region about the benefits of energy efficiency and renewable energy, fifteen demonstration projects were developed for implementation by the Eastern Metropolitan Regional Council (EMRC). While varied in scope and size, all are located within Perth's Eastern Region and mostly on public access buildings.

The EMRC represents the six Local Government Authorities (LGAs) located within Perth's Eastern Region: the Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan. To date, thirteen of the fifteen demonstration projects had been completed.

## SCHOOLS ENGAGEMENT

Perth Solar City has implemented three energy efficiency projects within schools: twenty energy audits, a school based documentary (Eco SuperStar), and an energy saving competition (Bring It Down).

Mundaring Christian College participated in Bring It Down, saving 7,601kWh of electricity, representing a 54% reduction on their benchmark or over $1,900 worth of electricity savings. The total combined energy savings of all participant schools amounted to over 64,000kWh, or over $16,000.

From the lessons gained through the implementation of programs such as Perth Solar City, opportunities are created to inform future government policy and the design of similar community initiatives. The over-riding lesson that has emerged from the implementation of the Program to date is that education based community engagement to create customer buy-in is critical to the success of new technology deployments.

Customers must fully understand the benefits and opportunities available to them - after all the true measure of a Program's success should be that it succeeds in achieving benefits for all participants.

**Andrew Blaver**
Program Implementation Manager,
Perth Solar City

## MESSAGE FROM WESTERN POWER'S MANAGING DIRECTOR

Western Power has been delighted to support the Australian Government's Solar Cities initiative. The Perth Solar City program has been warmly embraced by residents in Perth's Eastern Region while providing Western Power with many valuable opportunities. Innovation and a holistic approach have offered energy users and providers a chance to inform decisions on Australia's energy future. I applaud the Australian Government for supporting a program that invests in trials and research and brings together all levels of government, industry and the community.

The knowledge gained through the implementation of this Program is of particular importance to Western Australia, given our unique characteristic of not being connected to the national electricity grid.

Western Power's Smart Grid Trial focused on delivering benefits to customers by providing access to real time energy consumption data through the implementation of smart meters and a sophisticated communications system, while achieving network benefits.

This world-class smart grid has enabled a number of ground-breaking trials, such as the Air-Conditioning Trial to better manage peak demand. Customers involved in the trial reduced their energy consumption by 20 per cent at peak time.

The PV Saturation Trial provides a valuable opportunity to test the network's capacity to manage a high saturation of solar PV systems in the network. This information will be critical for Western Australia's energy future given the increasing penetration of distributed generation.

The installation of large scale solar PV systems through the Perth Solar City program has enabled Western Power to gain valuable experience in connecting large scale systems to the grid.

Through the Program, Western Power has expanded relationships with its customers and illustrated the benefits of combining smart grid technologies with community engagement and education programs. Community engagement is an important factor in driving behaviour change – a key element to the success of the smart grid programs.

By gaining customer buy-in and encouraging the adoption of smart grid tools (such as in-home displays, direct load control and time-of-use tariffs) customers have achieved their primary objective of reducing energy costs. In turn, Western Power can use existing resources more efficiently and minimise costs associated with expanding the network.

Community engagement and behaviour change programs are the bridge between customer wants and network needs. Without community engagement and behaviour change, smart grid programs risk limited return on investment, customer dissatisfaction, and potential intervention by peak bodies or regulatory authorities.

Perth Solar City's extensive and professional community engagement programs have been outstanding and have truly helped customers to make real savings, and deliver ongoing behaviour change.

I would like to thank the Perth Solar City Program Office for their tireless efforts in managing the delivery of the Program and the Perth Solar City Consortium for the high quality service provided to our community.

Finally, I would like to thank the Australian Government, as we look forward to the final 18 months of the Program.

**Doug Aberle**
Managing Director, Western Power
Consortium Leader of Perth Solar City

# “WESTERN POWER HAS BEEN DELIGHTED TO SUPPORT THE AUSTRALIAN GOVERNMENT’S SOLAR CITIES INITIATIVE”

**DOUG ABERLE, MANAGING DIRECTOR, WESTERN POWER**

# 2.0 INTRODUCTION

The Perth Solar City program (the Program) is the most comprehensive energy efficiency initiative in Western Australia. It is a unique partnership of industry, government and the community all working together to change the way we produce, use and save energy.

Perth Solar City is part of the Australian Government's $94 million Solar Cities program designed to trial new sustainable models for the supply and use of electricity. The Solar Cities program is being implemented in seven separate electricity grid-connected areas around Australia - Adelaide, Alice Springs, Blacktown, Central Victoria, Moreland, Townsville and Perth.

The Solar Cities program is administered by the Department of Climate Change and Energy Efficiency (DCCEE), in partnership with local and state governments, industry, business and local communities.

The overall objectives of the Australian Government's Solar Cities program are to:

- demonstrate the environmental and economic effects of combining cost reflective pricing with the widespread use of solar technology, energy efficiency and smart meters
- find out what barriers exist regarding energy efficiency, electricity demand management and the use of solar technology, among businesses and householders in different parts of Australia, and test ways to deal with these barriers

The Program launched in November 2009 after securing $13.9 million seed funding from the Australian Government's Solar Cities program and a further $33.3 million of cash and in-kind contributions from the Perth Solar City Consortium.

To support the overall objectives of the Australian Government's Solar Cities program, the Perth Solar City program objectives are to:

- identify and understand barriers to the uptake of energy efficiency and renewable energy in the residential sector of Perth's Eastern Region
- test new energy efficiency technologies and undertake trials
- inform future government policy
- bring together industry, business, government and community to change the way we produce, use and save energy

## LEADING PERTH SOLAR CITY

Perth Solar City is managed locally by Western Power – Western Australia's largest electricity distributor. Through the Funding Agreement with the DCCEE, Western Power is accountable for the overall Program delivery and manages its implementation through a dedicated Program Office.

The Perth Solar City Program Office (image 2-A) is responsible for ensuring that the activities detailed in each Consortium Agreement between Western Power and individual Consortium members are delivered on time and in-line with agreed funding arrangements.

The Program Office is also responsible for the overall program management, including project reporting, marketing, communications, media, community engagement, quality assurance, customer service and data management.

Image 2-A: Perth Solar City Team

**A UNIQUE PARTNERSHIP OF INDUSTRY, GOVERNMENT AND THE COMMUNITY ALL WORKING TOGETHER TO CHANGE THE WAY WE PRODUCE, USE AND SAVE ENERGY**

Positioned as the single destination for households within Perth's Eastern Region to become more energy efficient, Perth Solar City has become a trusted educator, helping customers to attain their identified goals of reducing their energy costs and greenhouse gas emissions.

Through Perth Solar City, Western Power and its partners are proving innovative 'smarter' technologies, which have the potential to develop into new energy efficiency products and services for households. For example, the In-Home Display Trial provides participating households with access to real time electricity consumption and cost information as a means of helping them to better manage their electricity use. Together with the incentivised Air Conditioner trial, Western Power has achieved some Australian-first applications of these technologies, which are helping households to better mange their energy use while at the same time helping Western Power to better manage the electricity network.

## THE PERTH SOLAR CITY CONSORTIUM

Western Power is supported by a Consortium of local industry leaders including the Botanic Gardens and Parks Authority, the Eastern Metropolitan Regional Council, Mojarra, Prospero Productions, Solahart, SunPower and Synergy.

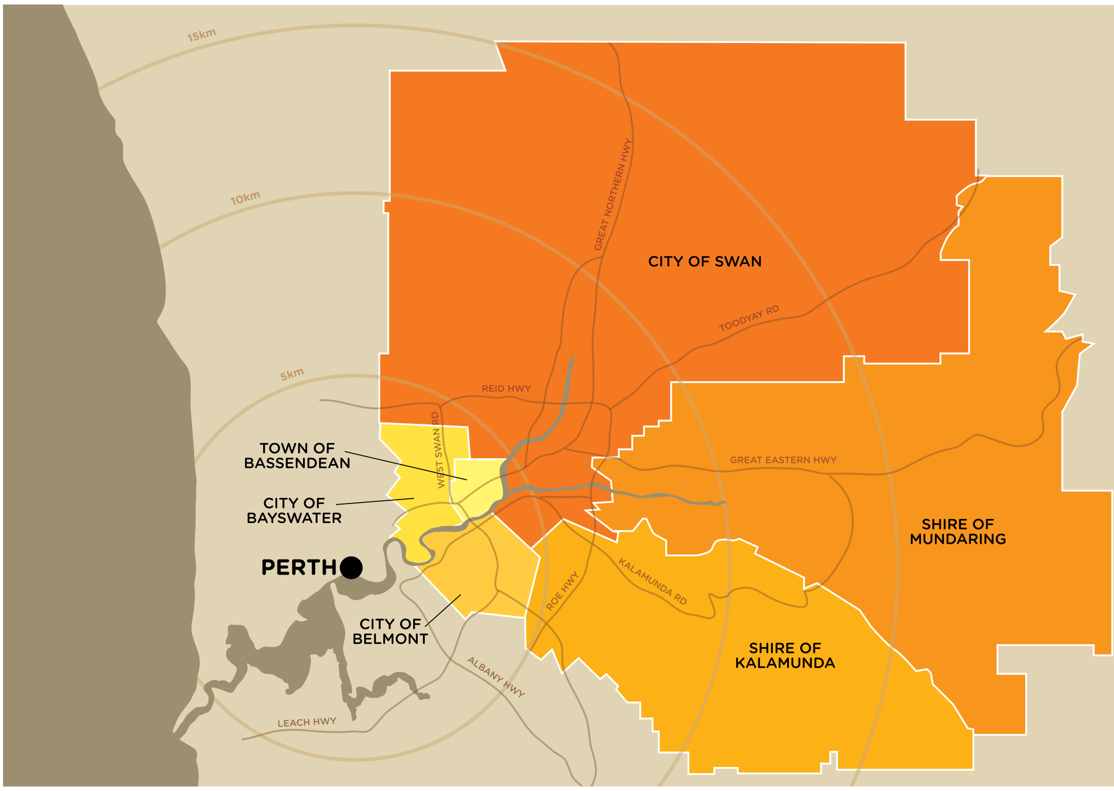
To deliver on the objectives of the Perth Solar City program, the Consortium brings together a comprehensive range of energy efficiency products, services, engagement programs and technical trials (table 2-A).

Perth Solar City Launch at the Railway Workshops, Midland , 5 Nov 2009

**Table 2-A: Perth Solar City Consortium**

| Consortium Member | | Activities |
|---|---|---|
| westernpower | Western Power is Western Australia's largest electricity distributor, connecting people with energy. Western Power builds, maintains and operates the electricity network in the south west of Western Australia, bringing power to more than 1.5 million West Australians every day. | • Program management – governance, compliance, quality assurance, program reporting, data management, marketing and communications<br>• Smart Grid Trial<br>• Air-Conditioner Trial – technical solution<br>• Photovoltaic Saturation Trial<br>• School energy competition – Bring it Down |
| Botanic Gardens & Parks Authority | The Botanic Gardens and Parks Authority is a Western Australian State Government authority established to conserve and enhance Kings Park and Botanic Garden and Bold Park with the community, and to conserve biological diversity generally. | • Kings Park Education Building |
| EMRC | The Eastern Metropolitan Regional Council (EMRC) is a progressive and innovative regional local government authority working on behalf of six member councils located in Perth's eastern suburbs:<br>• Town of Bassendean • Shire of Kalamunda<br>• City of Bayswater • Shire of Mundaring<br>• City of Belmont • City of Swan<br>Providing services in waste management, environmental management and regional development. | • Behaviour Change via the Department of Transport's Living Smart program<br>• Demonstration projects at 15 Local Government Authority (LGA) sites<br>• Sustainable Communities Competition |
| mojarra | Mojarra provides renewable energy and energy efficient solutions to residential and commercial clients and are based in Cannington, Western Australia. | • 3,500 Home Eco-Consultations<br>• 20 School energy audits |
| Prospero Productions | Prospero Productions is one of Australia's leading independent documentary production companies based in Fremantle, Western Australia. Prospero Productions have made quality, multi-award winning documentaries and documentary series for nearly 20 years. | • Eco Superstar documentary |
| Solahart hot water free from the sun® | Solahart pioneered solar water heating in Australia in 1953 and are a leading manufacturer of solar hot water systems, supplying over 80 countries worldwide. Solahart design and manufacture virtually all solar water heaters, including many of the components in Perth, Western Australia. | • 1,200 residential solar hot water systems |
| SunPower | SunPower has been developing world record-breaking solar technology since the 1970s. SunPower is the global leader in developing high-efficiency solar solutions for homes, businesses, commercial buildings and utilities. | • 825 residential solar PV systems<br>• Iconic PV installations:<br>- Central Institute of Technology<br>- Midland Foundry<br>- Perth Zoo - stage one and two |
| synergy energy solutions you can use | Synergy is Western Australia's largest energy retailer, with over 900,000 residential and business customers. | • 2,200 In Home Displays<br>• 375 Air-Conditioner Trial participants recruited<br>• 1,000 Time-Of-Use Tariff Trial participants recruited<br>• Iconic solar PV installation - Perth Arena |

Image 2-B: Perth Solar City's target location




## PERTH'S EASTERN REGION

Perth's Eastern Region is home to the Perth Solar City program, after the Eastern Metropolitan Regional Council (EMRC) was successful in its bid to host a Solar City.

Perth's Eastern Region stretches from the edge of the Perth central business district, along the Swan River, to the Swan Valley, and up to the Perth Hills (image 2-B). Home to approximately 300,000 people from diverse cultural backgrounds, Perth's Eastern Region is one of Perth's fastest growing areas. The Region encompasses 2,100 square kilometres or around one-third of the Perth metropolitan area and includes substantial parklands, river foreshore areas, national parks, state forests and water catchments.

The Region is a major transport hub, accommodating the international and domestic airport terminals and Kewdale Intermodal Freight Terminal, as well as major roads and rail infrastructure linking Perth to regional centres of the state and to the rest of Australia.

The EMRC's six member Councils include the Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan.

Perth's Eastern Region is an ideal location to host a trial such as Perth Solar City, with its multiple demographic and geographic types.

## PROGRAM EXPENDITURE

As at 30 September 2011, the Perth Solar City program has expended $10,414,751 (75%) of the $13.9 million funding from the Australian Government (table 2-B).

Table 2-B Perth Solar City program expenditure to 30 September 2011

| | Forecast Cash / In-Kind | Forecast DCCEE | Forecast Total | Actual Cash / In-Kind | Actual DCCEE | Actual Total |
|---|---|---|---|---|---|---|
| Total expenditure to 30 Sept 2011 | $22,535,743 | $10,499,466 | $33,035,208 | $22,220,458 | $10,414,751 | $32,635,208 |
| Total Program expenditure | $33,304,231 | $13,900,000 | $47,204,231 | $22,220,458 | $10,414,751 | $32,635,208 |

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URATION TRIAL
LAR PV SYSTEMS
LAR HOT WATER

# SMARTGRID TRIAL

## 3.1 BACKGROUND

Peak load growth is a significant challenge for Western Power's network, contributing to growth in the capacity requirements of the network and increasing energy prices.

Smart grid, and the resulting smart metering infrastructure, is new technology shown to both help reduce peak demand, facilitate increased network efficiencies and provide customers with the ability to reduce their overall energy consumption through access to smart grid enabled technologies and programs.

Perth Solar City has provided Western Power with a unique opportunity to prove smart grid technology, and to quantify the benefits that accrue to customers and the network.

Western Power's Smart Grid Trial is strategically significant for the State of Western Australia as its outcomes will contribute towards informing government and the community of the societal costs, benefits, risks, and mitigating actions associated with a broader deployment of the technology. Experience and evidence from this Trial will assist Western Power to set a strategic direction for future planning, design and operations.

Smart grid provides an enabling platform to test the capabilities and measure the benefits to both the customer and the network. These benefits may be accrued through as the application of:

- demand management - the ability to test customer response to MAX (In Home Display Trial), ACT (Air-Conditioner Trial) and PowerShift (Time-Of-Use Tariff Trial) as tools to reduce energy consumption, particularly at peak times
- distributed generation - a Solar PV Saturation Trial to understand and manage the aggregated impact of the large-scale uptake of distributed generation by households
- distribution automation and operational efficiencies - the ability to test grid automation and remote applications to increase network efficiency, reduce costs, enhance reliability and power quality
- system integration - Western Power technical and business processes, including improved outage management processes and response times
- community engagement – the opportunity to test and understand the most effective communications and engagement strategies for the meter exchange process itself, as well as the recruitment of customers to participate in one or more of the smart grid enabled products and services, such as MAX, ACT and PowerShift

In order to adequately test these applications, the technology was designed to meet Ministerial Council on Energy (MCE) recommended minimum functional requirements (see Appendix A) including, but not limited to:

- remote meter reading and data collection
- remote connection and disconnection of supply
- remote meter software and tariff configuration
- remote communications configuration and Home Area Network (HAN) Energy Services Portal provision and management, and HAN service provision, including real-time energy information
- demand management functions (planned and emergency) and interfaces with system management control and monitoring systems
- real time outage and restoration data integration with existing trouble call and customer management systems
- power quality measurement

Image 3-A: Western Australian Minister for Energy, the Hon. Peter Collier and Western Power Managing Director, Doug Aberle

A key enabling technology of the smart grid is the smart meter and associated communications infrastructure. The Smart Grid Trial under Perth Solar City commenced in July 2010 (image 3-A) and replaced basic function electronic and electro-mechanical meters with advanced function electronic meters that are communications enabled, accommodating the two-way flow of electricity and information.

**SMARTGRID TECHNOLOGY HAS SHOWN TO HELP REDUCE PEAK DEMAND, FACILITATE INCREASED NETWORK EFFICIENCIES AND PROVIDE CUSTOMERS WITH THE ABILITY TO REDUCE THEIR OVERALL ENERGY CONSUMPTION**

The establishment of the Home Area Network (HAN), an open communications platform enabled in the home by the smart meter, provides for additional services to customers. This includes access to real time energy consumption information via a number of tools such as In Home Displays, computer-based USB devices and smart-phone applications, as well as participation in incentive based appliance (i.e. air-conditioning) load-control trials.

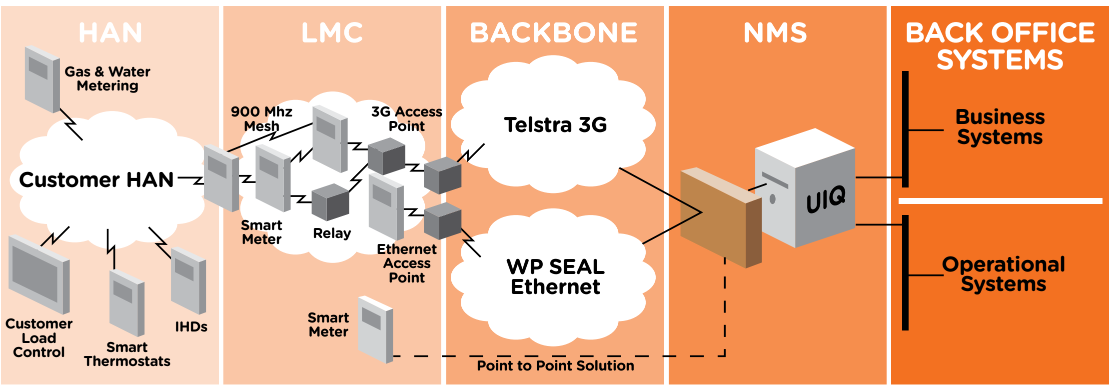
The smart grid end to end system designed for the Perth Solar City Trial is integrated wirelessly from the customer meter through to Western Power's network management system via a radio frequency mesh, and ethernet backbone (image 3-B).

The technology was chosen through a competitive worldwide tender process to source a best-of-breed end-to-end application suitable for the Western Australian energy market. The tender comprised of smart meters, the communications system and the smart grid network management system.

This further involved tendering for smart meters and associated communications infrastructure, field deployment services, evaluating and testing smart meters, and installing, commissioning and enabling the HAN by integrating smart meters to the communications backbone. This would provide an open and upgradable platform that meets MCE minimum recommended functional requirements.

As an outcome of the tender, Western Power selected Landis and Gyr to provide the smart meter (image 3-C), with Silver Springs Networks providing the smart grid network management platform.

Image 3-B: End to End system for Perth Solar City Smart Grid Trial




**HAN** – Home Area Network | **LMC** – Last Mile Communications (RF Mesh – Silver Springs)
**Backbone Comms** – Substation Equipment Access Link and 3G | **SSN** – Silver Springs Networks
**NMS** – SSN Network Management System for Smart Grid-AMI | **UIQ** – SSN Utility IQ Product Suite

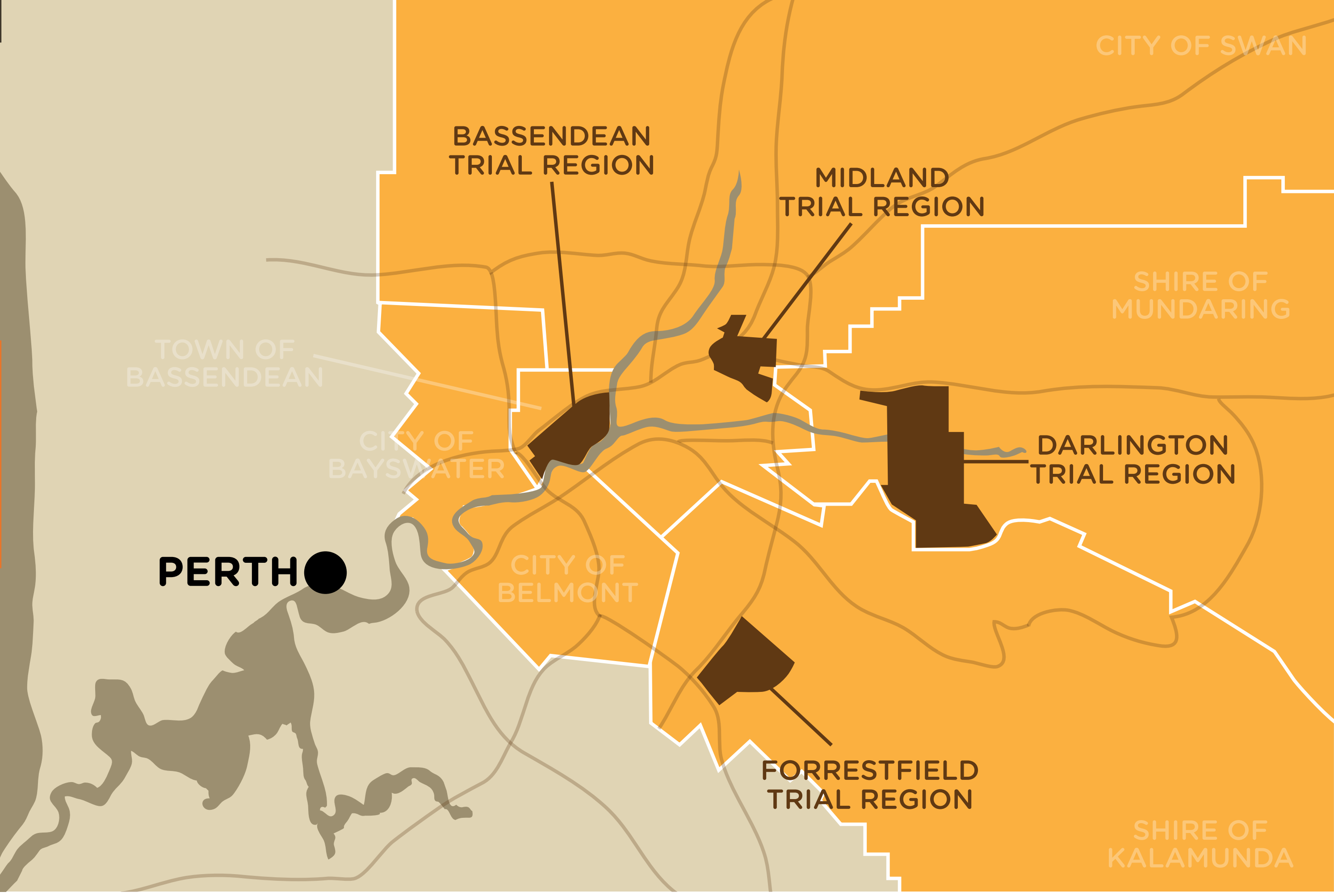
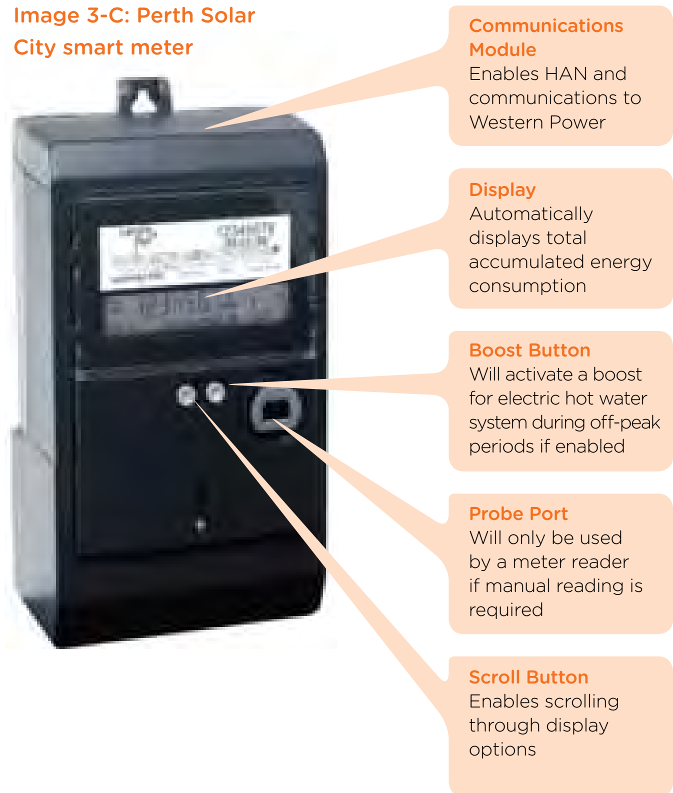



Image 3-D: Selected Smart Grid Trial locations within Perth's Eastern Region

Image 3-C: Perth Solar City smart meter




The Perth Solar City Smart Grid Trial has installed over 8,700 smart meters in four specific locations within Perth's Eastern Region - the suburbs of Bassendean, Darlington, Forrestfield and Midland (image 3-D). The smart meters were provided without a direct contribution from recipient households.

These suburbs were selected as well-suited locations due to a strong variability between the selected locations of demographic, geographic and infrastructure factors, including:

- percentage owner/ occupier
- the Index of Relative Socio-Economic Disadvantage
- average electricity consumption
- power quality and reliability benefits
- demand-side management benefits
- ability to test communications technology
- sufficient number of meters
- EMRC member council suburb

## 3.2 OBJECTIVES AND PROGRESS

Western Power's Smart Grid Trial as part of Perth Solar City has three core objectives:

- to prove end-to-end smart grid technology including the establishment of the HAN as an open platform for delivering additional services to customers
- to understand customer response to smart grid technology
- to develop a robust cost benefit analysis for a wider roll-out of the smart grid technology

To achieve these objectives, Western Power established the following Key Performance Indicators (KPIs), as outlined in table 3-A:

**Table 3-A: Key Performance Indicators for Perth Solar City Smart Grid Trial**

| Key Performance Indicator | Timeframe | Status | Comments |
|---|---|---|---|
| **Deployment** | | | |
| Installation locations selected | 2009/ 10 | Complete | Locations selected in Bassendean, Darlington, Forrestfield and Midland |
| Procurement (meters, communications and system integration services) completed | 2009/ 10 | Complete | Procurement completed |
| Lab/ field testing of meters and communications completed | 2009/ 10 | Partially complete | Lab testing complete for single and three phase meters. Lab testing commenced for CT meters |
| Pre-deployment customer notification campaign completed | 2009/ 10 | Complete | Customer notification campaign complete |
| Installation of 8,767 smart meters completed | 2010/ 11 | Complete | Meter installation complete Installation target exceeded |
| Validation of sites completed | 2010/ 11 | Complete | Site validation audit complete |
| Installation of 40 point-to-point sites | 2011/ 12 | On track | Single point-to-point meter installed. CT meter testing commenced |
| **Operation** | | | |
| MCE function 1, 2 and 9 – half hour interval data recorded and remotely read | 2010/ 11 | Complete | Interval data receipt performing above benchmarks |
| MCE function 15 and 16 - HAN enabled | 2010/ 11 | Complete | Home Area Network enabled with performance above SLA. MAX displays functioning across HAN. Year 1 ACT completed |
| MCE function 12 - remote connect/ disconnect | 2011/ 12 | Complete | Performance above SLA |
| MCE function 10, 11 and 18 - appropriate import/ export and power quality data captured | 2011/ 12 | Complete | Data collection achieved |
| **Evaluation** | | | |
| Cost benefit analysis completed | 2010/ 11 | Complete | Cost benefit analysis complete (see Appendix B for Executive Summary) |
| Customer notification - evaluation completed | 2010/ 11 | Complete | Evaluation completed |
| Business as usual deployment/ operation model completed | 2011/ 12 | On track | To be completed by 30 June 2012 |
| Network benefits quantified | 2011/ 12 | On track | To be completed by 30 June 2012 |
| Ongoing evaluation and data analysis of asset performance | 2011/ 12 | On track | To be completed by 30 June 2012 |
| Energy efficiency/ consumer benefits of HAN applications quantified | 2012/ 13 | On track | Preliminary indications included in this report |

## 3.3 KEY RESULTS

Key results have been provided below for each of the three KPI categories outlined in section 3.2.

### 3.3.1 DEPLOYMENT

The specific target for the smart meter deployment for Perth Solar City is 8,767 smart meters installed. As at 30 November 2011, the program target has been exceeded with a total of 8,944 smart meters installed in Bassendean, Darlington, Forrestfield and Midland. Table 3-B below outlines performance to date against Perth Solar City milestones.

**Table 3-B: Perth Solar City program milestones – smart meter deployment**

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| Smart meters installed | 8,767 | 8,944 | 8,767 |

Western Power has installed a total of 8,944 smart meters in the following suburbs:

- Bassendean - 3,163 meters
- Darlington - 1,401 meters
- Forrestfield - 2,698 meters
- Midland - 1,682 meters

As the last of the Solar Cities to be launched, Perth Solar City had a particularly aggressive timeline, with smart meter deployment being 'front-loaded' in order to be completed during the first year of implementation. The aggressive timeline would also allow the smart grid dependant technical trials, such as the ACT and MAX, to be implemented subsequent to meter deployment in order to provide immediate opportunities for smart meter households.

Image 3-E shows the meter deployment timeline for Perth Solar City. Meter installation began in May 2010, with the bulk of the meters (8,290 of the targeted 8,767) installed between May and September 2010. Western Power delayed the installation of the final 477 meters (5.4 percent of total deployment) in order to improve the end-to-end installation processes as informed by lessons and learnings from the original meter deployment. The resultant successful deployment of the remaining meters, plus the installation of an additional 177 meters, occurred during July 2011.

Image 3-F shows the meter deployment breakdown for all 8,944 smart meters installed under Perth Solar City. Key categories outlined in the table include:

- site location – Bassendean, Darlington, Forrestfield, Midland
- site type – residential, commercial, industrial or farm
- site power supply – single phase, three, current transformer
- site tariff type – all time, time of use, renewable energy all time, renewable energy time of use

### 3.3.2 OPERATION

As at 30 November 2011, the three key elements of the smart grid infrastructure - smart meters, communications infrastructure, and the network management system - have been successfully deployed and are operating as planned or exceeding performance benchmarks, including the Home Area Network.

The benchmarks for each of the operational KPIs are outlined below, along with performance against these benchmarks. Overall, the Perth Solar City smart grid system has consistently exceeded performance benchmarks.

Note: the information provided below includes benchmarks and performance from Western Power's regional Smart Grid Trial under the Green Town project. The Green Town project included the installation of 2,111 smart meters in the WA south coastal towns of Denmark and Walpole, which is not part of the Perth Solar City program.

**MCE function 1, 2 and 9 – Half hour interval data recorded and remotely read**

The provision of interval data transfer to the Western Power back office is measured by performance against the following benchmarks:

| Category | Bench-mark | Achieved |
|---|---|---|
| Interval data transfer - within 4 hours | 99.0% | 99.3% |
| Interval data transfer - within 24 hours | 99.9% | 99.7% |

Image 3-E: Smart meter installations - per month and cumulative

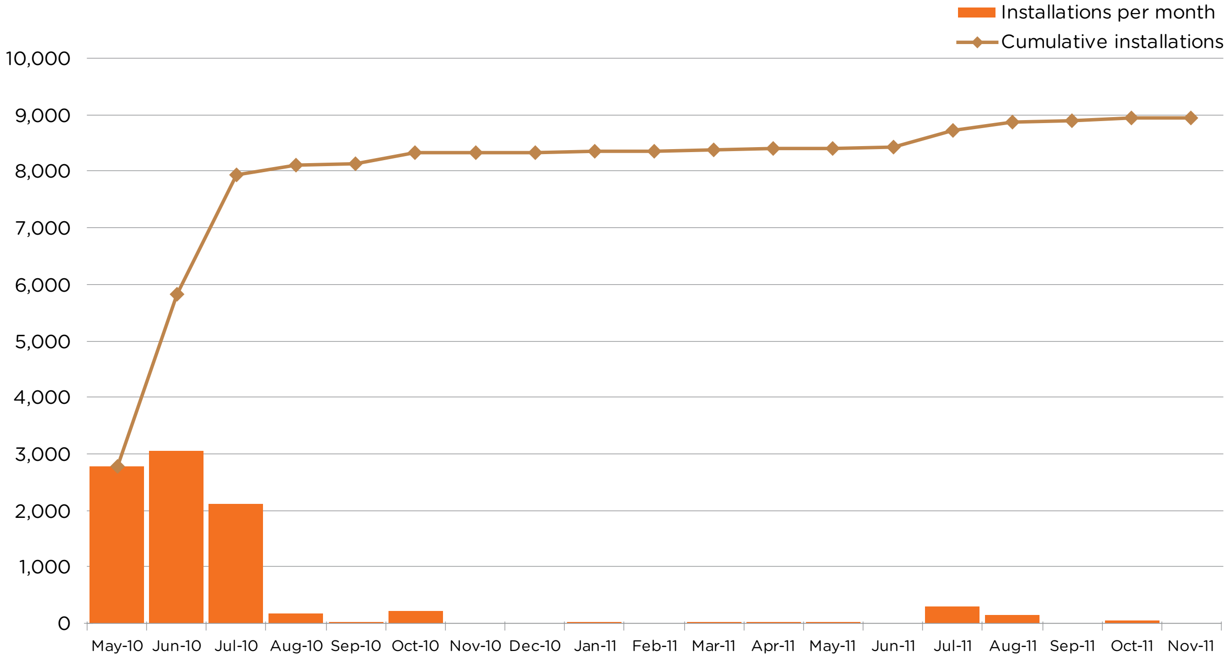



Image 3-F: Smart meter installation breakdown for Perth Solar City deployment

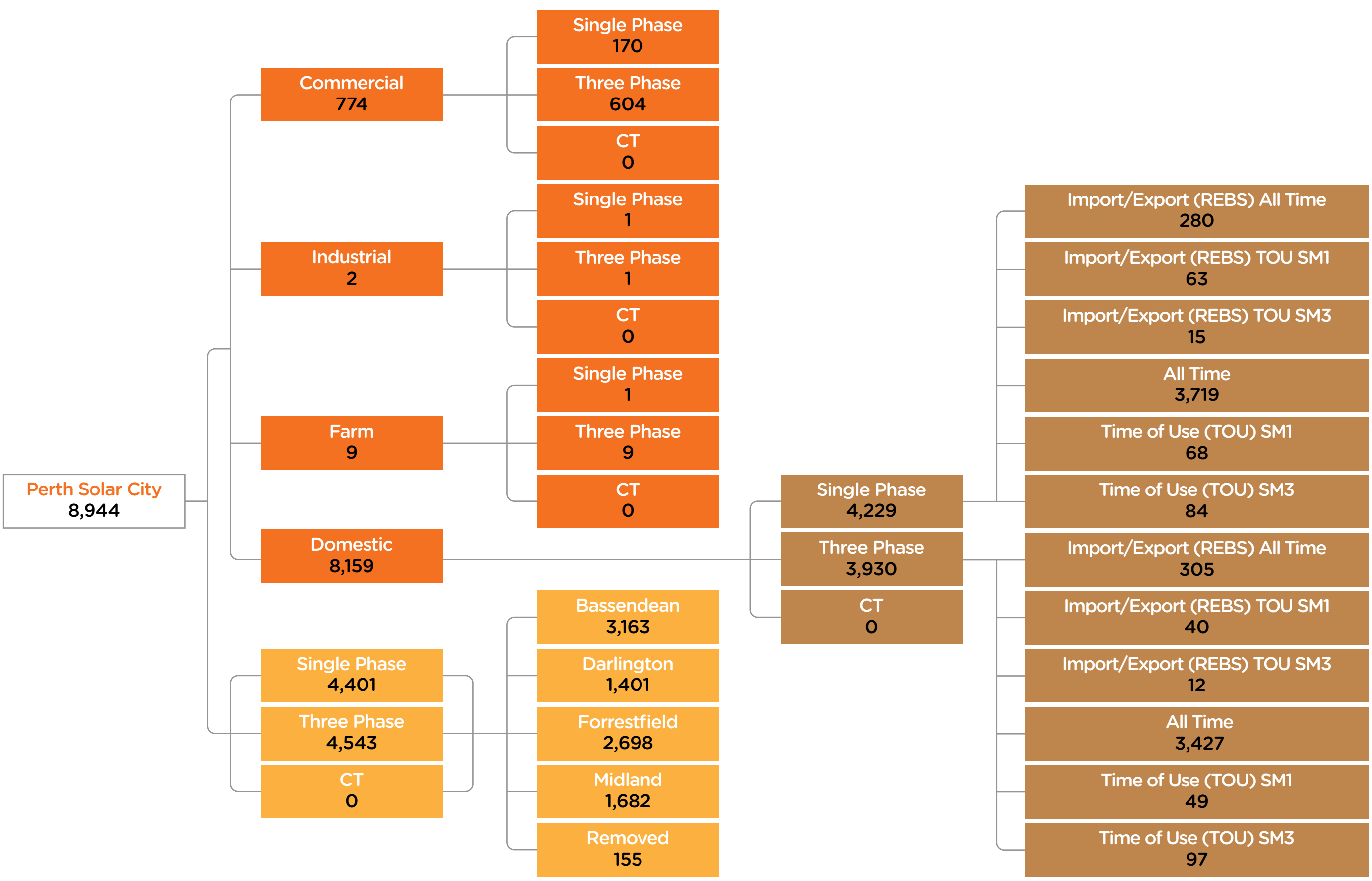
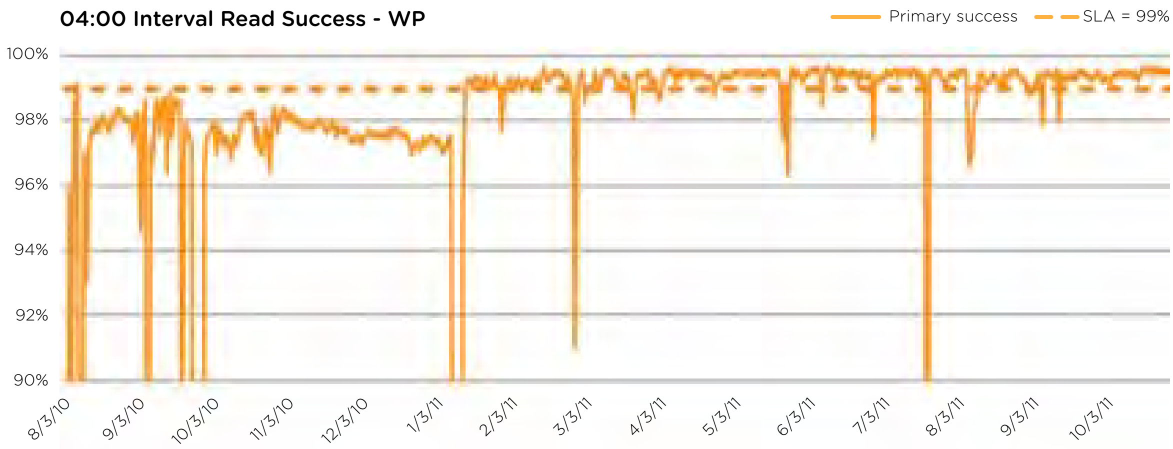


Image 3-G: Performance against Service Level Agreement benchmarks for 4 hourly and daily intervals



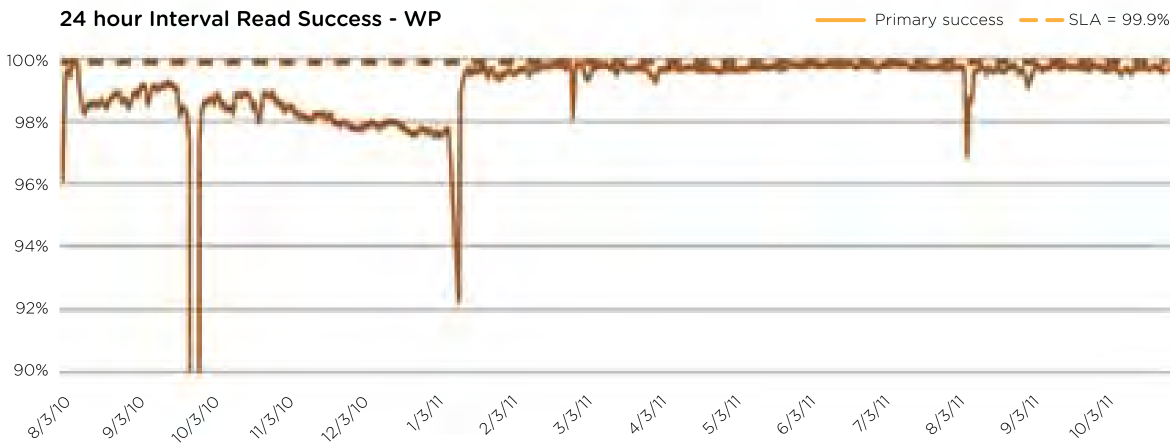




Image 3-G shows the performance against these benchmarks since August 2010.

Note: Interval read success is for the 04:00 interval read – one of six four-hourly interval data reads per day.

Image 3-G shows early performance was below the expected benchmark for interval data transfer. In order to consistently achieve the benchmarks Western Power undertook a process of communications optimisation for the four trial locations. Optimisation of the communications infrastructure includes installing external antennas and relays to fringe-of-trial locations where communications strength was below optimal.

It is worth noting that due to the style of smart metering trials, where meter deployments are ring-fenced within small contained areas, fringe locations with sub-optimal communications strength may be more prevalent than in a larger scale deployment.

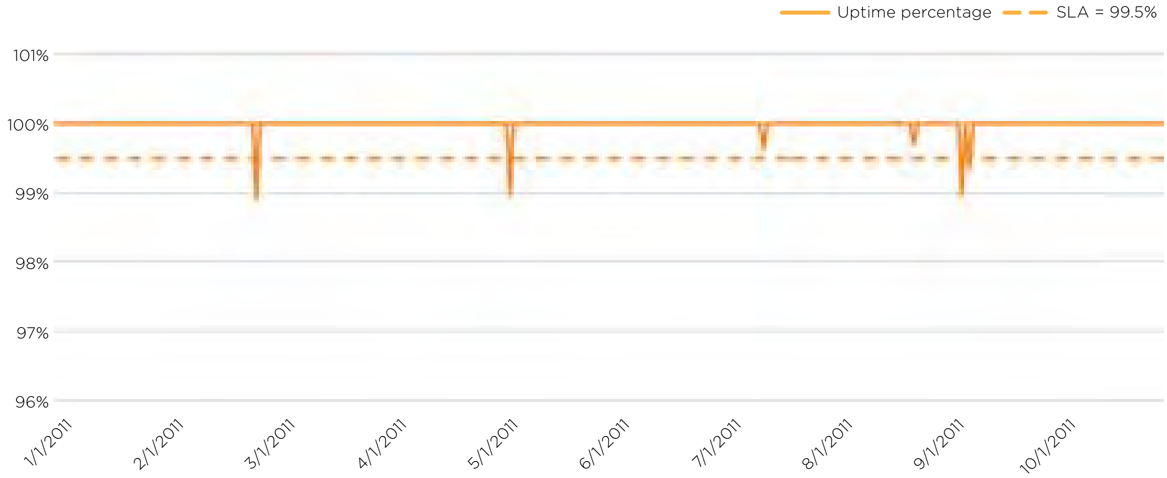
*Performance during the September 2011 quarter*

During the September 2011 quarter, the average performance achieved for the remote 24 hour collection of interval data was 99.72 percent. Further optimisation of the communications and meter change process will be undertaken during the March 2012 quarter, which is anticipated to increase performance to greater than 99.9%.

### Network Management System

The Network Management System for Western Power's Smart Grid Trial, known as Utility IQ (UIQ) is provided by Silver Springs Networks. UIQ is the central control and monitoring point for the smart meters and communications infrastructure. In the event of system down-time, Western Power would be unable to remotely read meters or issue service commands to meters, such as reconnect/disconnect commands. The specific performance benchmarks for UIQ availability time are:

**Image 3-H: UIQ availability for Western Power's Smart Grid Trial**




| Category | Benchmark | Achieved |
|---|---|---|
| Network management system availability time | 99.50% | 99.99% |

Image 3-H shows the performance against these benchmarks since August 2011.

*Performance during the September 2011 quarter*

In the September 2011 quarter, following the deployment of the final smart meters under Perth Solar City, UIQ maintained an availability performance time of 99.99 percent. This amounts to approximately 12 minutes of downtime during the quarter.

### Backhaul communications infrastructure

The backhaul communications infrastructure provides the 'large pipe' communications link from the Western Power back office into the suburbs where the last mile mesh commences. This infrastructure is made up of existing Western Power fibre and microwave communication links to substations, or a public carrier 3G private ethernet cloud to redundant access entry points, which provide access into the last mile radio-frequency mesh. Backhaul communications is a critical component in the two way transfer of data between individual meters and the Western Power back office. The specific performance benchmarks for backhaul communication connection availability time are:

| Category | Benchmark | Achieved |
|---|---|---|
| Backhaul communication connection availability | 99.0% | 100% |

Since the inception of the backhaul communications network in April 2010, the availability of the infrastructure has not dropped below 100%. This includes an unplanned five day outage on an access point at Darlington, during which time the Midland access point acted as a backup.

### Load profiling of Perth Solar City smart grid suburbs

Western Power compiled baseline load profiles for each of the four suburbs participating in the Smart Grid Trial (images 3-I – 3-L). The purpose of compiling this data was to establish the average usage profile prior to the installation of smart meters within each participating area. This information, compiled from manually read interval meters, will be used to compare consumption profiles post smart meter deployment to determine if there are any usage changes within the PSC areas, as well as the quantum of these changes.

The use of interval data for residential premises provides Western Power with the ability to pinpoint network constrained areas. Image 3-I shows is the 24 hour load profile for the suburb of Darlington. The load profile shows a significant peak beginning at 16:00, peaking at 19:00 and concluding around 22:00. The peak is significant, at an average of around 3.4 kWh - over double the usage at peak time for Bassendean (1.4 kWh: image 3-J) and Midland (1.5 kWh: image 3-K). This information enables the network operator to potentially design smart grid enabled demand response programs to be deployed in a targeted manner to reduce the identified constraint.

**Image 3-I: 24 hour load profile for Darlington**

Average Consumption Pre-AMI Deployment (July 2009 -Feb 2010)

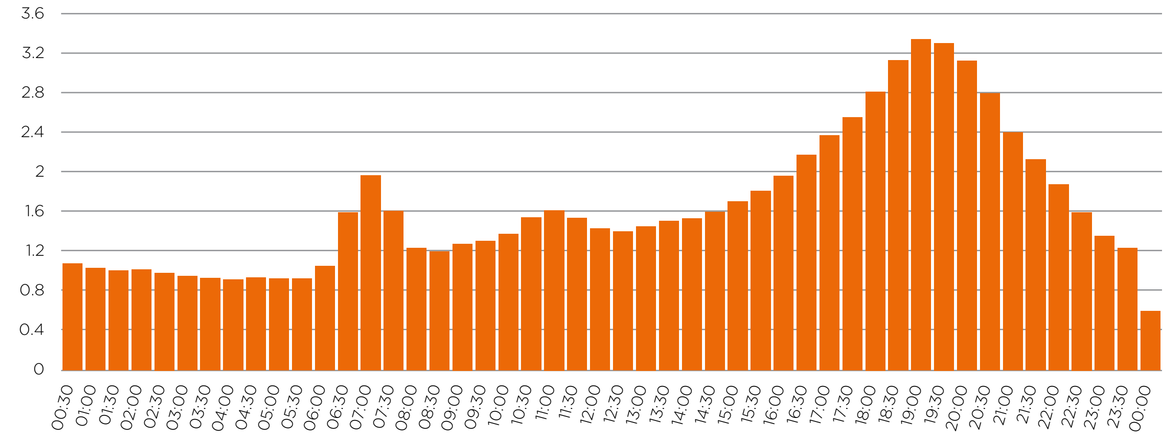



**Image 3-J: 24 hour load profile for Bassendean**

Average Consumption Pre-AMI Deployment (July 2009 -Feb 2010)

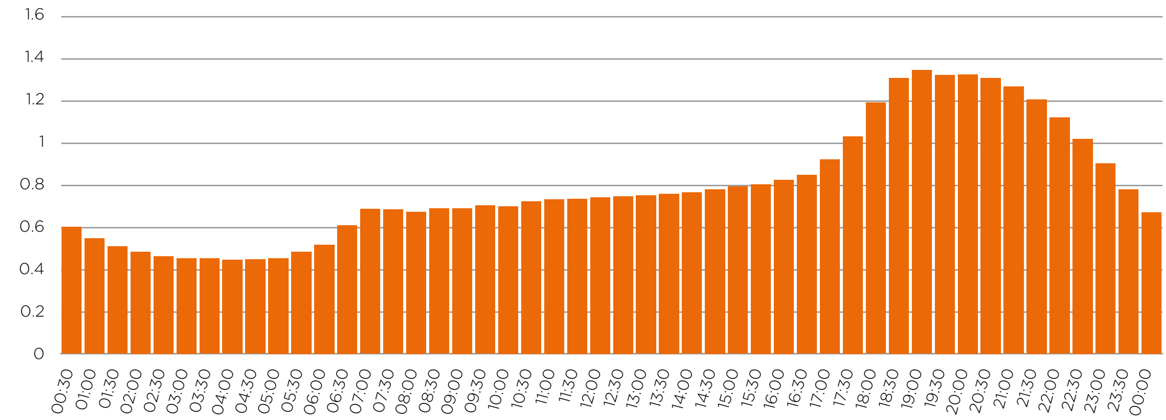



**Image 3-K: 24 hour load profile for Midland**

Average Consumption Pre-AMI Deployment (July 2009 -Feb 2010)

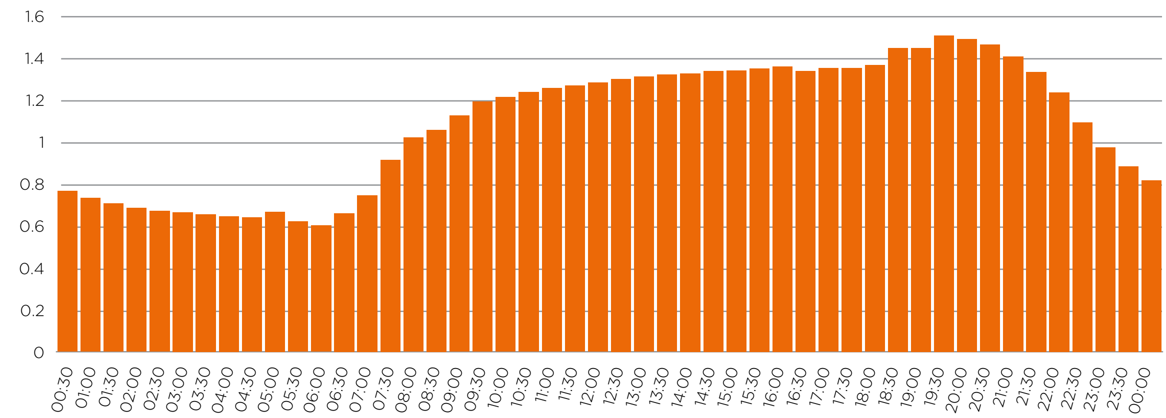
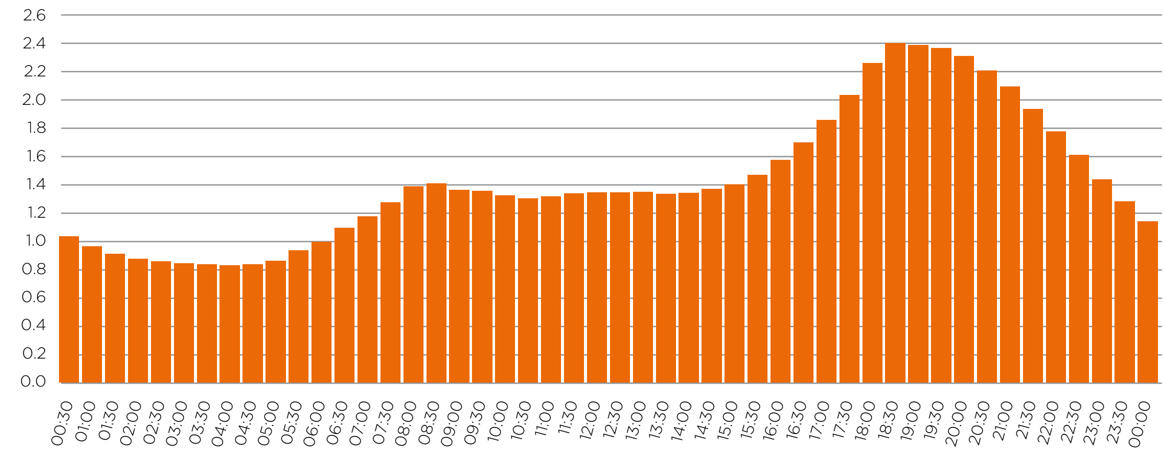



**Image 3-L: 24 hour load profile for Forrestfield**

Average Consumption Pre-AMI Deployment (July 2009 -Feb 2010)



# SMART METERS HAVE BEEN SUCCESSFULLY DEPLOYED AND ARE OPERATING AS DESIGNED OR EXCEEDING PERFORMANCE BENCHMARKS

*MCE function 15 and 16 - Home Area Network enabled*

Interfacing with an In Home display, to provide real-time energy consumption information, or the management of other in-home devices, such as appliances in order to manage loads, via the HAN using an open standard has been achieved. This was accomplished via the ACT (chapter 4) and MAX Trials (chapter 5).

The specific performance of the HAN can be measured in the time period within which a command is received remotely by a HAN-enabled device (issued from Western Power's head office). For example, commands are issued to participating air-conditioners during a load-cycling event as part of the opt-in Air-Conditioner Trial. The specific performance benchmarks for the HAN are:

| Category | Benchmark | Achieved |
|---|---|---|
| Command received by device – within 3 hours | 90.0% | 100% |
| Command received by device – within 12 hours | 99.0% | 100% |

Through the Smart Grid Trial, the HAN is operating as expected for 100% of commands where the design of the installation is within the distance limits of the wireless technology.

These commands are also being received by 100% of the online HAN devices within a 2 minute period from initiation of the command in UIQ. This is consistently above the performance benchmark.

To date some communication issues have been encountered between HAN devices during the Trial. This has been observed in situations where meter points are located further than 50 metres from the home. Testing in 2011/12 will focus on improving the HAN coverage distance to 80-100 metres and therefore the number of customers that can have a successfully operational HAN.

**MCE function 12 - remote connect/ disconnect**

Disconnections and reconnections can be requested by a building occupier in order to allow electrical or maintenance work on the property. Alternatively they may be requested by the retailer after a customer leaves a premises, or as a result of non-payment of electricity accounts. The ability to remotely disconnect and reconnect the power supply to an individual premises offers benefits to the customer and the network operator by:

- negating the requirement for a vehicle and qualified contractor to visit the site. Cost and productivity efficiencies result as not only is the time taken to carry out the work significantly reduced, but field resources can also be utilised for alternative purposes
- significantly reduced power restoration time. Power can be restored within minutes of a reconnection request being submitted. Currently, reconnection can take 2 business days in the Perth metropolitan area, and up to 5 business days for regional customers
- potentially reducing customer costs in the case of customer-requested disconnections and reconnections, as generally the cost for these services is passed on to the requestor

Targeted performance benchmarks for the remote connection and disconnection of power supply are:

| Category | Benchmark | Achieved |
|---|---|---|
| Remote connect/ disconnect – within 10 min | 90.0% | 100% |
| Remote connect/ disconnect – within 1 hour | 99.0% | 100% |
| Remote connect/ disconnect – within 6 hours | 99.0% | 100% |

Western Power has completed customer connection and disconnection remotely at 178 sites using the smart grid technology. In all cases, disconnection and connection commands were received and activated by the meter within 0 - 2 minutes. During November 2011, the average time to achieve remote disconnection or reconnection of power supply was 58 and 35 seconds respectively. This significantly exceeds the service benchmarks outlined above.

During the reconnection of seven three-phase meters, a technical issue occurred resulting in failure. All sites were successfully reconnected on the second attempt. This technical issue is currently under investigation by Western Power.

Note: disconnection time is calculated from UIQ to meter point only. Additional automation time periods for downstream commands, such as automated requests via the electricity retailer, have not been included here.

*MCE function 10, 11 and 18 - appropriate import/ export and power quality data captured*

The capture of power quality data provides opportunities to understand and potentially implement measures that will increase the operating efficiency of the network and reduce expenditure. Datasets captured are:

| MCE function | Description | Measurement |
|---|---|---|
| 10 | Half-hour reactive interval energy measurement and recording on single and three phase meters. | Power factor (kwh-r) |
| 11 | Records active energy flows both into the electricity grid and out, where the customer has installed local generation (i.e. Solar PV systems). | Net import/ export (kWh) |
| 18 | Enables meters to record information in relation to quality of power supply and other events (eg: out-age). The event log could then be read remotely. | Voltage profile<br>Voltage events (+/ - 10% of nominal volt-age - 240V) |

Recording these datasets provides the network operator with the ability to:

- detect power quality issues prior to customer complaints, and allow planners to identify locations for improvement
- identify voltage non-compliance and proactive remedial action
- identify locations for capacitor installations to boost power factor and improve the capacity and efficiency of the existing network
- correlate photovoltaic system output with power quality data for the purposes of the PV saturation Trial (chapter 8)

Data capture results for the Perth Solar City Smart Grid Trial are:

| Criteria | Results |
|---|---|
| MCE function 10 | Successful in 100% of three phase PSC smart meters. Single phase to be tested in 2012 |
| MCE function 11 | Successful in 100% of Renewable Energy sites |
| MCE function 18 | Successful in 100% of sites selected for PV Saturation Trial |

## 3.3.3 EVALUATION

**Customer engagement and feedback**

Prior to the rollout of smart meters, recipient householders were provided with information-heavy printed material (Appendix C) outlining the purpose and benefits of the smart meter. Due to the contained locations of the Trial, wider large-scale engagement was not utilised. After the rollout, smart meter recipients received additional targeted communications, informing them of the opportunities and benefits to be gained from their participation in such smart meter enabled projects as the ACT and MAX Trials.

Western Power provided the following information-heavy communication materials to smart meter recipients.

1. An initial introductory letter was mailed to:

- advise the householder that they would be receiving a smart meter at no direct cost to them as part of the Perth Solar City program
- outline the purpose of the Smart Meter Trial
- outline the opportunities for participation in Perth Solar City Trials enabled by the smart meter
- reinforce the message that that there would be no change to their retailer or tariff arrangements

2. An outage notification letter was sent prior to meter replacement. This is an established market process for meter exchange.

3. A smart meter fact sheet and Western Power customer call centre contact details were provided at the time of installation. This information was provided directly to the customer or placed in the mailbox and outlined how to read the meter and described its main features. (Note: a frequently asked questions tool was developed to support the Western Power call centre in managing enquiries.)

For the purposes of completing a meter exchange, this communications approach proved to be successful. A total of 225 calls (out of 8,977 meter exchanges – around 2.5%), were received as at 30 November 2011. Table 3-C outlines the type of customer enquiry received by Western Power, and is ranked according to prevalence.

**Table 3-C: Perth Solar City smart meter related enquiries and responses**

| Reason for enquiry | Western Power response/ action |
|---|---|
| Import/ export meter recently installed by customer (e.g. for Renewable Energy Buyback Scheme). | Western Power and Synergy refunded the cost of the import/ export meter installation if installed within the preceding 12 month period. |
| Perceived high bill (enquiry received via electricity retailer) | Investigation undertaken following each call. In all cases the meter was found to be recording consumption correctly |
| Late bill (enquiry received via electricity retailer) | Some late bills were received by smart meter recipients. Western Power confirmed success or failure of billing data transfer to market and rectified accordingly. |
| How to read the smart meter | Recipient sent 'how to read your meter' (Appendix D) instructions via email/ post. |
| Renewable Energy Buyback Scheme reconfiguration (enquiry received via electricity retailer) | Western Power confirmed correct configuration of recipients meter and reconciled data if required. |
| Enquiry as to meter exchange charges | Smart meter recipient is informed that no charges are levied as a result of the smart meter deployment. |
| Confusion between the installation of a smart meter with an existing Synergy time of use tariff product branded *Smart Power* | The differences between the Synergy product and the Trial meter deployment were explained and discussed with the smart meter recipient. |
| Request for a smart meter from households outside the Trial locations. A total of 10 requests for smart meters were received from outside the Trial locations. | Customer was informed that the Smart Grid Trial is for defined locations only, and results of the Trial will inform future deployment. |
| Radio frequency interference – querying whether smart meter could be the cause | Recipient is provided with information on the radio frequency of the smart meter. No reports of ongoing appliance interference as a result of the smart meter have been recorded. |
| Property access - recipient questioning legitimacy of meter installer | Western Power assures recipient of legitimacy by confirming recipient site and scheduled meter installation date. |
| Follow-up on the proposed meter installation date | Installation date confirmed with recipient |
| Objection to smart meter installation. (A total of three smart meter recipients contacted Western Power with strong initial objections to the installation.) | Recipient concerns are discussed, and the purpose of the Trial was explained. In all cases to date the smart meter has been successfully installed. |

A survey of 104 smart meter recipients was conducted during October 2010, with the following results:

- level of satisfaction - 82% of customers surveyed rated the smart meter installation process as either excellent, very good, good or neutral. 6% of customers rated the process as very poor.
- level of understanding regarding the benefits of the smart meter (unprompted and prompted) - 62% of smart meter customers did not understand the benefits of smart meters
- interest in receiving further smart meter related information - 88% of customers wanted to know more about the benefits of their smart meter

As a result of the survey, Western Power identified that information-based communications are successful for meter deployment as an asset replacement, however are largely ineffective in raising awareness or achieving an understanding of the benefits of smart meters. In short, prior a larger scale rollout, the development and implementation of a comprehensive education-based engagement program is required.

### Cost Benefit Analysis

The opportunity to trial the deployment of a smart grid in a contained area on a 1% scale has enabled Western Power to validate the technology and gain a critical understanding of a successful deployment model.

As a result of the Smart Grid Trial, and its lessons and learnings, as well as utilising results from other trials and deployments in Australia and world-wide, Western Power has completed a detailed Cost-Benefit Analysis in support of a wider smart meter deployment. Subsequently, as part of its network access arrangement submission for the period 2012 to 2017 to the Economic Regulation Authority (ERA) of Western Australia, Western Power has applied for funding to deploy a further 332,000 smart meters.

As at 30 November 2011, the Western Power's submission was under review by the ERA.

## 3.4 TRANSFERRABLE LESSONS

Western Power's Smart Grid Trial is the largest sub-project under Perth Solar City, and the transferrable lessons and learnings are significant and varied. Lessons and learnings (tables 3.4.1 – 3.4.5) for the Smart Meter Trial to date have been categorised as:

- overall project
- engagement
- smart meters
- communications infrastructure
- IT systems integration

**WESTERN POWER'S SMART GRID TRIAL IS THE LARGEST SUB-PROJECT UNDER PERTH SOLAR CITY, AND THE TRANSFERRABLE LESSONS ARE SIGNIFICANT AND VARIED**

### 3.4.1 OVERALL PROJECT

| Subject | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Timeline** | BARRIER:<br>Aggressive timeline for meter deployment. As the key enabler for other technical trials (ACT, MAX and PowerShift), all 8,767 smart meters were scheduled to be deployed within the first six months of the Smart Grid Trial. | OUTCOME:<br>A smaller trial in the field for a subset of the targeted meters was not completed prior to the full Trial deployment. This resulted in the occurrence of technical and/ or billing impact issues on a larger scale than anticipated.<br>LESSON:<br>In order to test the end-to-end impact of such a new technology, a smaller subset could have been implemented prior to full deployment. This would have mitigated a number of the early teething problems experienced.<br>The opportunity to delay the rollout of the final 477 meters (5.4% of total deployment) offered Western Power the ability to test the lessons and learnings of the initial rollout. |
| **Product Maturity** | BARRIER:<br>Western Power was a close follower behind the Victorian roll-out of single phase smart meters, however Western Power became a market leader in the deployment of three phase smart meters. | OUTCOME:<br>SilverSprings version of UIQ to support three phase meters was not available at the time of the three phase meter roll-out. The mitigation strategy to manually probe reads for three phase meters failed (strategy passed in lab testing, however failed in the field).<br>LESSON:<br>Smart meter deployments should continue with basic readings until communications are proven. Once proven, a parallel meter reading process should be run for a minimum of one billing cycle. |
| **Procurement** | BENEFIT:<br>Western Power pursued a 'best-of-breed' solution from multiple vendors, as opposed to an end-to-end solution from a single vendor. | OUTCOME:<br>This solution was the most cost-efficient method of achieving high level functionality. However, interoperability between different vendor solutions can create delays in resolving issues due to requirements for multiple vendor collaboration and their interpretation of standards.<br>LESSON:<br>Best of breed solutions provide the best outcomes for functionality. However, oversight and facilitation of multiple vendor collaboration is required. |
| **End-to-end testing** | BARRIER:<br>The Trial's aggressive timeline did not permit sufficient end-to-end testing by vendors and integrators. | OUTCOME:<br>Existing mitigation strategies were not always effective, and as a result, delivery of some billing data to the market was delayed.<br>LESSON:<br>Aggressive timelines must be balanced with robust risk and impact assessment and should be adjusted accordingly. |

| Subject | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Publication of interval data to market** | BARRIER:<br>Electricity retailer requested interval data for all smart meter installations from the date of installation.<br><br>The version of UIQ to collect three-phase interval data was delayed. | OUTCOME:<br>Western Power implemented a mitigation strategy to manually read three phase meters. However, the mitigation strategy (field manual data collection process) subsequently failed due to file incompatibilities, causing some delays in billing to customers.<br><br>LESSON:<br>Smart meter deployments should continue with basic readings until end-to-end interval data transfer processes are proven. Once proven, a parallel meter reading and data transfer process should be run for a minimum of one billing cycle. |
| **Resourcing** | BARRIER:<br>Limited experience in the Australian service consulting industry on smart grid scope, architecture and deployment. | OUTCOME:<br>Western Power utilised additional internal resources. As a result of smart grid functions being undertaken internally, Western Power achieved cost savings of up to 30%, whilst achieving the same level of service.<br><br>LESSON:<br>Where possible, develop and maintain internal smart grid capacity and capability. |
| **Meter installation process** | BARRIER:<br>Some cases of incomplete or mismatched site data following meter exchange | OUTCOME:<br>Around 0.02% of meters were installed on incorrect or mismatched sites. This resulted in late or mismatched bills. A full site audit for all deployed meters was required.<br><br>LESSON:<br>For a wider rollout, the contracted meter installer will require meter deployment management tools, such as wireless PDAs integrated with Western Power's asset management system, to handle 10,000 meters per month.  This is required together with sufficient oversight by Western Power.<br><br>Installed smart meters must be capable of being read manually. |
| **Security** | BARRIER:<br>Emergence of potential cyber-security threats | OUTCOME:<br>Western Power's smart grid incorporates a number of security mechanisms which are currently being extensively and independently tested.<br><br>LESSON:<br>Due to the potential impact of failure, robust cyber-security protection of all elements of the smart grid system is a high priority, requiring detailed risk-assessment and testing.<br><br>Security considerations should also include authentication and limitation of operator-initiated actions such as supply disconnections. |

### 3.4.2 ENGAGEMENT

| Subject | Barrier | Outcome and/or lesson |
|---|---|---|
| **Information-based engagement** | BARRIER:<br>As part of the meter exchange process, all smart meter recipients were provided with information-heavy communication materials. | OUTCOME:<br>62% of smart meter recipients did not understand the immediate benefits of smart meters.<br><br>88% of smart meter recipients wanted to know more about the benefits of their smart meter.<br><br>LESSON:<br>Under trial conditions in contained areas, it remains difficult to provide broad education-based engagement. However, a comprehensive education-based customer engagement campaign prior to a wider roll-out is essential in raising awareness about the benefits associated with smart meters. |
| **Technical trials** | BENEFIT:<br>Smart meter recipients were provided with the opportunity to benefit from smart grid enabled product and service trials. | OUTCOME:<br>Demonstrated benefits of smart grid.<br><br>LESSON:<br>Smart meter roll-out should be closely followed by opportunities for customers to benefit (i.e. to save money, to help the environment). |
| **Recruitment and engagement for smart meter enabled technical trials** | BARRIER:<br>Lack of clear incentives and/ or drivers for deployment partner/s | OUTCOME:<br>Ineffective delivery against contract milestones required significantly more contract management and oversight than anticipated.<br><br>LESSON:<br>Engagement and recruitment for smart grid enabled products and services should be undertaken by organisations for which energy efficiency and demand-side management is part of its core business or is appropriately supported by regulatory-based incentives. |
| **Access to data** | BARRIER:<br>Lack of demographic data | OUTCOME:<br>Inability to effectively target appropriate market segments with smart grid enabled products and services.<br><br>LESSON:<br>The comprehensive gathering of demographic data to assist in the development and implementation of targeted smart grid products and services is required. |
| **Acquisition of customer energy consumption data by third parties** | BARRIER:<br>Lack of process for third party providers to acquire the energy consumption data of its current and prospective customers | OUTCOME:<br>Historical consumption data not readily available to create benchmarks.<br><br>LESSON:<br>Data acquisition processes should be streamlined to allow simple customer agreement and subsequent access to historical consumption data. |

### 3.4.3 SMART METERS

| Subject | Barrier | Outcome and/or lesson |
|---|---|---|
| **Gross PV output** | BARRIER:<br>Inability of three phase metering technology to accommodate gross metering for energy import/ export applications. | OUTCOME:<br>To achieve gross import/ export metering in a three phase scenario requires the installation a second meter.<br>LESSON:<br>A cost effective and flexible solution for 3 phase gross import/ export metering is required. |
| **HAN / ZigBee issues** | BARRIER:<br>On large sites, some meter points are located significant distances from the home. | OUTCOME:<br>HAN range has proven to have a limit of around 50 meters.<br>LESSON:<br>HAN range limitations should be anticipated, and external antennae or relay devices tested and made available as required. |
| **Meter size / format** | BARRIER:<br>Plug-in and multiple-meter sites were bypassed for the Trial. | LESSON:<br>In a larger scale roll-out, a smaller smart meter or adapter will be required, otherwise affected meter boards will need to be re-wired. |

### 3.4.4 COMMUNICATIONS INFRASTRUCTURE

| Subject | Barrier | Outcome and/or lesson |
|---|---|---|
| **Capacity** | BARRIER:<br>Capacity of communications infrastructure | OUTCOME:<br>Although generous communications capacity was provided, some range issues were encountered in fringe areas of the ring-fenced Trial.<br>LESSON:<br>The capacity of the communications infrastructure should be sufficient to handle normal and exceptional traffic conditions including meter and communications card firmware updates and network outages and restoration.<br>LESSON:<br>Sufficient capacity should also be provided for growth, as well as the addition of water or gas meters. |
| **RF coverage** | BARRIER:<br>RF coverage in low-density areas. | OUTCOME:<br>Poor RF coverage in low-density areas, or where long-distances or difficult topography exists.<br>LESSON:<br>Additional relays or external antennae may be required, but should require additional minimal software or configuration costs. |
| **Backhaul service** | BENEFIT:<br>Use of Western Power's existing optical fibre network. | OUTCOME:<br>Due to cost and performance, Western Power's existing optical fibre Sub-station Equipment Access Link (SEAL) network will be used for Access Point backhaul wherever possible, with Telstra's 3G service as an alternative for remote sites.<br>LESSON:<br>The SEAL infrastructure may need to be enhanced or extended to meet the needs of a full scale roll-out. |

| | | |
|---|---|---|
| **Order of Deployment** | BARRIER:<br>Communications infrastructure not deployed prior to smart meter installation | OUTCOME:<br>Re-work required to correct communications issues.<br><br>LEARNING:<br>Wherever possible, the communications infrastructure should be deployed prior to smart meter installation. Similarly, external antenna requirements should be planned upfront. |

### 3.4.5 IT SYSTEM INTEGRATION

| Subject | Barrier | Outcome and/or lesson |
|---|---|---|
| **System complexity and expertise** | BARRIER:<br>Underestimated IT resource requirements | OUTCOME:<br>IT system integration delays were encountered during the Trial.<br><br>LESSON:<br>Considerable care should be taken to anticipate complexity, and provide dedicated expertise that will not be distracted by conflicting business priorities. |
| **Business process integration** | BARRIER:<br>Difficulty in testing applicable business-as-usual processes during a ring-fenced trial | OUTCOME:<br>Some manual processes remain in operating the trial smart grid.<br><br>LESSON:<br>A wider rollout should be fully integrated into Western Power's existing business systems and processes with minimal manual intervention required. |

## 3.5 FUTURE FOCUS

The key focus of Western Power's Smart Grid Trial for 2011/12 is to:

- conduct further trials of smart grid applications, such as network self-healing and customer neutral integrity (prevention of electric shocks), to further validate network and customer benefits
- test and install point-to-point metering technology for locations outside of the RF mesh coverage areas
- test and install current transformer (CT) smart meters for customers with larger loads. The CT smart meters will be the first of their kind in Australia
- trial the capture and display of gross solar PV system output on HAN enabled devices
- test Zigbee repeaters as a tool for enhanced coverage of the HAN




# AIR CONDITIONER TRIAL

## 4.1 BACKGROUND

Peak electricity demand, the very short time during which the highest demand for electricity occurs, places significant strain on Western Power's electricity network. Peak demand results in the inefficient use of existing network resources (the top 15% percent of electricity supplied is used 1% of the time), requires costly network augmentation to support, and is rising year on year (image 4-A).

Peak demand on Western Power's network usually occurs on the hottest weekdays during summer, and is largely driven by the increasing penetration and use of air-conditioners.

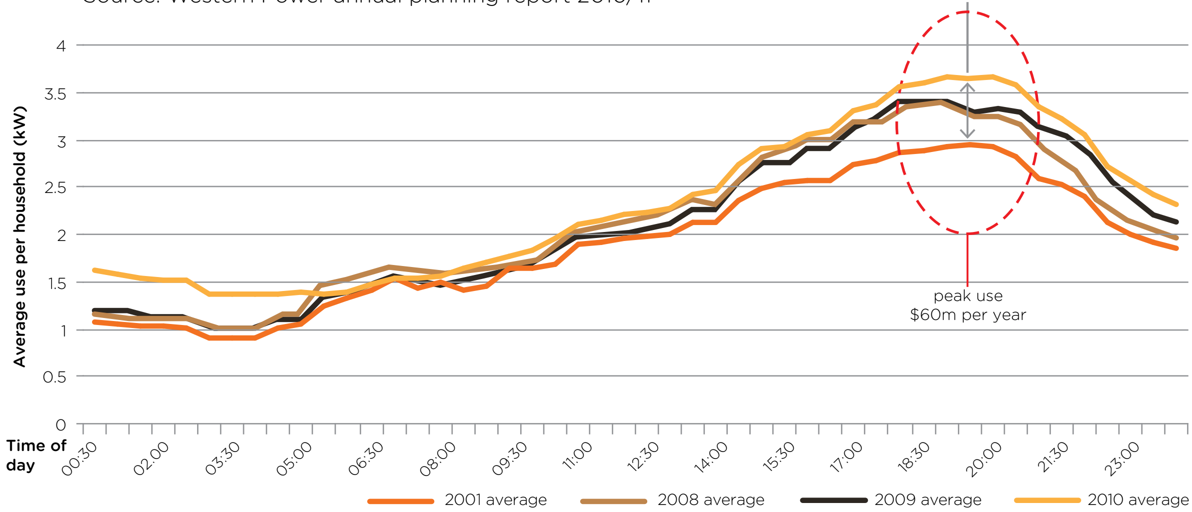
As part of Perth Solar City, Western Power is undertaking an opt-in Air-Conditioner Trial. This project trials the Direct Load Control (DLC) of domestic air-conditioners over the summer periods of 2010/2011 (Year 1) and 2011/2012 (Year 2). The trial is researching the technical feasibility and cost-effectiveness of DLC as a demand side management tool for reducing electricity consumption at times of peak demand.

**"THE WESTERN POWER TRIAL IS THE FIRST OF ITS KIND IN AUSTRALIA... AND PROVIDES PERHAPS THE NATION'S FIRST ILLUSTRATION OF WHAT THE INTELLIGENT NETWORKS OF THE FUTURE MAY LOOK LIKE, PARTICULARLY IN REGARD TO DEMAND RESPONSE."**

**MARK PATERSON**
**CHAIR OF STANDARDS AUSTRALIA EL-054 COMMITTEE**

Image 4-A: Average load per household during summer

Source: Western Power annual planning report 2010/11



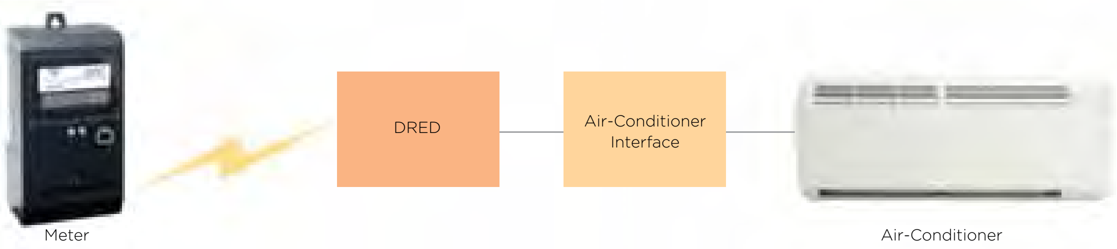

Participants are paid an incentive, and the Trial utilises Western Power's foundation smart grid (Chapter 3.0) to wirelessly communicate with air-conditioners to cycle the compressor while the fan continues to run. The Air Conditioner Trial is the first of its kind in Australia to utilise smart grid infrastructure.

By selecting and constraining the operation of air-conditioners during certain time periods, DLC has the potential to significantly reduce participant aggregated electricity consumption at peak times without noticeably impacting the comfort levels of participants. The aggregated reduction of demand during times of peak use may in turn defer the need for capacity investment to supply these peaks.

The trial uses custom-designed Demand Response Enabling Devices (DREDs) installed in the air-conditioners of eligible participants. The DRED was designed and manufactured in Australia specifically for the purposes of the Perth Solar City Trial. The DREDs receive signals from the smart meter via the Home Area Network (HAN), allowing the operation of the air-conditioner's compressor to be controlled via remote signals initiated by network (image 4-B).

Synergy is the single electricity retailer in the Western Australian South-West Interconnected System (SWIS) residential sector (for electricity users below 50MWh/annum). As a Perth Solar City Consortium member, Synergy is responsible for the engagement and recruitment of Air Conditioner Trial participants. The Air Conditioner Trial was branded ACT in the marketplace and was offered to all households who had previously received a smart meter. The financial incentive to participate in the trial is a $100 electricity bill credit each year for two years.

Image 4-B: End-to-end process for DLC of air-conditioners



## 4.2 OBJECTIVES AND PROGRESS

The key objectives of ACT are to:

- test and prove the operation of the end-to-end DLC technology (Year 1 and 2)
- measure the demand reduction achieved through the use of DLC (Year 1 and 2)
- determine the potential of using DLC to defer costly network investment - cost of demand reduction (Year 2)
- understand overall participant response, as well as the most effective means of engaging and recruiting participants to such trials (Year 2)

Specific Key Performance Indicators (KPIs) developed specifically for Year 1 of ACT included:

| Activity | Key Performance Indicator | Timeframe | Progress |
|---|---|---|---|
| Technology | Procure DRED | 2010/11 | Complete |
| | Test DRED | 2011/12 | Complete |
| Recruitment | Develop marketing and communications material | 2010/11 | Complete |
| | Recruit 375 participant households | 2011/12 | Complete* |
| | Install DREDs on participating households | 2011/12 | Complete |
| | Provide technical support as required | 2011/12 | Complete |
| Trial | Complete 10 load-control events | 2011/12 | Complete |
| | Pay incentive to participant households | 2011/12 | Complete |
| Evaluation | Post Implementation review of year 1 recruitment | 2011/12 | Complete |
| | Post Implementation review of year 1 technology performance | 2011/12 | Complete |
| | Undertake preliminary analysis on reductions in peak demand | 2011/12 | Complete |

*202 households were recruited for Year 1 of the trial involving 211 DREDs

### 4.2.1 TECHNOLOGY

**DRED procurement**

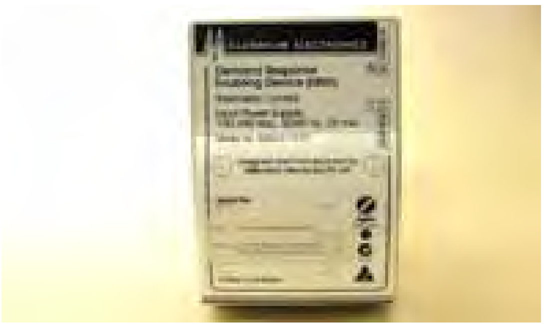
Western Power completed a design specification for the DRED device during March 2010 and released it to tender. As a result of the tender, it was discovered that local industry knowledge and experience to develop, install and provide ongoing support for the DRED was minimal. As such, a successful vendor was selected to develop the DRED, while a separate vendor was selected for the installation and support functions.

The technical specification of the DRED and the development of prototypes for testing were completed during the June 2010 quarter. Zigbee certification was also achieved for the devices, which were manufactured as two types:

- type A – for compressor control, generally suitable for non-inverter, older air-conditioners (image 4-C)
- type B – for thermister control, generally used for newer air-conditioners, and the most commonly used DRED (image 4-D)

Image 4-C: Type A DRED


Image 4-D: Type B DRED



**DRED testing**

End to end testing and the ability of the DRED to pair with smart meters via the HAN was successfully completed by Western Power at the end of October 2010.

Some technology integration issues were uncovered, including the device losing its secure connection with UIQ after two minutes, and were resolved with support from the DRED developer and UIQ vendor.

## 4.2.2 RECRUITMENT

**Marketing and communications material**

6,600 smart meter households were invited to participate via an Expression of Interest (EOI) campaign that included a letter, brochure (image 4-E), EOI form and reply paid envelope. This was further supported by website content, and a call centre for enquiries.

To be eligible to participate, households were required to complete an EOI form and return it to Synergy. Completion of the EOI formed part of a seven step recruitment process (image 4-F).

Image 4-F: ACT participation process

| | |
|---|---|
| Step 1 | Expression of Interest received |
| Step 2 | Prequalification by Synergy |
| Step 3 | Site visit 1: Assessment of air-conditioner |
| Step 4 | Customer Agreement completed |
| Step 5 | Site visit 2: Installation of DRED |
| Step 6 | Participation in PSC load-control events |
| Step 7 | Payment of $100 by Synergy |

Households that successfully prequalified (step 2) received a 'Yes' pack and were scheduled for a site visit. Households that failed step 2 received a 'No' mail pack promoting alternative energy efficiency offers available through the Perth Solar City program.

Image 4-E: ACT brochure

Once site visits were completed using an external contractor, and DREDs were installed (completion of step five), successful participants received a 'congratulations' postcard (image 4-G). Participants whose air-conditioners were deemed unsuitable on either of the site visits were provided with a 'regrets' postcard.

Image 4-G: ACT 'congratulations' postcard


## Recruitment of households

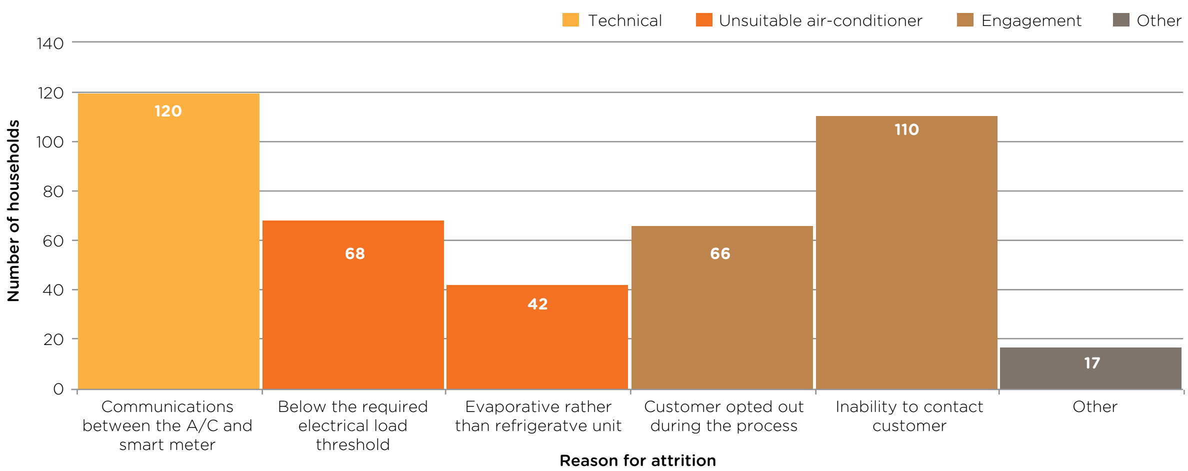
Of the 6,600 invitations sent to smart meter households, 788 EOIs were received (11.9%). Of the EOIs received, 625 were considered suitable for further assessment, after which 211 DREDs were successfully installed (26.8% of the respondents or 3.1% of the original invitees).

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| ACT participants | 375 | 260 | 320 |

Of the 625 leads passed on to Western Power by Synergy in Year 1, 423 households did not participate in the ACT trial. The reasons for attrition included:

- technical
  - inability to install the DRED or communicate effectively with it due to distance or other obstacles between the air-conditioner and the smart meter
- unsuitable air-conditioner
  - below the required air-conditioner electrical load threshold (below 1.5kW electrical capacity)
  - evaporative rather than refrigerative (compressor-based) unit
- engagement
  - inability to contact the householder
  - participant opted-out during the process

Image 4-H: ACT – Attrition by type



**Installation of DREDs**

DRED installation is a relatively complex process due to the presence of different brands and models of air-conditioner units, and can take anywhere between 1 – 2 hours. Generally, installation involves taking the cover off the unit, wiring the DRED itself to the air-conditioner by either cutting into the thermistor circuit of the air-conditioner unit or the power supply to the compressor. For installations in the ceiling, this process is considerably more involved.

Once the DRED is installed it is commissioned via a phone call to a Western Power operator, who sends a command to the smart meter to initiate a pairing window for approximately 5 minutes, during which time a button on the DRED must be pressed to 'pair' it to the smart meter.

An ongoing repository of air-conditioner data is being developed to aid with installation on similar units. Air-conditioner manufacturers have also been consulted to understand how to best perform direct load control on their products.

## 4.3 KEY RESULTS

Key results for Year 1 of the ACT trial focus on:

- performance of the smart meter enabled DLC technology
- measurable effect on peak electricity demand

### 4.3.1 PERFORMANCE OF THE SMART METER ENABLED DLC TECHNOLOGY

Ten Air-Conditioner Trial events were run between January 2011 and March 2011. Air-conditioners were cycled either in alignment with other participant air-conditioners (synchronised off and on times) or randomly (randomisation) across the time period (table 4-A).

Table 4-A: ACT Year 1- Characteristics of ten events

| Event No. | Date | No. of house-holds | Time of event | Duty cycle (%) | Duty cycle^ (mins) | Maximum temp. (°C) | Specific objectives and comments |
|---|---|---|---|---|---|---|---|
| 1 | 27/01/2011 | 20 | 16:00 to 17:00 | 50% | 15 mins on, 15 mins off | 37.8 | - test systems and technology<br>- pilot event for Zigbee technology<br>- no randomisation |
| 2 | 10/02/2011 | 40 | 16:00 to 17:00 | 50% | 15 mins on, 15 mins off | 35.1 | - test systems and technology (20 new participants)<br>- no randomisation |
| 3 | 15/02/2011 | 40 | 16:00 to 17:30 | 50% | 15 mins on, 15 mins off | 36.3 | - test systems and technology with a new set of customers<br>- no randomisation |
| 4 | 16/02/2011 | 80 | 16:00 to 17:30 | 66% | 20 mins on, 10 mins off | 39 | - test systems and technology with Event 2 & 3 participants with a new duty cycle<br>- randomisation |
| 5 | 23/02/2011 | 60 | 16:00 to 19:00 | 50% | 15 mins on, 15 mins off | 34.9 | - tested systems and technology with new participants at dispersed locations<br>- no randomisation |
| 6 | 25/02/2011 | 50 | 13:00 to 17:00 | 66% | 20 mins on, 10 mins off | 37.5 | - tested systems and technology with new participants at dispersed locations<br>- no randomisation |
| 7 | 3/03/2011 | 180 | 14:10 to 18:00 | 50% | 15 mins on, 15 mins off | 34.3 | - tested systems and technology with all available participants<br>- no randomisation |
| 8 | 09/03/2011 | 185 | 14:10 to 18:00 | 50% | 15 mins on, 15 mins off | 32.2 | - tested systems and technology with all available participants<br>- no randomisation |
| 9 | 15/03/2011 | 186 | 15:10 to 19:00 | 50% | 15 mins on, 15 mins off | 35.4 | - tested systems and technology with all available participants<br>- randomisation |
| 10 | 24/03/2011 | 188 | 15:10 to 19:00 | 50% | 15mins on, 15 mins off | 35.2 | - tested systems and technology with all available participants<br>- randomisation |

^Duty cycle refers to time compressor is cycled on and off

The first six events involved smaller groups of participant air-conditioners, and were between one and four hours in duration. These events confirmed the end-to-end functionality of the smart grid and HAN infrastructure, including the DREDs.

| Category | Benchmark | Achieved |
|---|---|---|
| Command received by device – within 3 hours | 90.0% | 100% |
| Command received by device – within 12 hours | 99.0% | 100% |

These commands were received by 100% of the selected DREDs within a two minute period from initiation of the command in UIQ. This is consistently above the performance benchmark. The results of the Year 1 trial confirm that the smart grid infrastructure can be used for wireless direct load control of air-conditioners.

### 4.3.2 EFFECT ON PEAK ELECTRICITY DEMAND

While Year 1 of ACT was largely used to test and prove the performance of the end-to-end technology, it did provide some opportunity to measure the associated reduction of electricity consumption during times of peak demand, particularly during events seven to 10. Analysis was conducted using the interval reading of customer electricity consumption, as enabled by the smart meters. This measures the whole-of-house consumption, and not just that of the air-conditioners.

Events seven to 10 included all available participants and were run for up to four hours each. Generally, the duty cycle of all events was designed such that the off-on switching of air-conditioners (cycling) aligned with the smart meter reading intervals. As such, during a 50% duty cycle on a 30 minute cycling time, the meter reading time aligned with the 15 minute cycling time of the air-conditioners. This ensures that the zig-zag 'cycling' pattern of aggregated customer loads (including the air-conditioners) is clearly visible (see Event seven) when all participants' switching is synchronised.

In events four, six, nine and 10, the 'cycling' of the air-conditioners was not aligned to the meter reading interval of the smart meters. In these events, the off-on switching was randomised across all participants, independent of each other within certain constraints. The results from such events do not show a clear zig-zag 'cycling' pattern and have a relatively smooth load profile. This was completed deliberately to observe the effect of random cycling on electricity demand (see Event 9). This is more likely to be the mode of operation for a wider (beyond trials) application of DLC.

#### Event seven – 3 March 2011

During event seven, 22 of the 180 participating air-conditioners appeared to show clear evidence of 'cycling' for the entire duration of the event (Group 1). 87 of 180 air-conditioners appeared to show clear evidence of cycling for at least part of the duration of the event (Group 2). 71 air-conditioners, or 39%, showed no evidence of being switched on during the event (Group 3). Data was analysed for each group separately, as well as in aggregate (table 4-B).

**Table 4-B: Event 7 participation mix**

| Group | No. of participants | Average demand reduction per air-conditioner (kW) |
|---|---|---|
| Group 1 | 22 | 0.90 kW |
| Group 2 | 87 | 0.63 kW |
| Group 3 | 71 | 0.00 kW |
| Total | 180 | 0.34 kW |

By calculating the difference between the average demand and the average peak demand during a cycle, the total demand reduction across all 180 participating households amounts to 50kW. This represents a 20% reduction in total aggregate demand of the participants (image 4-I).

The likely reasons for only a proportion of air-conditioners showing clear evidence of cycling for the entire event (22 out of 180) could be that:

1. participant air-conditioners were turned on for the entire duration of the event
2. the event was conducted between 14:10 and 18:00, and did not coincide with the residential peak demand, (between 17.00 and 20.00)
3. the maximum temperature recorded was only 34.3°C

These factors will be taken into account while planning for events for Year 2.

Image 4-I: Total electricity demand for ACT participants – event 7

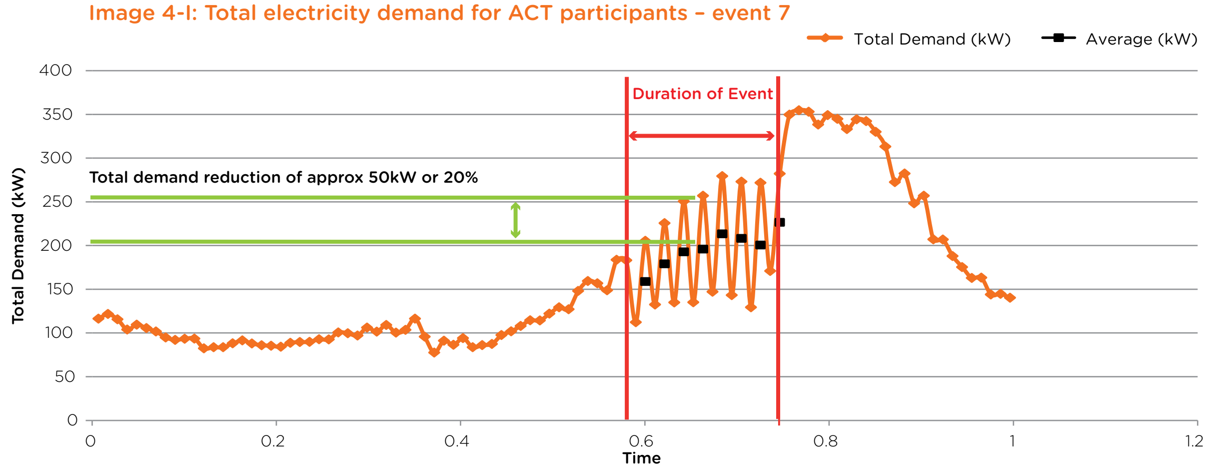
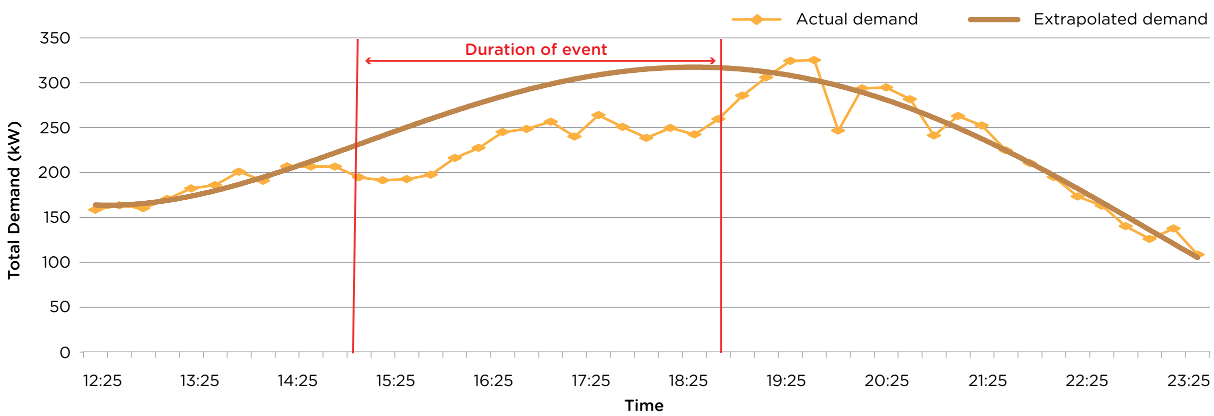



Image 4-J: Total electricity demand for ACT participants – event 9




## THESE RESULTS VALIDATE DLC AS AN EFFECTIVE MEANS OF REDUCING ELECTRICITY DEMAND DURING PEAK HOURS

**Event nine – 15 March 2011**

During Event nine, the off-on switching of 186 participant air-conditioners was randomised, for example each air-conditioner 'cycled' independently of other participants within the fixed event duration, and the 'cycling' of air-conditioners was not aligned to the meter reading interval of the smart meters. The results show a relatively smooth load curve (image 4-J).

The smooth curve is the extrapolated load profile for the duration of the event and is compared with the actual aggregated load profile of all participants. The difference between these load profiles is the reduction in electricity demand achieved during the event. The average demand reduction recorded for this event was 53.58kW across 186 participants or approximately 20% of total aggregate demand.

**Overall outcomes of Year 1**

The average reduction recorded across all 10 events ranged between 154.64W and 891.91W per air-conditioner, or up to 20% of the peak demand of participant households.

Year 1 results show a significant reduction in peak electricity demand as a direct result of the Trial. This essentially validates DLC as an effective means of reducing electricity demand during peak hours of the day. The cost-benefit of the Trial's wider application will be analysed and understood after Year 2 of the trial is completed.

In practice, when large numbers of air-conditioners are involved, a random cycling of air-conditioners may be more suitable as it minimises power quality impacts associated with a large amount of electricity load being switched on and off at the same time.

Year 2 of the trial will more specifically target peak demand by timing events to coincide with times of peak residential and system-wide electricity demand (15:00 to 20:00).

## 4.4 TRANSFERRABLE LESSONS

### 4.4.1 RECRUITMENT

| Activity | Barrier or Benefit | Outcome and/or lesson |
|---|---|---|
| **Recruitment of participants** | BARRIER:<br>Recruitment in Year 1 was a three-step process requiring two site visits: EOI, air-conditioner assessment, and DRED installation. | OUTCOME:<br>Due to the length of time between the initial EOI and the installation of the DRED, some households opted out of the trial.<br>LESSON:<br>A campaign with a condensed recruitment process (single site visit), is likely to result in greater participation. |
| **Engagement by assessors** | BARRIER:<br>DRED installers did not possess adequate knowledge of the trial and its objectives. | OUTCOME:<br>In a number of cases, installers were unable to overcome informational barriers. A poor conversion rate from assessment to participation resulted.<br>LESSON:<br>DRED installers should either undergo more extensive training, be supported in the field via telephone access to knowledgeable experts, or be accompanied by such experts in the field. |

### 4.4.2 TECHNICAL

| Activity | Barrier or Benefit | Outcome and/or lesson |
|---|---|---|
| **Proving the technology** | BENEFIT:<br>The end-to-end technical solution performs as designed, including the DRED, communication via the smart meter, and control via UIQ. | OUTCOME:<br>Ten DLC events were successfully conducted during Year 1.<br>LESSON:<br>Smart grid infrastructure can be utilised to conduct residential load control. |
| **Air-conditioner interface with smart grid** | BARRIER:<br>Interfacing with air-conditioners is complex and invasive. | OUTCOME:<br>A customised device (DRED) was required.<br>LESSON:<br>Use of the AS4755 standard for demand response interfaces should be mandated. Alternative DRED devices/interface should be sought to reduce the cost of remotely managing priority appliances such as air-conditioners. |
| **Pairing of DRED and smart meter.** | BARRIER:<br>The HAN's coverage is insufficient over long distances (typically over 50 meters) and through obstacles such as walls. | OUTCOME:<br>DRED installation failed in 55 cases because the air-conditioner was too far from the meter. External antennas were installed on nine sites to boost the signal, with success achieved on five sites.<br>LESSON:<br>Variants of the existing DRED are required such as the inclusion of in-built antennas to boost signal strength. |

| Activity | Barrier or Benefit | Outcome and/or lesson |
|---|---|---|
| **DRED installation** | BARRIER:<br>The success or otherwise of a DRED installation was not known until the commencement of an event. | OUTCOME:<br>27 DREDs failed to respond to the meter command to run the DLC event. This was due to incomplete/ unsuccessful commissioning, faulty DREDs or incorrect DRED wiring.<br>LESSON:<br>Western Power will run a test DLC event during DRED commissioning in Year 2. |
| **Measuring data for properties with a solar PV system** | BARRIER:<br>Power generated by solar PV systems is not measured independently of household consumption. | OUTCOME:<br>The reported demand reduction results were conservative.<br>LESSON:<br>Where possible, provide a second element or second meter solution to measure solar PV output for participants with both a solar PV system and a DRED. |
| **Procurement of DREDs** | BARRIER<br>Limited experience exists in Australia with regard to the development of specialist technical products such as DREDs. | OUTCOME:<br>No 'off the shelf' DRED was available. A customised device was required to be designed, manufactured and tested prior to the trial.<br>LESSON:<br>"Smart appliance" standards and interfaces (including AS4755) which will integrate the demand response capability into appliances should be mandated where demonstrated to be cost-effective. |

## 4.5 FUTURE FOCUS

Having successfully tested the DLC technology in Year 1, the focus for Year 2 of ACT will be:

- recruitment of 164 additional participants
- continue to address known technical barriers and issues, such as using external antennas to increase coverage of the HAN beyond 50 metres.
- design 10 DLC events to be conducted at times of peak demand
- measure the demand reduction achieved through the use of DLC
- determine the potential of using DLC to defer costly network investment - cost of demand reduction
- understand overall participant response, as well as the most effective means of engaging and recruiting participants to such trials

# IN HOME DISPLAY TRIAL

## 5.1 BACKGROUND

Households in Western Australia currently receive an electricity bill approximately every 60 days. This is considered a limiting factor in a householder's ability to better manage their energy use.

Perth Solar City provides a Western Australia-first trial, to test In Home Display (IHD) technology and its impact on residential energy use. Householders were provided an IHD that shows their electricity consumption in real-time both in units (kWh) and in cost ($). This information allows them to monitor and understand their electricity use (through cause and effect), which may in turn have an impact on their electricity consumption behaviour.

As a Perth Solar City Consortium member, Synergy is responsible for the procurement and deployment of IHDs, and the recruitment of trial participants. The IHD was branded MAX (MAXimise your savings) and was provided free of charge to up to 2,200 smart meter households. Synergy is the single electricity retailer in the Western Australian residential sector (for energy users below 50MWh/annum).

The IHD is enabled by Western Power's Smart Grid (chapter 3.0). The IHD communicates wirelessly with the smart meter via the Home Area Network (HAN) to provide real time electricity consumption information. The device is portable within the home, allowing householders to view the change in consumption and cost as a result of switching appliances on or off. Western Power also provides ongoing technical support to IHD participants.

Two generations of the IHD (procured from Canadian manufacturer Energy Aware) have been developed for the Perth Solar City IHD trial, providing:

- standard energy consumption information – generation 1 and 2
- micro-generation information – generation 2 only

The standard first generation IHD, (image 5-A), has three main functions:

- show electrical energy consumption information in units and dollars
- show historical electricity consumption based on a user defined date and time
- coloured lights representing time-based tariff consumption blocks
- show current tariff rate in dollars per unit

The micro-generation capable, second generation IHD has additional functionality to show the household's net generation, for example when a solar PV system is installed on the home.

Prior to participants receiving an IHD, Western Power pre-matches the IHD to their smart meter. Once the IHD is received, the householder must follow a relatively simple pairing process (image 5-A).


Image 5-A: Perth Solar City standard model IHD

## 5.2 OBJECTIVES AND PROGRESS

The objectives of the In Home Display trial under Perth Solar City are:

- to test the IHD technology via Western Power's smart grid enabled Home Area Network
- to test the customer response to the IHD as a single method of providing participants with access to real time electricity consumption information

The specific Key Performance Indicators (KPIs) developed for the IHD trial are:

| Activity | Key Performance Indicator | Timeframe | Progress |
|---|---|---|---|
| **Technology** | Complete HAN interoperability testing of IHD for meter and network management system | 2010/11 | Complete |
| **Recruitment** | Develop marketing and communications material | 2010/11 | Complete |
| | Recruit participant households | 2010/11 | Ongoing |
| | Deploy 2,200 IHDs | 2010/11 | Ongoing |
| | Provide technical support as required | 2010/11 | Ongoing |
| **Evaluation** | Understand customer response via pairing rates | 2011/12 | Ongoing |
| | Understand customer response via impact on electricity consumption | 2011/12 | Ongoing |

### 5.2.1 TECHNOLOGY

**Complete interoperability testing**

Western Power carried out end to end system testing, functional testing and user acceptance testing for the first generation of IHDs. The IHD communicates wirelessly with the participant household's smart meter via the HAN - an open communications platform. Prior to deployment, the IHDs required a series of laboratory-based tests to ensure successful integration with the selected smart meter and network management system (UIQ).

For second generation IHDs, Synergy and Western Power worked with the IHD manufacturer to define the requirements to enable the display of net micro-generation via the HAN, reportedly a world first application.

Six Synergy and Western Power employees participated in an interoperability pilot prior to the mass deployment of IHDs. The pilot was conducted to ensure that bench-testing of IHDs in the lab had adequately uncovered any/all integration issues in the end-to-end operational process.

Considering that interoperability testing was conducted during office hours, the pilot uncovered several technical issues, for example Sunday tariffs not correctly registering in the IHD.

### 5.2.2 RECRUITMENT

Synergy is responsible for the engagement, and subsequent recruitment and deployment of IHDs as part of Perth Solar City. Synergy's target is to recruit 2,200 smart meter households to participate in the IHD trial. Synergy developed a unique brand - MAXimise energy savings - and developed information-based marketing materials (image 5-D).

As at 30 November 2011, Synergy had deployed a total of 1,931 IHDs to households.

| Sub-Project | Program target | Actual to date | Target to 30 Nov 2011 |
|---|---|---|---|
| IHDs deployed | 2,200 | 1,931 | 2,000 |

The majority of IHDs were deployed during the March 2011 quarter (image 5-C).

Image 5-C: IHDs deployed to participants per quarter and cumulative

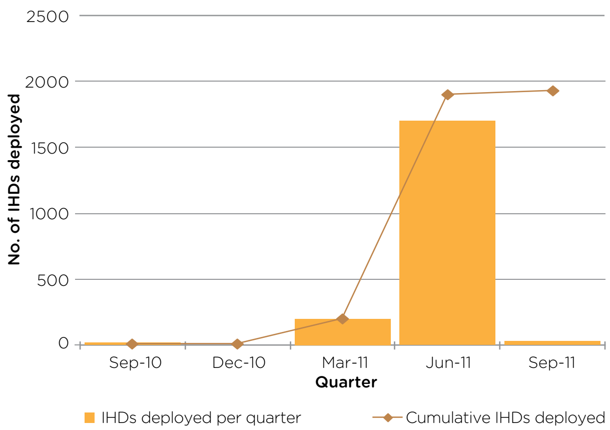
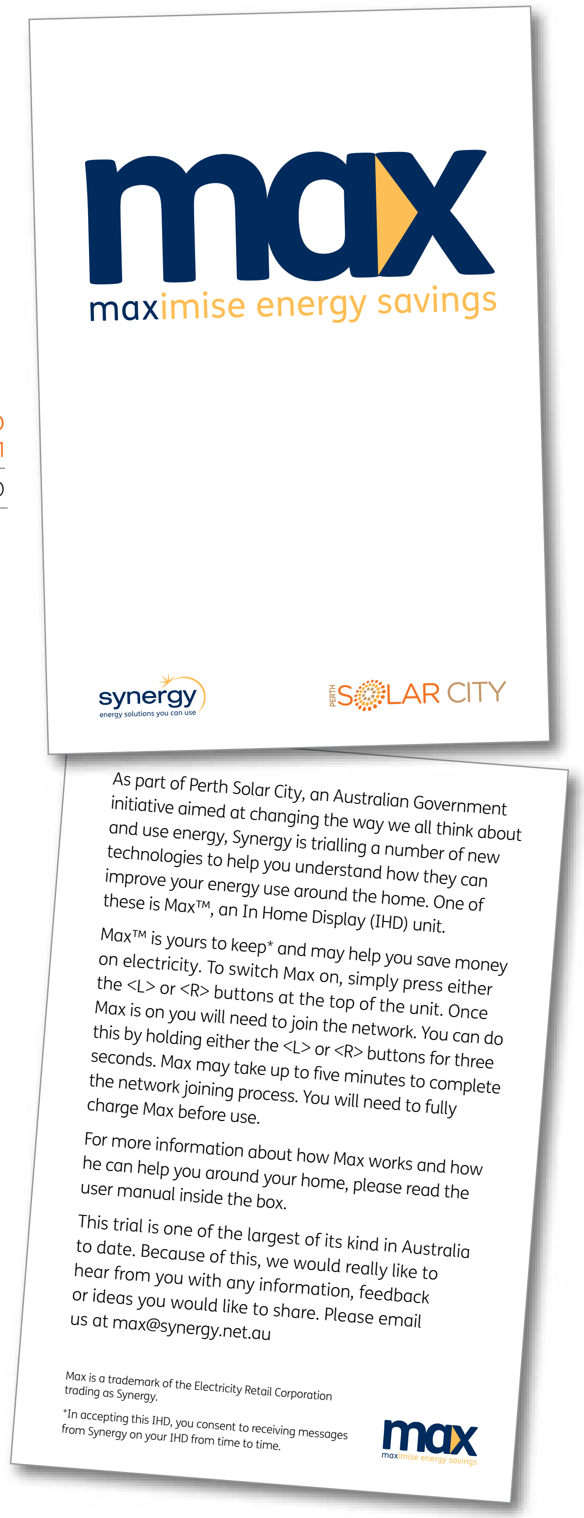



Image 5-D: MAX - deployment letter



max
maximise energy savings
synergy
energy solutions you can use
PERTH SOLAR CITY

As part of Perth Solar City, an Australian Government initiative aimed at changing the way we all think about and use energy, Synergy is trialling a number of new technologies to help you understand how they can improve your energy use around the home. One of these is Max™, an In Home Display (IHD) unit.

Max™ is yours to keep* and may help you save money on electricity. To switch Max on, simply press either the <L> or <R> buttons at the top of the unit. Once Max is on you will need to join the network. You can do this by holding either the <L> or <R> buttons for three seconds. Max may take up to five minutes to complete the network joining process. You will need to fully charge Max before use.

For more information about how Max works and how he can help you around your home, please read the user manual inside the box.

This trial is one of the largest of its kind in Australia to date. Because of this, we would really like to hear from you with any information, feedback or ideas you would like to share. Please email us at max@synergy.net.au

Max is a trademark of the Electricity Retail Corporation trading as Synergy.

*In accepting this IHD, you consent to receiving messages from Synergy on your IHD from time to time.

max
maximise energy savings

### Participant recruitment methods

Synergy's main recruitment method was to package the IHD and send it via mail to 1,544 smart meter households (including 345 households with a solar PV system). These households were pre-selected by Synergy without the householder specifically opting-in to the trial. The remainder of the 397 MAX units deployed to date, have been deployed to households that specifically opted-in to the trial (table 5-A).

**Table 5-A: Recruitment methods for Perth Solar City IHD trial**

| Group | Method of deployment | IHD type | Number of IHDs |
|---|---|---|---|
| **Opt-in** | | | |
| Group 1 | Offered to households as a bundled package with the PowerShift Time-Of-Use tariff product | Standard | 201 |
| Group 2 | Offered to households via a waiting list for IHD only (for households not wanting to switch to PowerShift) | Standard | 100 |
| Group 3 | Offered to households via a waiting list for generation capable IHD | Micro Generation | 55 |
| Group 4 | Offered to households as a bundled package with a free Home Eco-Consultation. | Standard | 31 |
| **Non opt-in** | | | |
| Group 5 | Pre-identified for an IHD by Synergy and sent the IHD in the mail | Standard | 1,199 |
| Group 6 | Pre-identified as having a PV system and selected by Synergy for a micro-generation capable IHD | Micro-generation | 345 |
| | | **TOTAL** | **1,931** |

### Pairing rates

The IHD units require a simple pairing process to calibrate the unit to the smart meter (image 5-B). Households are required to complete this step once in receipt of their IHD. The pairing rates for IHDs show the number of households who are active participants in the trial. Recipient households who do not pair their IHD to the smart meter are not considered active participants. Table 5-B shows the pairing rates for each of the deployment campaigns implemented by Synergy.

**Table 5-B: Pairing rates for IHDs by deployment mechanism**

| Campaign | Type of IHD | Number of IHDs | Number of IHDs paired | Pairing rate |
|---|---|---|---|---|
| Group 1 | First generation | 201 | 151 | 75% |
| Group 2 | First generation | 100 | 75 | 75% |
| Group 3 | First generation | 1,199 | 590 | 52% |
| Group 4 and 5 | Second generation | 400 | 255 | 64% |
| **TOTAL** | | **1,900** | **1,071** | **56%** |

Note: Pairing rates for the 31 IHDs deployed during the December 2011 quarter are not included.

The pairing rate for IHDs that were not opt-in was significantly lower than for opt-in households.

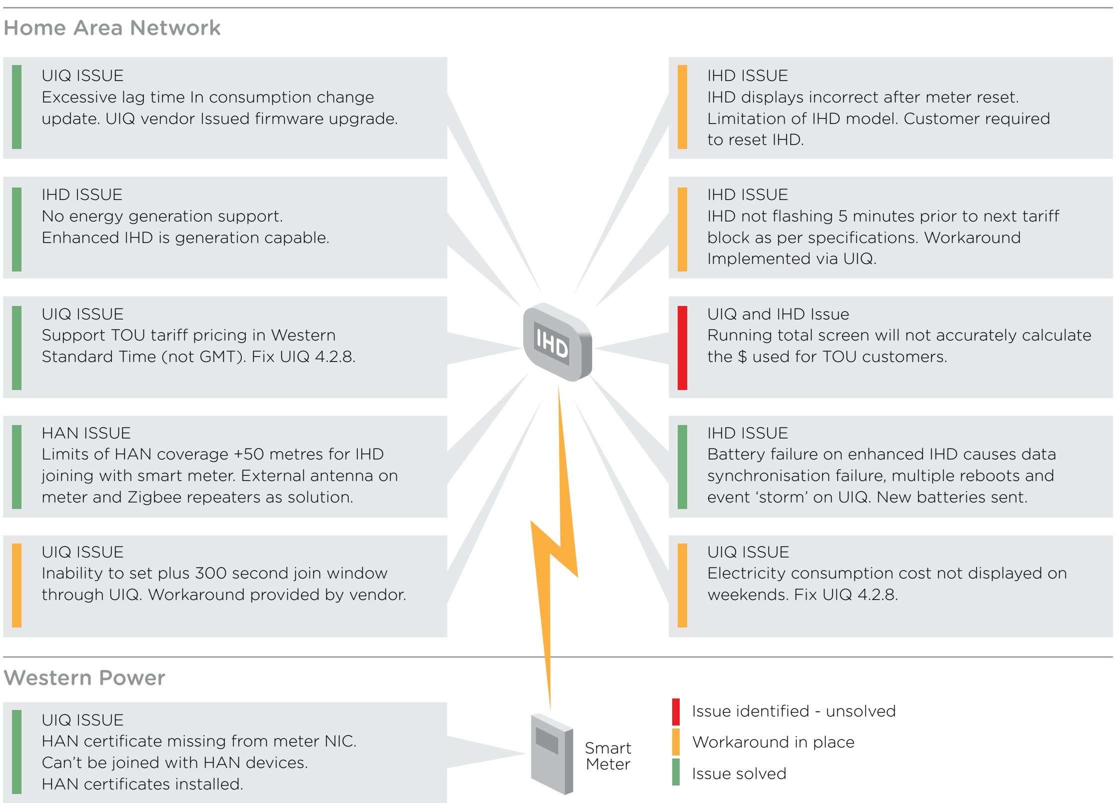
### Technical support

Western Power provides technical support in the form of pre-pairing IHDs and ongoing customer support escalated via the Synergy call centre.

For pre-pairing, Synergy would pre-allocate an IHD to a customer and inform Western Power prior to deployment. Western Power would then pre-pair the device to UIQ and request that the vendor (SilverSprings Networks) open an unlimited join window in the system to allow customer connection following receipt of their IHD. Once the join window is established, approval for dispatch is provided to Synergy. Upon receiving their IHD in the mail, the customer is required to remove the IHD from the box and complete the pairing process.

Western Power has provided on-going technical assistance in support of the IHD trial, which has experienced a number of technical issues (image 5-E). This demonstrates the benefits of conducting such a trial prior to any proposed wider rollout.

**Image 5-E: Overview of technical support provided by Western Power for IHD trial**



# PERTH SOLAR CITY PROVIDES A WESTERN AUSTRALIA-FIRST TRIAL, TO TEST IN HOME DISPLAY (IHD) TECHNOLOGY AND ITS IMPACT ON RESIDENTIAL ENERGY USE

## 5.3 KEY RESULTS

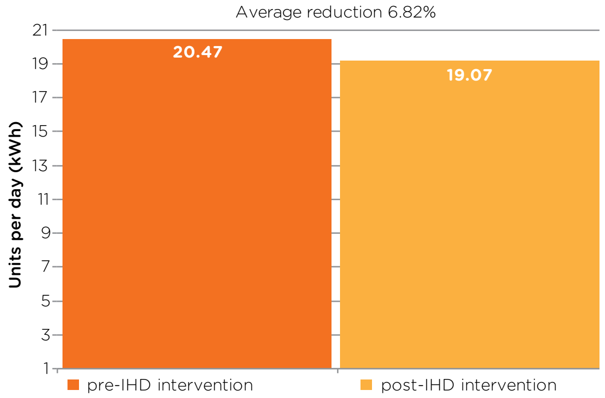
**Effect on electricity consumption – preliminary analysis**

Perth Solar City commissioned Data Analysis Australia (DAA) to provide preliminary analysis on the effect of the paired IHDs on electricity consumption. The analytic methodology developed is attached as Appendix E.

Analysis was completed for 813 participant households who had received and paired IHDs in the period 9 February 2011 to 30 June 2011. As the immediate timeframe following the deployment of the first IHD is short, the results are preliminary. An average 6.82% reduction in electricity use is evident. In short, there is some evidence to suggest that the IHDs lead to a reduction in energy consumption (image 5-F). This result is consistent with similar trials both in Australia and internationally. Further analysis will be completed during 2012, particularly after the 2011/12 summer, when energy consumption datasets will be significantly increased.

### Image 5-F: Effect on electricity consumption

Table 5-C shows the extrapolated annual cost and greenhouse gas savings for IHD participants, based on the preliminary results.




### Table 5-C: Extrapolated annual cost and greenhouse gas emissions savings

| Customer Group | Electricity cost savings per household ($/year)* | Greenhouse Gas savings (kg CO-e/year)^ |
|---|---|---|
| IHD | $114.44 | 474 |

* Calculation based on unit cost of $0.2187 per kWh

^ based on emission co-efficient of 0.93kg/CO2-e per kWh –National Greenhouse Account Factors July 2011

## 5.4 TRANSFERRABLE LESSONS

The IHD trial shows the potential benefit of providing access to real-time energy information to households. A number of recruitment and technical lessons have emerged from the trial to date.

### 5.4.1 RECRUITMENT

| Activity | Barrier or Benefit | Outcome and/or lesson |
|---|---|---|
| **Deployment of IHDs** | BENEFIT:<br>Access to real-time electricity consumption information | OUTCOME:<br>Despite 82% of IHDs being deployed to non opt-in participants along with no education-based engagement, participants who paired the IHD showed evidence of saving electricity (6.8%).<br><br>LESSON:<br>There is evidence to suggest that providing access to real-time energy consumption information will result in reductions in energy use. |
| **Engagement of households by retailer** | BARRIER:<br>82% of IHDs were deployed to households who had not opted-in to the Trial (i.e. had not requested to participate) | OUTCOME:<br>The pairing rate for IHDs by households that did not opt-in was lower (52% for first generation, 64% for second generation) than for opt-in households (75%).<br><br>Approximately 100 customers (6.5%) returned the IHD to the retailer.<br><br>LESSON:<br>To achieve better pairing results, IHDs should be deployed to participants who opt-in.<br><br>Prior to the wider deployment of IHDs, a comprehensive education-based engagement campaign must be implemented to raise awareness as to the opportunities and benefits of access to real time energy consumption information. |
| **Engagement and recruitment** | BARRIER:<br>Lack of clear incentive and/or driver for deployment partner | OUTCOME:<br>The delivery of IHDs within the target area was not as effective as anticipated.<br><br>LESSON:<br>Engagement and recruitment for smart grid enabled products and services should be undertaken by organisations for which energy efficiency and demand-side management is part of core business or is appropriately supported by regulatory-based incentives. |
| **Consortium Agreement** | BARRIER:<br>Lack of prescriptive engagement and recruitment methodology in the Consortium Agreement | OUTCOME:<br>IHD deployment was undertaken to meet basic contractual targets, irrespective of the effectiveness of the method of deployment.<br><br>LESSON:<br>Contracts for the delivery of smart grid enabled products and services should include provisions for engagement and recruitment methodology. |

## 5.42 TECHNICAL

| Activity | Barrier or Benefit | Outcome and/or lesson |
|---|---|---|
| **Deployment of basic function IHD** | BARRIER:<br>Lack of choice for householders between differing methods of providing access to real-time electricity consumption information | OUTCOME:<br>The Trial was limited to identifying the effectiveness of a basic function IHD.<br>LESSON:<br>Further trials should be conducted, which provide greater choice to householders including USB connections or smart-phone applications. |
| **Technical support for the deployment of new technology** | BARRIER:<br>The IHD technology is a relatively new technology in Australia | OUTCOME:<br>Ongoing technical support is required for the duration of the trial.<br>LESSON:<br>Technical support for IHDs should be integrated into business-as-usual processes prior to larger scale deployments. |
| **Conduct of small pilot prior to wider trial deployment** | BENEFIT:<br>A number of technical issues were identified during the implementation of a small six household pilot | OUTCOME:<br>Identified technical issues were resolved prior to the wider trial deployment.<br>LESSON:<br>When implementing new customer-oriented technologies, small pilots in the field are required. |

## 5.5 FUTURE FOCUS

The key focus for the IHD trial in 2012 will be to complete the deployment of the remaining 269 IHDs to households in Perth's Eastern Region. Deployment will be completed via an opt-in approach, whereby households will be actively recruited to participate.

Further data analysis will be undertaken to understand commonalities within groups that benefitted the most from participation in the IHD Trial.

# TIME OF USE TARIFF TRIAL

## 6.1 BACKGROUND

In Western Australia, households on the South West Interconnected System (SWIS) currently have two electricity tariff choices:

- A1 - a subsidised all-time tariff where customers are charged one flat rate (21.87c/kWh), regardless of when the electricity is used
- SmartPower - a four-part time-of-use (TOU) tariff where premium charges occur from 11am – 5pm on weekdays (42.15c/kWh during weekdays in summer)

Peak electricity demand on the SWIS generally occurs in summer between 17:00 and 21:00 on weekdays. Peak demand places significant strain on Western Power's electricity network, resulting in the inefficient use of existing network resources, and requiring costly network augmentation to support. Neither of the existing tariffs reflect the increased cost of electricity supply during peak demand periods, nor encourages households to use electricity outside of peak periods.

PowerShift is a voluntary three-part time-of-use tariff developed by Synergy for Perth Solar City, and is the first tariff in Western Australia which seeks to more closely align electricity consumption blocks with time-based costs of generation (table 6-A).

**Table 6-A: PowerShift consumption blocks and charges**

| Period | Time | Rate |
|---|---|---|
| Super peak | Weekdays - 14:00 - 20:00 | 36.62c/kWh |
| Peak | Weekdays - 07:00 - 14:00 and 20:00 - 22:00, Weekends - 07:00 - 22:00 | 20.83c/kWh |
| Off-peak | All days - 22:00 - 07:00 | 10.78c/kWh |

Note: prices current as at 30 November 2011

Synergy is responsible for the engagement and recruitment of participants to PowerShift. Participant households require an interval capable meter which can either be a smart meter recently installed under Perth Solar City, or an existing reprogrammable electronic meter. There are approximately 20,000 households with interval capable meters in the Perth Solar City target area.

## 6.2 OBJECTIVES AND PROGRESS

The key objectives of the PowerShift Trial are to:

- understand the potential for a voluntary peak-demand based price signal to shift household electricity consumption (from periods of peak demand to periods of off-peak demand)
- understand the potential for a voluntary peak-demand based price signal to reduce household electricity costs

### Review of time-of-use target

Synergy originally proposed a target of 5,000 PowerShift participants within the Perth Solar City target area. However, the target was reviewed during 2010/11 and subsequently reduced to 1,000 participants for the following reasons:

- households without an interval capable meter require a meter exchange, the cost of which would likely negate any potential cost savings the customer may make by switching to the PowerShift product
- PowerShift is an opt-in only product and would require penetration rates of over 25%. Synergy consider the standard industry benchmark for the uptake of time of use tariffs to be around 5%, or equivalent to approximately 1,000 households in the Perth Solar City target area

# POWERSHIFT IS THE FIRST TARIFF IN WESTERN AUSTRALIA WHICH SEEKS TO MORE CLOSELY ALIGN ELECTRICITY CONSUMPTION BLOCKS WITH TIME-BASED COSTS OF GENERATION

- the gazetted residential tariff in Western Australia still remains well below the cost of supply. The pricing bands of PowerShift are more closely aligned with cost reflectivity, and as such may be viewed as a more expensive proposition for potential participants

Table 6-B shows progress made towards the PowerShift recruitment target of 1,000 participants.

**Table 6-B: PowerShift participation target**

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| Time of Use tariff participants | 1,000 | 427 | 750 |

**Recruitment of participant households**

Prior to the commencement of the recruitment campaign for PowerShift, Synergy developed an interactive web-based calculator to assist households in determining the appropriateness of the product (image 6-A). The PowerShift calculator enables customers to see how much money they could save per annum by shifting various percentages of their consumption to off-peak periods.

In addition to the web-based calculator, Synergy developed a 'thank you' pack for participating households. This included simple reminder magnets (image 6-B) that customers can place on applicable appliances as a visual reminder to shift their consumption.

To market PowerShift, Synergy identified three groups of potential participants (table 6-C and image 6-C).

**Image 6-A: PowerShift web-based calculator**


**Image 6-B: PowerShift magnet**

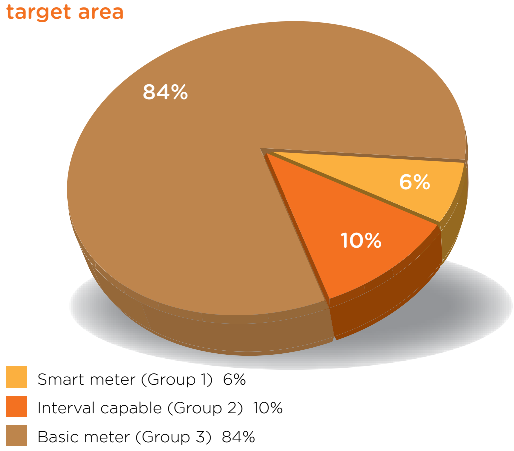

**Table 6-C: Target Groups**

| Group | Description | Approx no. of households | PowerShift participants | % uptake |
|---|---|---|---|---|
| Group 1 | Customers that have received a smart meter as part of the Program | 6500* | 243 | 3.7% |
| Group 2 | Customers that have a TOU capable meter installed at their home | 15,000 | 184 | 1.2% |
| Group 3 | Customers that have a basic meter installed, that can not be reprogrammed to enable TOU functionality. These customers would require a meter exchange | 100,000 | TBD | TBD |

*Number of smart meters installed at time of campaign

Participants in Group 1 and 2 require a meter reprogram, which would normally incur a $66 fee. Western Power and Synergy agreed to waive the $66 reprogram fee for Group 1 and 2 participants.

Image 6-C: Approximate residential meter mix in target area




### Participation - Group 1 (PSC smart meter recipient households)

Synergy launched PowerShift as a bundled product offer (with the MAX In-Home Display) to approximately 6,500 smart meter households on 24 January 2011, via information-heavy direct marketing material (image 6-D). This campaign resulted in the acquisition of 243 customers, a 3.72% response rate.

### Participation – Group 2 (TOU capable meter households)

Approximately 8,000 customers within the target area have a reprogrammable meter and use more than 15 units of electricity per day (considered by Synergy to be the minimum consumption rate to save on PowerShift). These households were sent an information-heavy direct mail pack which included a cover letter and PowerShift brochure (image 6-E). This direct mail campaign recruited 184 participant households.

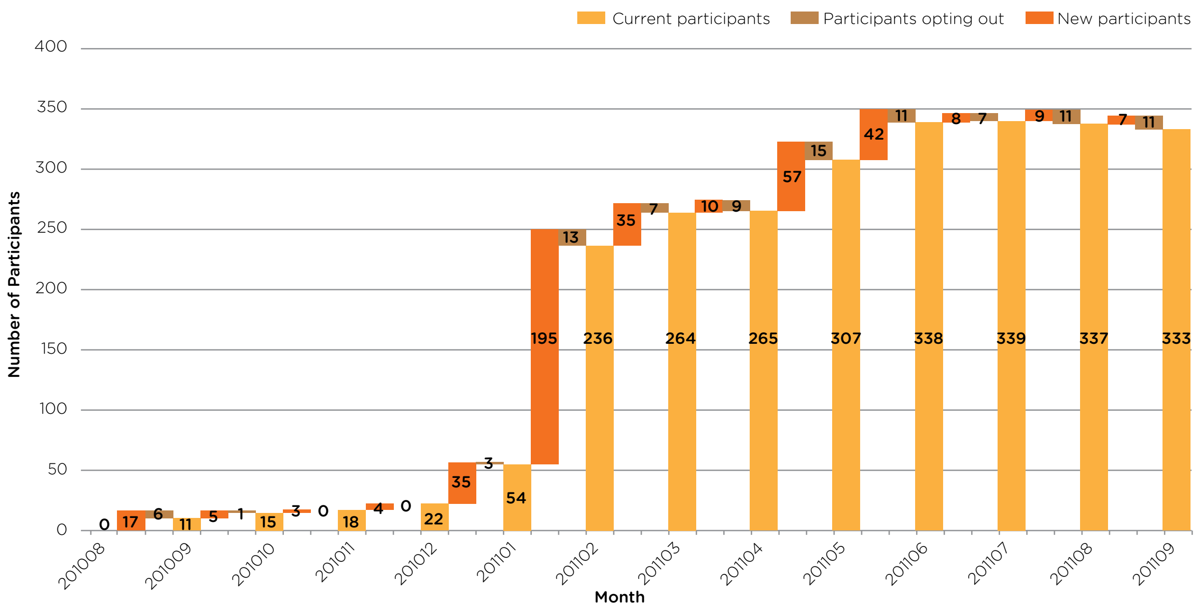
### Participation – Group 3 (Non-TOU capable meter households)

Recruitment of participants from households that do not currently have a TOU capable meter will commence in early 2012. These households will require a meter exchange that would normally cost $171 for a single phase meter or $268 for a three phase meter. This cost is seen as a significant barrier to recruitment considering it is likely to negate the savings made from changing to the PowerShift tariff. To remove this barrier, Western Power has agreed to cover the meter exchange cost for up to 500 participants.

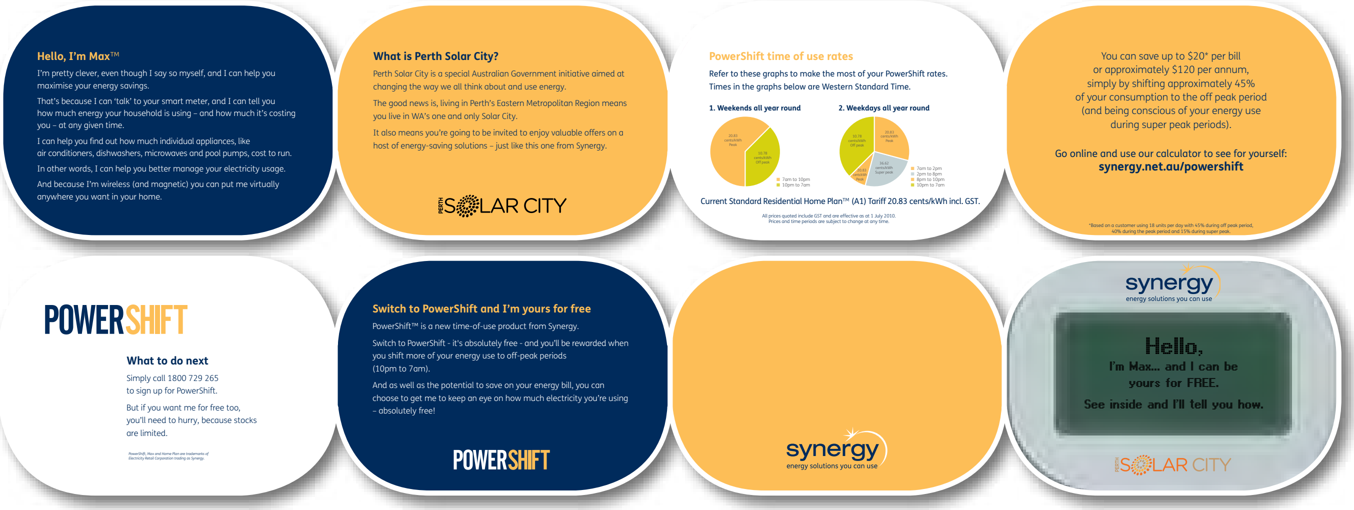
### Attrition rate for PowerShift

Of the 427 households who signed up for PowerShift, a total of 94 households have requested to return to the A1 all-time tariff – representing an attrition rate of 22% (image 6-F). A survey of participants that returned to the A1 tariff will be conducted in the first quarter of 2012.

Image 6-F: Attrition rate for PowerShift participants



## Image 6-D: Bundled PowerShift and MAX offer direct marketing leaflet




## Image 6-E: Group 2 PowerShift brochure

## 6.3 KEY RESULTS

Key results for the PowerShift Trial will focus on the preliminary analysis of:

- the impact on participant's load profile
- electricity cost savings

### 6.3.1 IMPACT ON PARTICIPANT'S LOAD PROFILE

The broad objective of PowerShift is not to reduce a householder's overall electricity consumption, but rather it seeks to:

- reduce electricity consumption at times of peak demand ('super-peak')
- reward householders for changing their electricity consumption behaviour to reduce consumption at times of peak demand

As such, preliminary analysis seeks to understand the reductions in electricity consumption at 'super-peak', as well as the effects of shifting behaviour on household electricity costs.

Perth Solar City commissioned Data Analysis Australia (DAA) to provide preliminary analysis on the effect of PowerShift on reducing participant electricity consumption during the allocated 'super peak' (14:00 - 20:00 on weekdays). The analytic methodology developed and used by DAA is attached as Appendix E.

Analysis was completed using NEM 12 (interval) data for 334 participant households who had signed up for and remained on PowerShift in the period 1 August 2010 to 30 June 2011. The preliminary analysis shows a reduction in electricity consumption during the 'super peak' of 10.9% (table 6-D).

### 6.3.2 ELECTRICITY COST SAVINGS

As a result of the load shifting from 'super-peak' weekday periods to either peak or off-peak periods, PowerShfit participants potentially saved an average of $32.51 - $53.21 annually (table 6-E).

Table 6-E: Average cost saving during 'super-peak'

| Consumption shift | Annual PowerShift cost saving |
|---|---|
| To peak periods (20.83c/kWh) | $32.51 |
| To off-peak periods (10.78c/kWh) | $53.21 |

However, given that associated electricity costs depend on the amount of electricity consumed during each of the PowerShift time bands (relative to the standard A1 all-time rate), it is possible that some households may have increased their electricity costs as a result of switching to PowerShift. Given that the majority of PowerShift participants were signed up from February 2011, analysis to understand the impact of PowerShift on participant's annual electricity costs will be conducted in 2012.

**PRELIMINARY ANALYSIS SHOWS A REDUCTION IN ELECTRICITY CONSUMPTION DURING THE 'SUPER PEAK' OF 10.9%**

Table 6-D: Reduction in electricity consumption during 'super-peak'

| Average consumption 'super peak' Pre-Powershift (kWh) | Average consumption 'super peak' Powershift (kWh) | Reduction in 'super peak' consumption (kWh) | % reduction during 'super peak' |
|---|---|---|---|
| 7.281 | 6.489 | 0.792 | 10.9% |

## 6.4 TRANSFERRABLE LESSONS

| Activity | Barrier | Outcome and/or lesson |
|---|---|---|
| **Product design** | BARRIER:<br>PowerShift pricing bands do not appear to be adequately rewarding load shifting/behaviour change. | OUTCOME:<br>22% of households returned to the A1 tariff.<br>LESSON:<br>A voluntary TOU product must be designed that offers meaningful cost savings for households that make the effort to shift electricity use to off peak times. |
| **Default pricing** | BARRIER:<br>The default tariff in Western Australia is still below cost-reflectivity. | OUTCOME:<br>Uptake of alternative tariffs is low.<br>LESSON:<br>Until standard all-time tariffs are increased to cost-reflectivity, householders are unlikely to look for alternatives. |
| **Latency period** | BARRIER:<br>Time-of-use tariffs are not common in Western Australia. | OUTCOME:<br>Campaigns for voluntary TOU tariff products often have a significant latency period.<br>LESSON:<br>The benefits of voluntary TOU tariffs are not easily identifiable to a household in the Western Australian marketplace. Correct pricing and education-based engagement would help to overcome this barrier. |

## 6.5 FUTURE FOCUS

The key focus for the PowerShift Trial in 2011/12 will be the recruitment of the remaining target of 573 participant households. This will be achieved by re-engaging with smart meter households (Group 1), as well as utilising the funding made available by Western Power to target households without a compatible meter type (Group 3).

Data analysis will seek to further understand the effect on load profiles and energy costs of PowerShift participants. Additionally, differences in load profiles and energy consumption of households that received both an In-Home Display (MAX) and participated in PowerShift will be analysed.

# 7.0 SOLAR PHOTOVOLTAIC SATURATION TRIAL

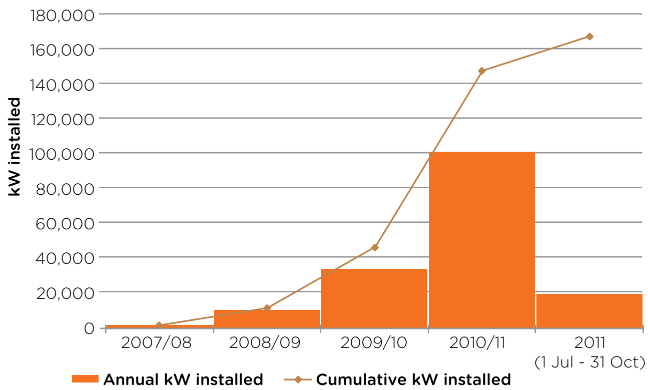
## 7.1 BACKGROUND

The uptake of residential solar photovoltaic (PV) systems in Western Australia has increased significantly in recent years (image 7-A). This is largely due to considerable PV system cost reductions to consumers as a result of reduced manufacturing costs, increased competition in the marketplace, and various state and federal government incentives.

The effects of this increased penetration of small-scale residential solar PV systems on the electricity network are not fully understood. The potential for effects such as localised power quality issues and voltage compliance issues need to be researched.

The Photovoltaic (PV) Saturation Trial is a Perth Solar City initiative seeking to investigate the effects of a high penetration of solar PV systems on Western Power's distribution network.

Image 7-A: Uptake of residential solar PV systems on SWIS




Results of a successful Trial would be used to provide recommendations regarding the methods of evaluating and managing high levels of solar PV system penetration on existing low voltage networks. This would include the development of guidelines for the design of future networks to accommodate the increasing amount of distributed energy generation in Western Australia.

For the purposes of the Trial, a minimum saturation level of 30% was established. A residential distribution transformer (low voltage) was selected in one of the four existing Perth Solar City smart meter deployment locations, thus enabling additional data capture. In order to achieve the 30% saturation target, a significant discount, was offered to households supplied by the transformer.

## 7.2 OBJECTIVES AND PROGRESS

The key objectives of the Solar PV Saturation Trial are to:

- provide research data on the performance of the local network under a high level of solar PV system penetration
- investigate the extent to which Power Quality (PQ) issues (such as high/ low voltage and/ or voltage distortion) might occur as a result of an increasing penetration of solar PV systems on the electricity network
- investigate the extent to which PQ issues might effect the operation of a solar PV system

In order to achieve these objectives, specific Key Performance Indicators (KPIs) were developed for the Solar PV Saturation Trial (table 7-A).

# THE UPTAKE OF RESIDENTIAL SOLAR PV SYSTEMS HAS INCREASED SIGNIFICANTLY IN RECENT YEARS

**Table 7-A: Key Performance Indicators for the Solar PV Saturation Trial**

| Activity | Key Performance Indicator | Timeframe | Progress |
|---|---|---|---|
| Recruitment | Select target location | 2010/11 | Complete |
| | Develop communication materials | 2010/11 | Complete |
| | Achieve uptake of minimum 30% saturation | 2010/11 | Complete |
| Installation | Install solar PV systems | 2010/11 | Complete |
| | Install data loggers | 2010/11 | Complete |
| Evaluation | Undertake analysis of network impacts of saturated solar PV | 2011/12 | Commenced |
| | Undertake analysis of network support provided by saturated solar PV | 2011/12 | Commenced |

## 7.2.1 RECRUITMENT

**Selection of target location**

A distribution transformer in the suburb of Forrestfield was selected, known as Pavetta1, which supplies a total of 77 households. Of these households, five had pre-existing solar PV systems, requiring the trial to install a minimum of 18 additional systems to achieve the 30% saturation target.

The distribution feeder that supplies the solar PV Saturation Trial network is a 22kV feeder from the Forrestfield substation. The feeder contains both underground and overhead conductors. The main characteristics of the network are summarised below:

| Category | Trial location | Control location |
|---|---|---|
| Suburb | Forrestfield | Forrestfield |
| Substation | Forrestfield | Forrestfield |
| Feeder | FFD 506.0 435 Dundas Rd, 22kV | FFD 525.0 1 Beyer Pl, 22kV |
| Distribution Transformer | Pavetta1 22kV/200kVa, Pole mounted | Pavetta2, 22kV/200kVa, Pole mounted |

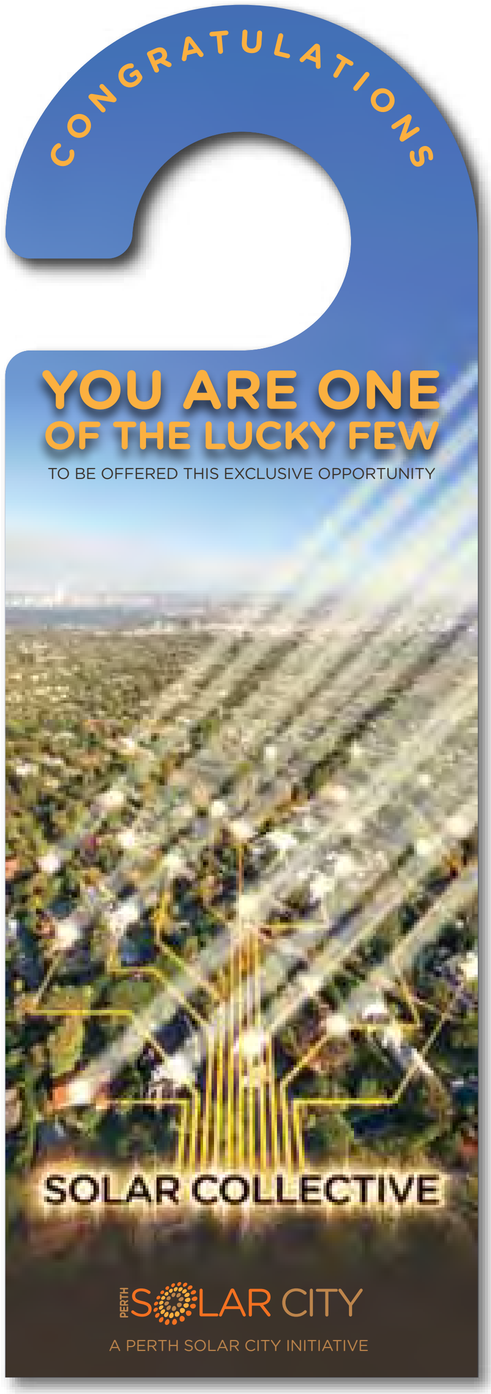
A control location (non-saturated) is supplied by a distribution transformer (Pavetta2) connected to a different distribution feeder, originating from the same substation. The control location has the same nominal characteristics and serves a similar customer base.

**Recruitment of participants**

Western Power developed a brand for the trial - Solar Collective - and partnered with Perth Solar City Consortium member SunPower to produce a compelling proposition for target households to purchase and install a solar PV system. A unique Trial discount of $2,500 was added to the existing Program discount.

The Solar Collective marketing campaign commenced in October 2010 with the delivery of the informational 'door hanger' to all houses on the Pavetta1 transformer target area (image 7-B). This was followed a week later by a folder containing a letter, an information sheet, a registration form, and a pricing list. Prospective participants were also contacted by phone to follow up on their interest and to schedule a free assessment.

Image 7-B: Solar Collective - door hanger




By December 2010, the minimum target of 18 participants was exceeded with a total of 20 participants recruited. 11 of the solar PV systems installed were the smallest and lowest priced system offered. The payback period for most of the systems purchased was projected to be approximately two years.

## 7.2.2 INSTALLATION

**Installation of solar PV systems**

All 20 solar PV systems were installed during January and February 2011. The 20 new systems combined with the five existing solar PV systems in the area provided a saturation level of 32% (25 solar PV systems in a total of 77 houses in the target area). The 20 solar PV systems added 35.5kW of renewable generation to the local distribution network, with the average system size being 1.7kW. Since the commencement of the Trial, the number of solar PV systems in the trial area has increased to 31 out of 77 (40% penetration by number of customers). The estimated total nominal solar PV generation connected to Pavetta1 is approximately 54kW, representing 27% saturation by transformer size.

The key statistics and parameters of the trial to 30 November 2011 are presented in table 7-A.

**Table 7-A: Key statistics to 30 November 2011**

| Description | Single Phase | Three Phase | Total |
|---|---|---|---|
| No. of customers connected to Pavetta 1 transformer | 51 | 26 | 77 |
| No. of PV customers connected to Pavetta 1 transformer^ | 19 | 12 | 31 |
| Total nominal solar PV system capacity installed* | | | 54kW |
| Average solar PV system nominal capacity | | | 1.7kW |
| Solar PV system penetration by transformer capacity | | | 27% |
| Solar PV system penetration by number of customers | | | 40% |

^All PV systems are single phase regardless of whether the service connection is single phase or three phase.

*Nominal capacity of PV systems is taken as the nominal power rating of the PV modules at standard test conditions as specified by module manufacturers. For systems for which no data was available, the nominal capacity was estimated based on the relative size of the array as seen in aerial photos.

**Installation of data loggers**

A power quality data logger was installed on the Pavetta1 distribution transformer in order to measure and evaluate network performance. Power quality data is being collected from the smart meters of participants supplied by Pavetta1. An additional data logger has been installed on the control group transformer (Pavetta 2).

## 7.3 KEY RESULTS

Key results for the Solar Collective Trial will focus on:

- transformer load profile
- transformer voltage profile and compliance
- transformer voltage Total Harmonic Distortion (THD) profile and compliance
- customer level voltage impacts at times of highest solar PV system generated electricity export to the network

### 7.3.1 TRANSFORMER LOAD PROFILE

Data was collected from the Pavetta1 transformer from 21 June to 31 August 2011, and from Pavetta2 (control group) from 5 to 31 August 2011. Subsequent data analysis produced the following results.

Image 7-C shows the load profile of a randomly chosen week during winter 2011. As seen in the graph, peak demand was slightly above 140kW, and minimum demand was approximately -6kW (reverse power flow). Negative power flow occurred at this solar PV system penetration level on a number of days during winter as the minimum load seen by the transformer was typically around zero watts.

Another observation from the profile is that the load is not well balanced, with the red phase being less loaded than the white and blue phases.

Image 7-C: Pavetta1 transformer seven day load profile (winter 2011)

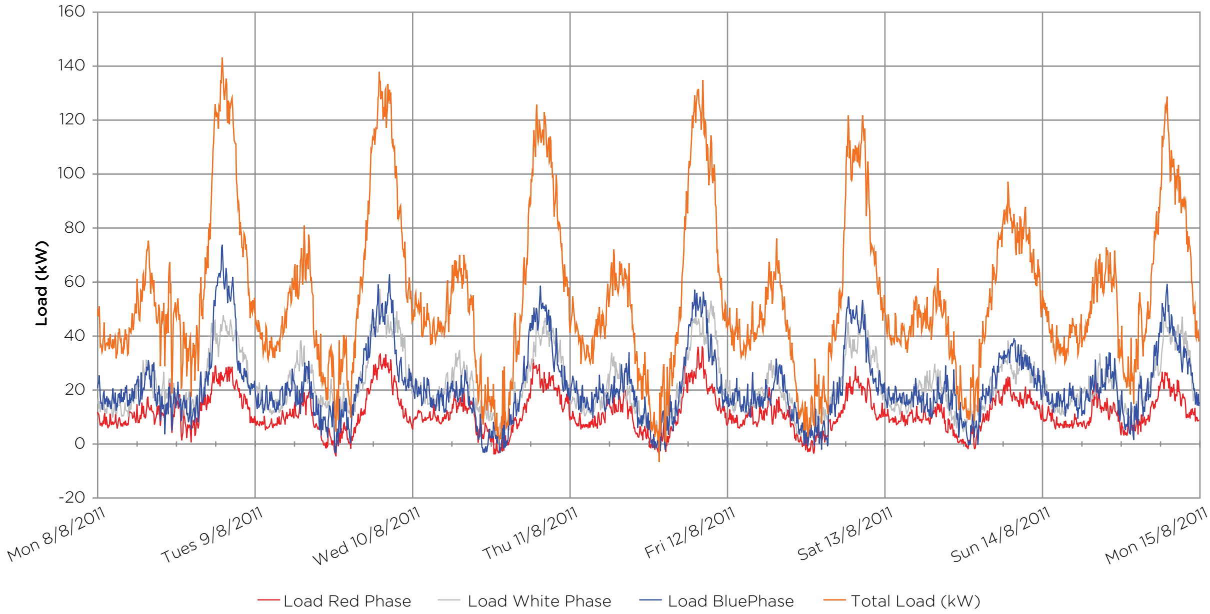



Image 7-D: Pavetta1 transformer load demand scatter plot

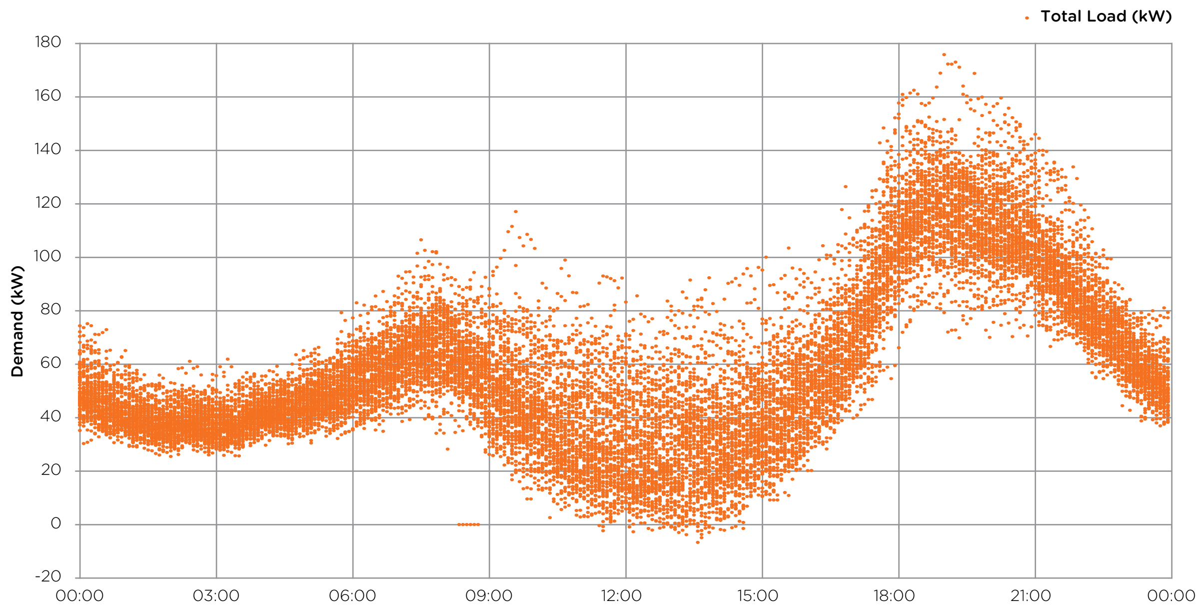



Image 7-E: Pavetta 2 transformer load demand scatter plot

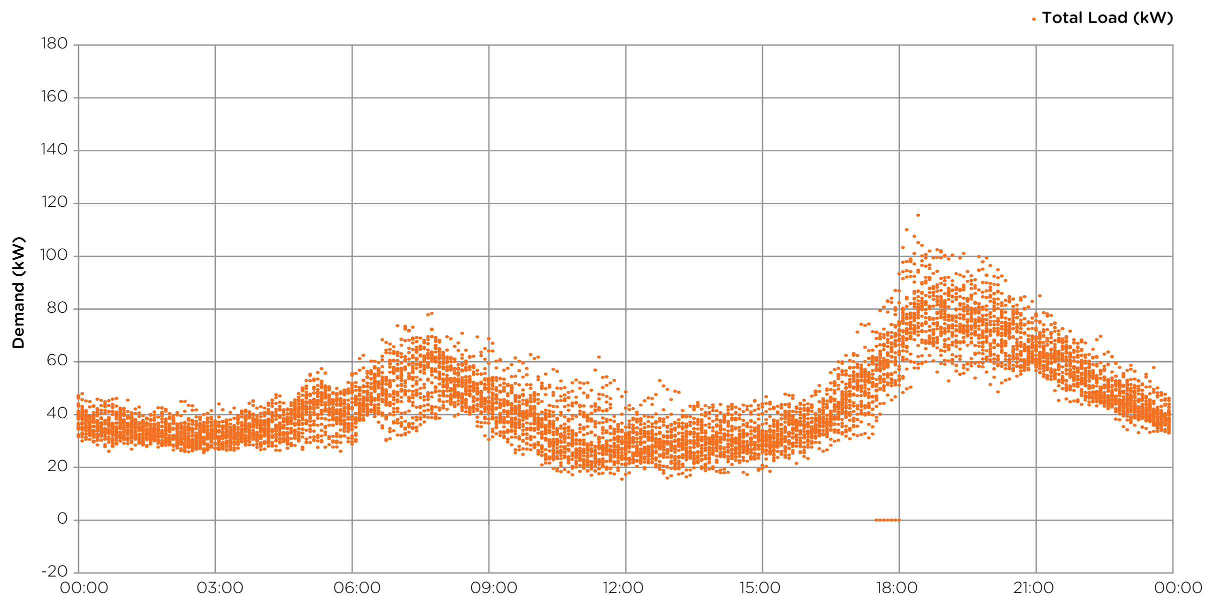


Image 7-D shows the scatter plot of the load on the Pavetta1 transformer across time. As seen in the graph, the transformer shows two distinct peaks, one around 08:00 and the main peak at around 19:00. Reverse power flow on the transformer occurred on several days between 11:30 and 14:30.

It is also evident that the night load profile shows significantly less variability, whereas the peak and low loads show much more dispersion. The latter is presumed to be due to the effect of variability in the output of the solar PV systems, as well as the weather dependent load demand at peak time.

Image 7-E shows the load profile of the Pavetta2 (control group) transformer. It can be seen that although more lightly loaded, the load profile follows a similar pattern as the Pavetta1 transformer. In short, morning and afternoon peaks occur at the same time. This confirms that the customer base of both transformers is very similar.

A further observation is that the minimum load of Pavetta2 ranges between approximately 20 and 40kW, whereas the minimum load of Pavetta1 ranges between zero and 60kW. The much higher dispersion of the Pavetta1 load between the peaks can be largely attributed to the presence of solar PV generation on this low voltage network.

**THIS HOUSEHOLD CONNECTION-POINT VIEW, AS ENABLED BY THE SMART METERS, FLAGS THE NEED TO POTENTIALLY ADDRESS VOLTAGE REGULATION ISSUES ON SATURATED SOLAR PV NETWORKS**

Image 7-F: Average Pavetta1 transformer voltage profile (winter 2011)

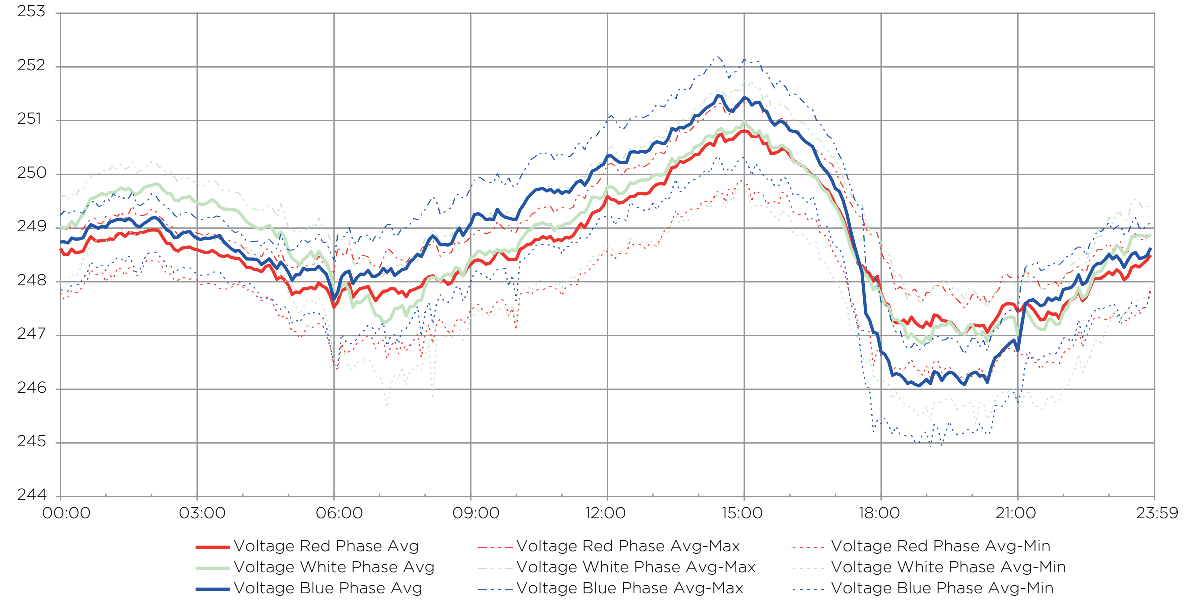



Image 7-G: Solar Collective - Pavetta 1 transformer scatter steady state voltage versus time

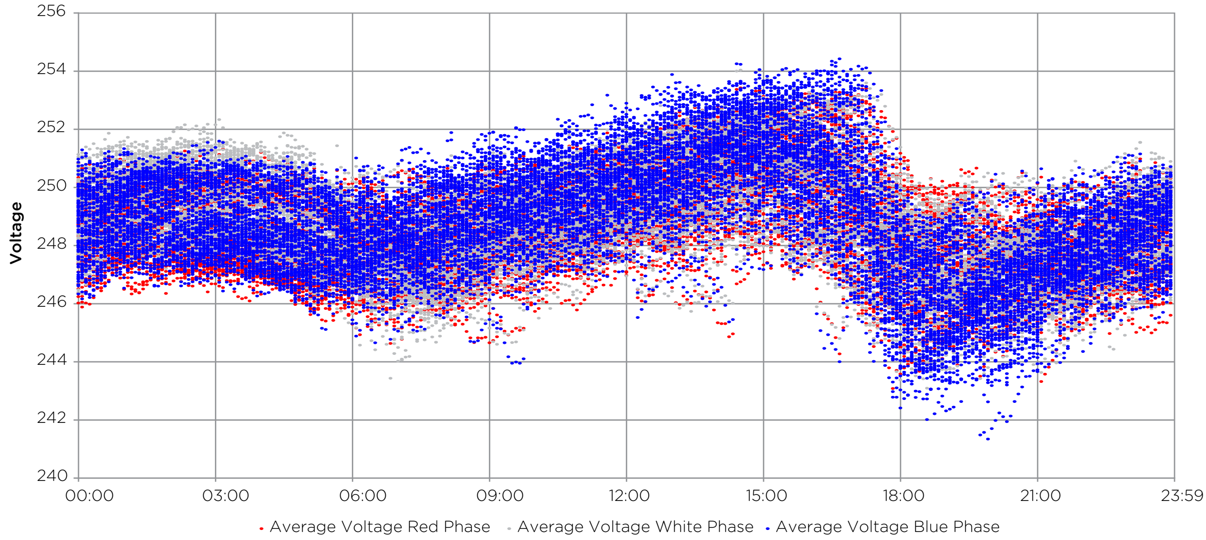
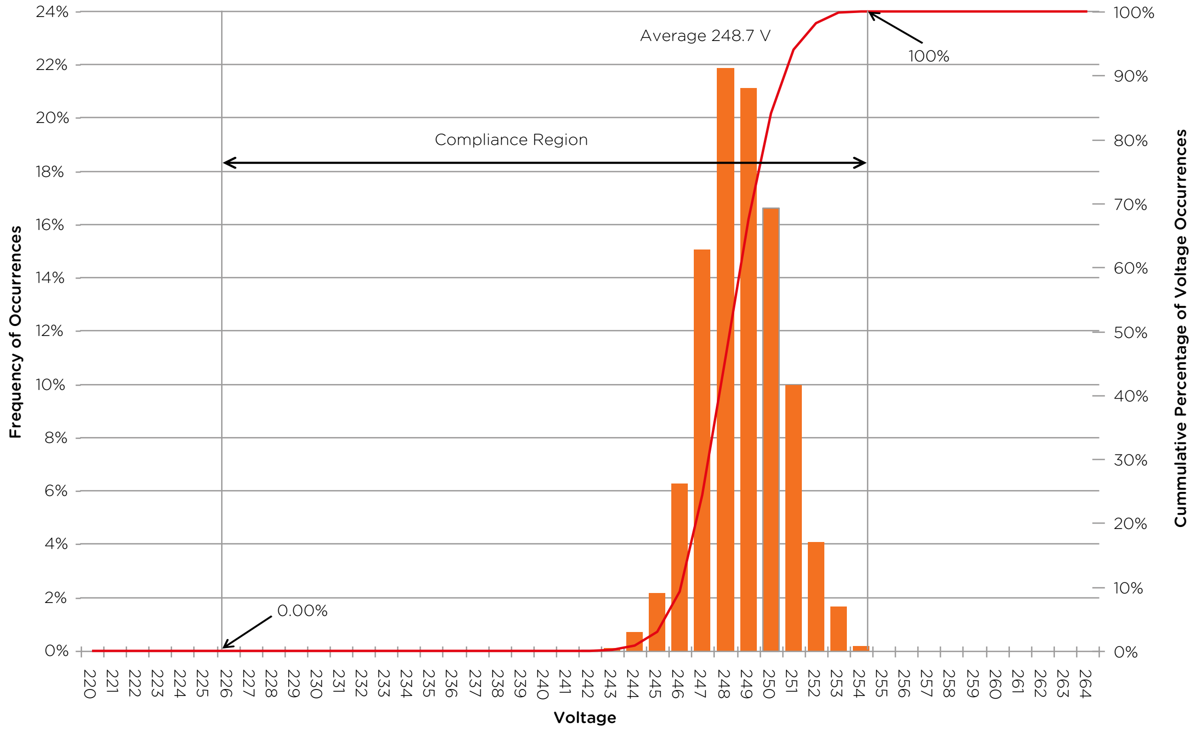



Image 7-H: Pavetta1 transformer voltage histogram and compliance



### 7.3.2 TRANSFORMER VOLTAGE PROFILE AND COMPLIANCE

As per Australian Standard AS60038 and the Western Power Technical Rules, the steady state voltage on the low voltage network at the point of connection with the customer, must be maintained within ± 6% of the nominal voltage (currently 240V). Sustained high, low or distorted voltage can lead to the damage of household appliances. Data was analysed to understand voltage levels at both the transformer level, and the point of connection with households (section 7.3.4).

Average and scatter voltage profiles are shown in image 7-F and image 7-G respectively. As can be seen in image 7-F, high voltage occurred around 15:00, which is a time of low load on the transformer. The lowest voltages occurred during peak demand hours.

As can be seen in image 7-G there were no steady state (5 minute average) voltage points outside the ± 6% limits.

Image 7-H shows that Pavetta1 transformer voltage is within compliance limits 100% of the time. However, further analysis of smart meter data is required to establish compliance at each participant's point of connection.

### 7.3.3 TRANSFORMER VOLTAGE TOTAL HARMONIC DISTORTION (THD) PROFILE AND COMPLIANCE

Voltage Total Harmonic Distortion (THD) at the terminals of the Pavetta1 transformer is presented in image 7-I. As can be seen from the histogram, Pavetta 1 is well within the planning and compliance limits for voltage harmonic distortion.

Pavetta1 voltage THD shows a larger dispersion and higher average voltage THD compared with Pavetta2. This is not completely unexpected as the inverters inject sinusoidal current into the network, leaving the network to supply all the harmonic current requirements of the load.

### 7.3.4 CUSTOMER LEVEL VOLTAGE IMPACTS AT TIMES OF HIGHEST PV GENERATED ELECTRICITY EXPORT TO THE NETWORK

Initial results show that reverse power flow into the high voltage (HV) network occurred regularly on clear days during the winter months. The voltage implications of reverse power flow can be seen in the following images.

Image 7-J shows the transformer load and voltage profiles on the day of maximum PV generated electricity export to the HV network from the Pavetta 1 circuit during winter.

The load profile is the total of all three phases and the voltage profile is the average of all three phases. Maximum PV generated electricity export was nearly 3kW and occurred around midday. Voltages at the LV transformer terminals remained well within the ± 6% planning criteria established in Western Power's Technical Rules. However, given that the voltage compliance limits apply to all customers at the point of connection, further evaluation of voltage profiles at the switchboard of individual premises was conducted using smart meters.

A sample of homes on each phase near the Pavetta1 transformer, as well as at the end of the low voltage (LV) network were used (image 7-K).

The results show that short term voltage excursions outside the + 6% limit occurred for at least one of the homes at the end of the LV network. The voltages at the customer level are within the appliance tolerance levels, and as such are not expected to cause any damage to appliances. This household connection-point view, as enabled by the smart meters, flags the need to potentially address voltage regulation issues on saturated solar PV networks.

From these preliminary results it is clear that a relatively simple adjustment on the distribution transformer tap to a lower level, could allow somewhat larger solar PV system penetration on this network while still maintaining voltages within limits for customers at the end of the LV network.

Image 7- I: Pavetta1 transformer voltage THD histogram and compliance

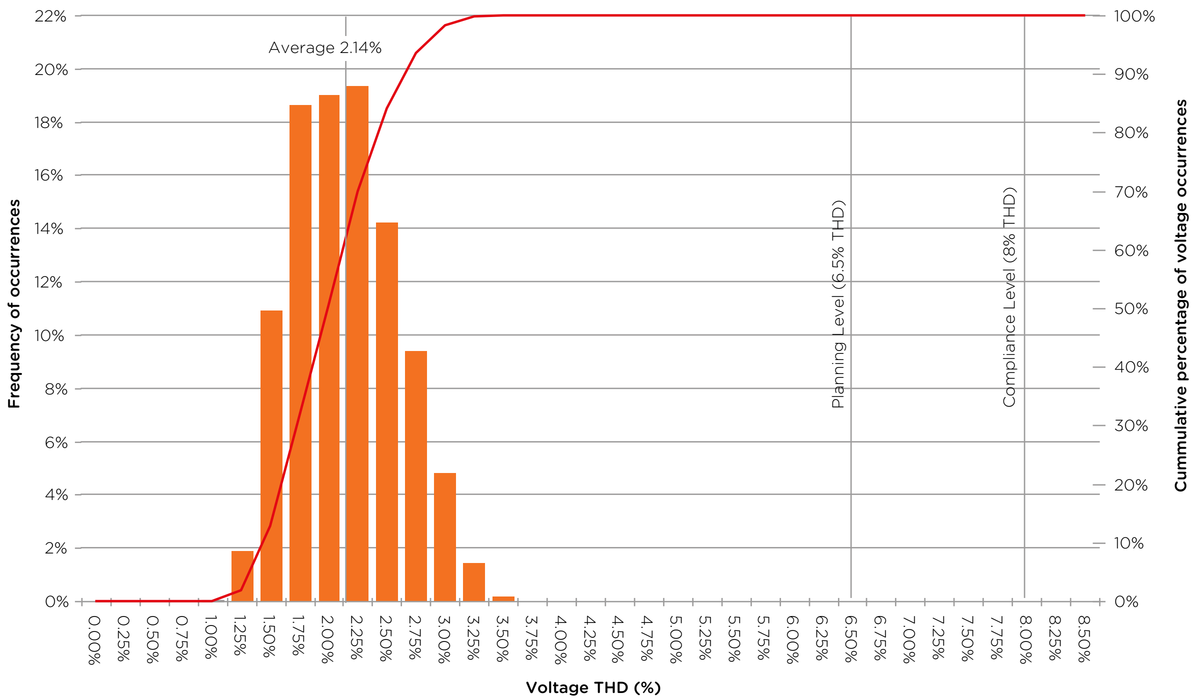



Image 7-J: Transformer LV voltage and power profiles on maximum winter export day

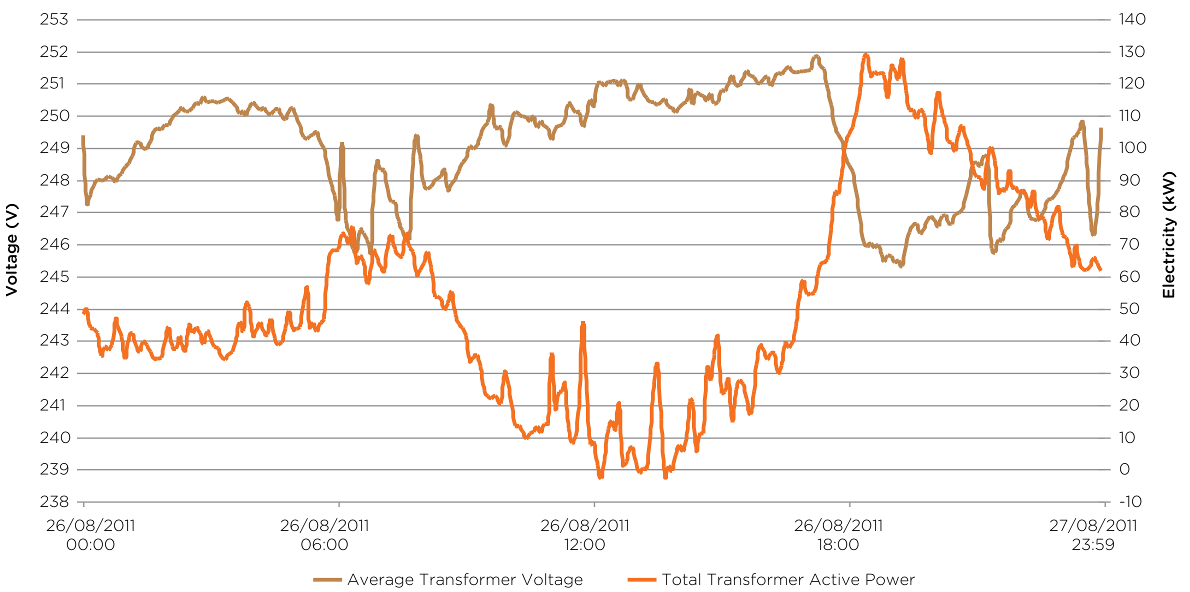
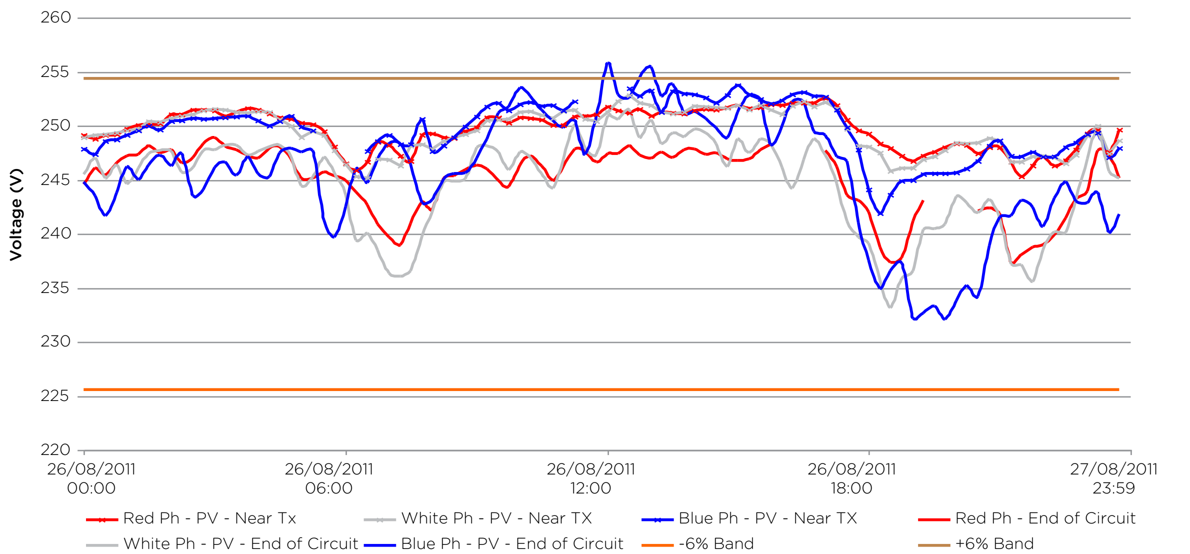



Image 7-K: Smart meter voltages at customer switchboard on maximum winter export day



## 7.4 TRANSFERABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Recruitment of Trial participants** | BENEFIT:<br>Significant discount offered on solar PV systems | OUTCOME:<br>The recruitment target was exceeded.<br><br>LESSON:<br>Householders respond well to the opportunity to participate in an incentivised and unique Trial. |
| **Capture of power quality data from smart meters** | BENEFIT:<br>Configuring UIQ to provide 15 minute interval power quality data | OUTCOME:<br>Power quality data suitable for analysis was retrieved using smart meters.<br><br>LESSON:<br>Western Power now has a solution that can be used by other parts of its business for network studies that require smart meter enabled power quality data. |
| **Solar PV Saturation Trial** | BARRIER:<br>Saturation of residential solar PV systems on low voltage networks | OUTCOME:<br>Voltage compliance is not always maintained at some individual meter points where PV saturation exists.<br><br>LESSON:<br>Voltage regulation issues on saturated PV networks may need to be addressed. |

## 7.5 FUTURE FOCUS

Two main research projects directly relating to the Perth Solar City PV Saturation Trial are underway in collaboration with Curtin University in Western Australia.

A model of the Pavetta 1 network was developed using Power Factory power systems simulation software. Preliminary evaluation using real data from the smart meters, the distribution transformer and the HV network showed good agreement between the model and the actual network monitoring data. This model is an important step as it can be used as the basis to evaluate solar PV sytem saturation in other LV networks within the South West Interconnected system (SWIS). Validated network models will be used to determine safe penetration levels and measures to enable higher distributed generation penetration before voltage regulation problems occur.

The effect of PQ issues on solar PV system performance will also be analysed during 2012.

# RESIDENTIAL SOLAR PHOTOVOLTAIC SYSTEMS

## 8.1 BACKGROUND

By installing solar photovoltaic (PV) systems, householders can generate their own electricity, and offset electricity consumption costs. This may include the export of surplus power to the local distribution network for which the householder is paid by the electricity retailer.

Perth receives an average of 7.9 sun hours per day[1] and as such has premium conditions for the generation of solar power. SunPower, with dealers located in the heart of the Perth Solar City region, is the premium brand in the solar PV system market place, and has the highest efficiency panel at 19% efficiency.

Perth Solar City is assisting households in Perth's Eastern Region to take full advantage of these factors by providing a minimum $1,260 discount on SunPower residential solar PV system.

The discount is made available via selected SunPower dealers in Perth's Eastern Region, and in addition to other rebates such as Renewable Energy Certificates (RECs) and the Western Australian residential net feed-in tariff (NFiT).

SunPower dealers receive Perth Solar City referrals from the Living Smart program, through enquiries to the Perth Solar City call centre, and directly from the public. The solar PV system discount is promoted through broad reach marketing as well as the installation of larger scale solar PV systems at iconic locations such as the Perth Zoo and Midland Foundry (installed by SunPower). 'Iconic' installations, (chapter 13.0), aim to engage and educate the public about the benefits of solar PV systems as a viable renewable energy technology.

SunPower has also been sponsors of other Perth Solar City initiatives such as the Sustainable Communities competition and the Eco House competition.

## 8.2 OBJECTIVES AND PROGRESS

SunPower's primary objective is to install a total of 825 residential solar PV system systems at a minimum size of 1.05kW per system.

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| Residential PV systems | 825 | 429 | 519 |

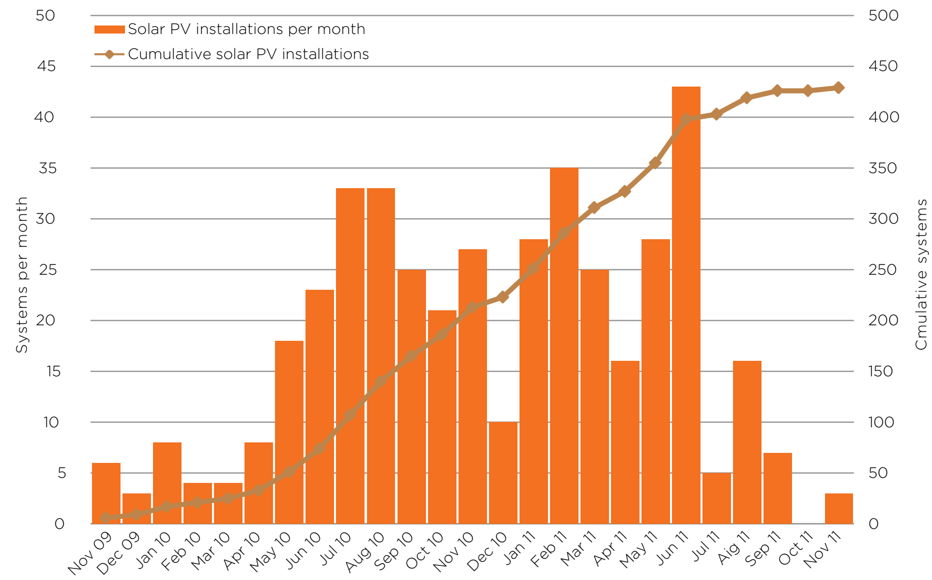
As at 30 November 2011, SunPower had achieved 83% of the residential PV target. Image 8-A shows the number of installations by month, and cumulatively.

Strong solar PV system sales occurred for the period January 2011 to June 2011, with a subsequent sharp decline in sales following 1 July 2011. This is concomitant with the reduction in RECs as well as the ending of NFiT.

1. Bureau of Meteorology. (2011). Climate statistics for Australian locations. Retrieved 13 December 2011, from http://www.bom.gov.au/

## PERTH RECEIVES AN AVERAGE OF 7.9 SUN HOURS PER DAY AND AS SUCH HAS PREMIUM CONDITIONS FOR THE GENERATION OF SOLAR POWER

Image 8-A: Perth Solar City residential solar PV system installations by month and cumulative



## 8.3 KEY RESULTS

Key results for residential solar PV systems will focus on:

- system installation trends
- average system size
- average cost to householders
- demographic trends
- income band of solar PV system purchasers
- electricity demand trends
- electricity demand of solar PV system and non-solar PV system households
- effect of solar PV system installation on participant electricity consumption

### 8.3.1 SYSTEM INSTALLATION TRENDS

**Average system size**

The total installed capacity of residential solar PV systems under Perth Solar City is 976kW, with an average size of 2.27kW.

**Average cost to householders**

The average cost per household for standard configuration SunPower solar PV systems is outlined in table 8-A. The average cost per Watt of installed capacity is $3.97.

Table 8-A: Average cost by PV system size and per watt

| | |
|---|---|
| Average cost - 1.5kW system | $4,969.48 |
| Average cost - 2.1kW system | $9,836.50 |
| Average cost – 2.4kW system | $11,714.00 |
| Average cost per Watt capacity | $3.97 |

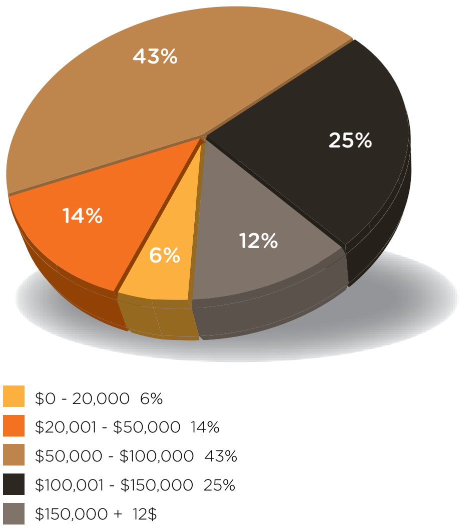
### 8.3.2 DEMOGRAPHIC TRENDS

Table 8-B and image 8-B show the household income band for Perth Solar City residential PV system purchasers. While the majority of households (53%) preferred not to provide income information, the most prominent income band was $50,001 to $100,000 for the 199 households that did.

Table 8-A: Household income bands of PV purchasers

| Income band | Number | Percentage of total |
|---|---|---|
| $0-20,000 | 11 | 3% |
| $20,001-$50,000 | 28 | 7% |
| $50,001-$100,000 | 88 | 21% |
| $100,001-$150,000 | 49 | 12% |
| $150,000+ | 23 | 5% |
| Unknown | 221 | 53% |
| **TOTAL** | **420** | |

Image 8-B: Known income bands



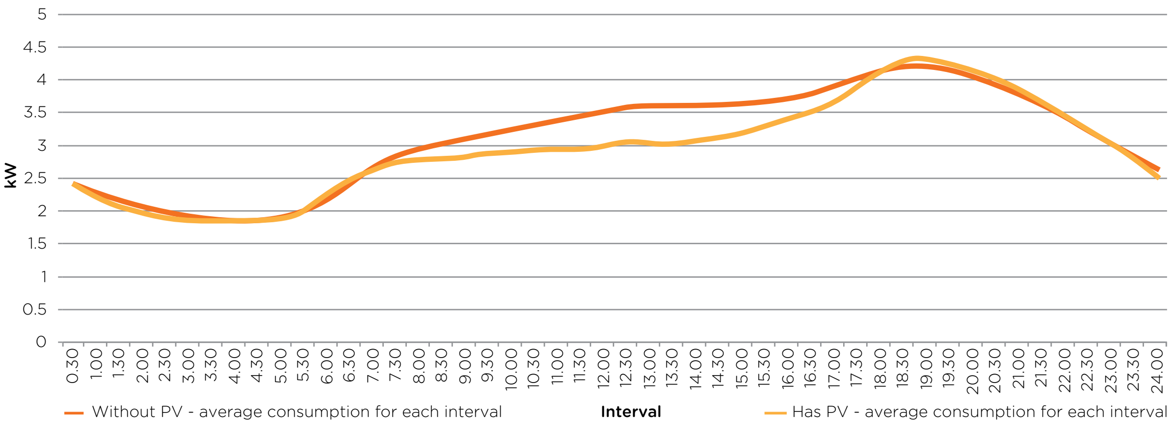

### 8.3.3 ENERGY DEMAND TRENDS

Electricity demand of solar PV system and non-solar PV system households

Analysis was undertaken using data from 6,064 smart meter households: 348 with a solar PV system and 5,716 households without a solar PV system. Image 8-C shows the differences in electricity demand between the two groups.

As expected, analysis indicates that for the majority of half-hour intervals where the solar PV system is generating electricity, the average interval demand is significantly less than that of customers without solar PV system generation. However, customers with solar PV system generation have slightly higher electricity demand (4.3kW) at peak times (17:30 – 20:30) than customers without (4.2kW).

**Image 8-C: Average electricity demand for solar PV system and non-PV households**




**Effect on electricity consumption – preliminary analysis**

The Program engaged Data Analysis Australia (DAA) to provide preliminary results on the effect of the installation of solar PV systems on electricity consumption (image 8-D). The analytic methodology developed and used by DAA is attached as Appendix E.

Analysis was completed for 360 households with a SunPower system installed for a minimum of 12 months. The results are significant, with an average electricity reduction of 57.9%, or 11.36kWh per day (image 8-E).

Analysis included excess generated electricity that is fed into the grid (i.e. electricity that is produced by the solar PV system system but not used by the household).

**Image 8-D: Residential PV – Effect on electricity consumption**

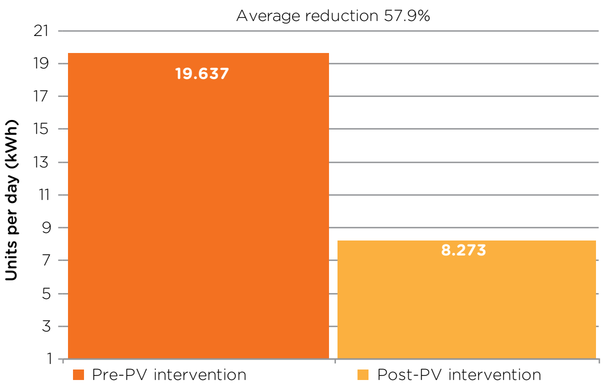



Table 8-C shows the average annual cost and greenhouse gas emission savings for the 360 participant households.

Note: due to differing rates of purchase, calculations do not include any payment received by the household for electricity that is generated and fed into the electricity grid.

**Table 8-C: Average annual cost and greenhouse gas emission savings for solar PV system households**

| Customer group | Electricity cost savings per household ($/year)* | Greenhouse Gas savings (kg CO-e/ year)^ |
|---|---|---|
| Solar PV system | $907.14 | 3,857.5 |

* Calculation based on unit cost of $0.2187 per kWh
^ based on emission co-efficient of 0.93kg/CO2-e per kWh
– National Greenhouse Account Factors July 2011

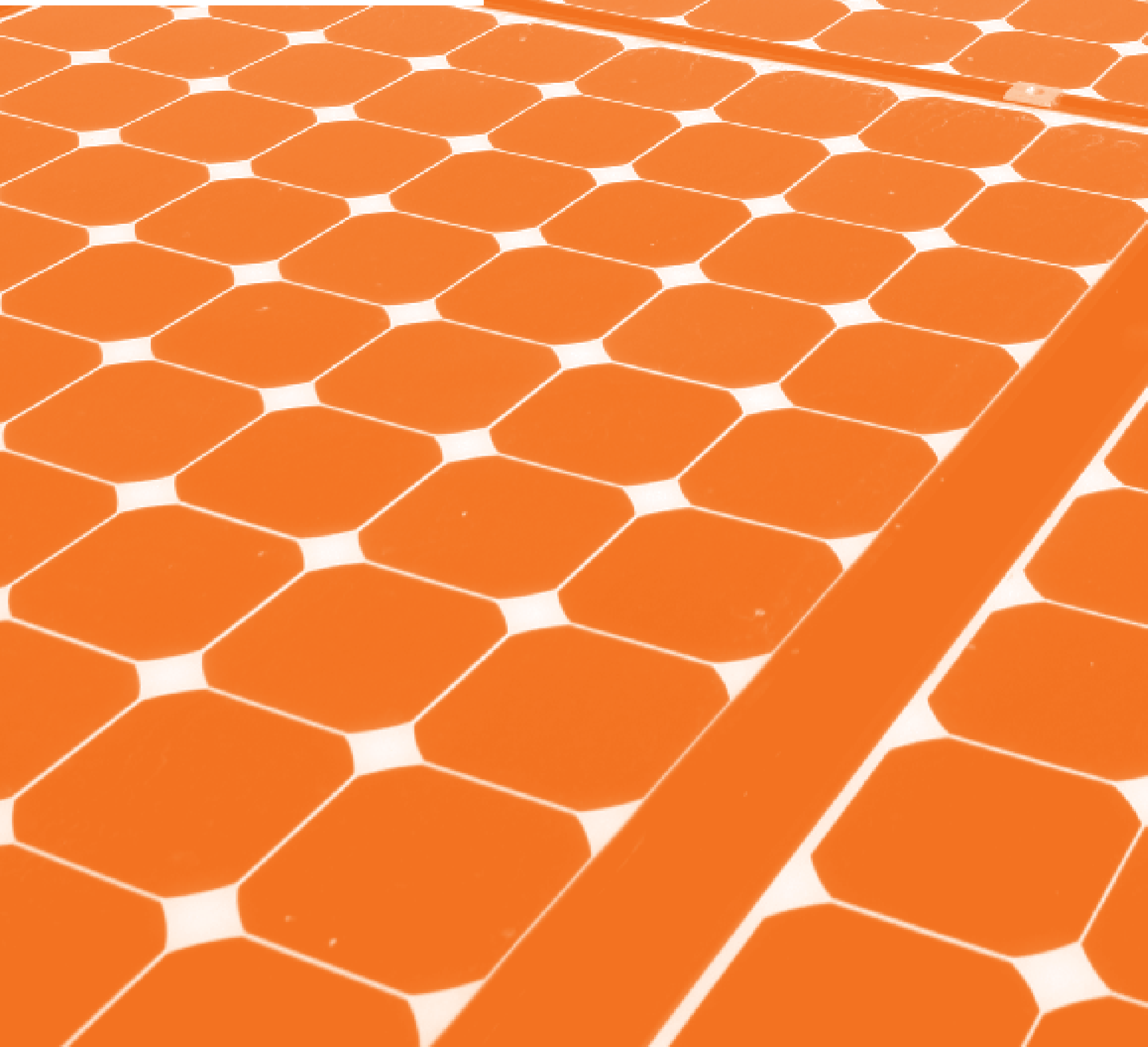
## 8.4 TRANSFERABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Financial incentives for solar PV systems** | BENEFIT:<br>Federal (RECs) and State Government (NFiT) rebates and incentives | OUTCOME:<br>Increased solar PV system sales.<br>However, uncertainty over the continuation and/or reduction or cessation of financial incentives resulted in significant spikes and drops in demand.<br>LESSON:<br>Long term certainty is required with respect to solar PV system rebates and incentives. |
| **WA net feed-in tariff** | BARRIER:<br>Through net feed-in tariffs, solar PV system households are receiving greater incentive to feed electricity into the grid, as opposed to using it directly to offset consumption. | OUTCOME:<br>Solar PV system households are deferring electricity consumption to periods where PV generation is minimal (generally late afternoons/ early evening). This has the potential to increase demand at a time when the network is experiencing peak demand.<br>LESSON:<br>Net feed-in tariffs may have adverse network effects. Alternative incentive models should be investigated. |
| **Premium brand** | BARRIER:<br>High cost of premium SunPower brand in competition with other brands in target area. | OUTCOME:<br>Conversion rate of customer enquiries is relatively low, particularly after reductions in incentives and rebates.<br>Potential participants are purchasing lower cost non-Perth Solar City systems.<br>LESSON:<br>Informational barriers regarding the benefits of purchasing a premium brand are required to be overcome. |
| **Premium brand** | BENEFIT:<br>A premium brand offers high quality workmanship, longer warranties and professional customer service. | OUTCOME:<br>Customer satisfaction is high.<br>LESSON:<br>Whilst utilising a premium solar PV system brand does have barriers, high customer satisfaction and quality service provide good outcomes for energy efficiency programs. |

## 8.5 FUTURE FOCUS

Perth Solar City and SunPower will continue to work towards the target of installing 825 residential solar PV systems. Re-engagement of the target community will include direct marketing and incrementally increased incentives.

Continued data analysis will include further understanding of the impact of the aggregated effect of residential PV systems on peak electricity demand, as well as further segmentation of demographic groups.



# 9.0 RESIDENTIAL SOLAR HOT WATER SYSTEMS

## 9.1 BACKGROUND

Heating water represents 25% of an average Perth household's energy costs [1]. Solar hot water systems are proven to be more cost-effective than most other storage and instantaneous systems for heating water. This is particularly the case in the Perth metropolitan area which receives an average of 7.9 sun hours per day [2].

The Perth Solar City program and Solahart provide a $1,100 discount (inc. GST) on family-sized Solahart solar hot water systems to residents in Perth's Eastern Region. Solahart are a Western Australian based company which manufactures solar hot water systems in Perth.

The Perth Solar City discount is made available via selected Solahart dealers in Perth's Eastern Region, and is offered for both gas and electric boosted solar hot water systems. The discount is provided in addition to other state and federal government rebates.

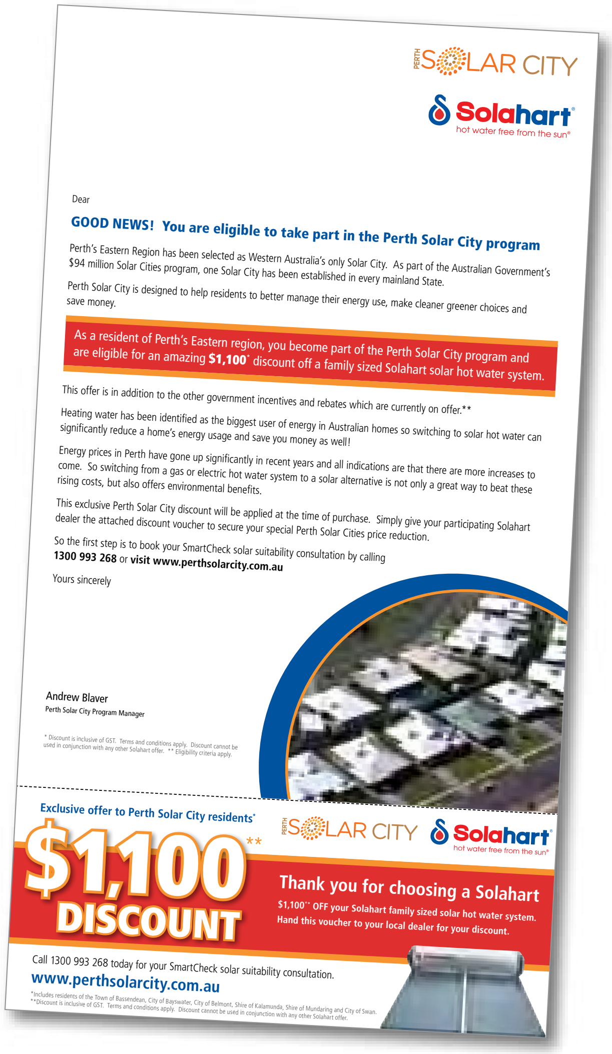
Solahart dealers receive Perth Solar City referrals from the Living Smart program, enquiries through the Perth Solar City call centre, and directly from the public. Methods used to promote the solar hot water discount includes broad reach marketing, demonstration projects such as the Eco House, as well as from direct marketing (image 9-A) to eligible households.

Solahart has also provided sponsorship of Perth Solar City initiatives such as the Sustainable Communities Competition and the Eco House competition.

[1] Australian Government. (2010). Technical Manual - Design for lifestyle and the future. Retrieved from http://www.yourhome.gov.au/technical/fs61.html

[2] Bureau of Meteorology. (2011). Climate statistics for Australian locations. Retrieved 13 December 2011, from http://www.bom.gov.au/

Image 9-A: Solahart direct marketing letter



PERTH SOLAR CITY

Solahart
hot water free from the sun®

Dear

**GOOD NEWS! You are eligible to take part in the Perth Solar City program**

Perth's Eastern Region has been selected as Western Australia's only Solar City. As part of the Australian Government's $94 million Solar Cities program, one Solar City has been established in every mainland State.

Perth Solar City is designed to help residents to better manage their energy use, make cleaner greener choices and save money.

As a resident of Perth's Eastern region, you become part of the Perth Solar City program and are eligible for an amazing **$1,100*** discount off a family sized Solahart solar hot water system.

This offer is in addition to the other government incentives and rebates which are currently on offer.**

Heating water has been identified as the biggest user of energy in Australian homes so switching to solar hot water can significantly reduce a home's energy usage and save you money as well!

Energy prices in Perth have gone up significantly in recent years and all indications are that there are more increases to come. So switching from a gas or electric hot water system to a solar alternative is not only a great way to beat these rising costs, but also offers environmental benefits.

This exclusive Perth Solar City discount will be applied at the time of purchase. Simply give your participating Solahart dealer the attached discount voucher to secure your special Perth Solar Cities price reduction.

So the first step is to book your SmartCheck solar suitability consultation by calling **1300 993 268** or **visit www.perthsolarcity.com.au**

Yours sincerely

Andrew Blaver
Perth Solar City Program Manager

* Discount is inclusive of GST. Terms and conditions apply. Discount cannot be used in conjunction with any other Solahart offer. ** Eligibility criteria apply.

Exclusive offer to Perth Solar City residents*

PERTH SOLAR CITY Solahart hot water free from the sun®

**$1,100** DISCOUNT**

**Thank you for choosing a Solahart**

$1,100** OFF your Solahart family sized solar hot water system.
Hand this voucher to your local dealer for your discount.

Call 1300 993 268 today for your SmartCheck solar suitability consultation.

www.perthsolarcity.com.au

*Includes residents of the Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan.
**Discount is inclusive of GST. Terms and conditions apply. Discount cannot be used in conjunction with any other Solahart offer.

## 9.2 OBJECTIVES AND PROGRESS

Solahart's main objective is to utilise the Perth Solar City discount to sell and install 1,200 family-sized solar hot water systems on households in the Perth Solar City target area.

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| Residential Solar Hot Water systems | 1,200 | 610 | 684 |

As at 30 November 2011, Solahart had achieved 89% of their target.

## 9.3 KEY RESULTS

Key results for residential solar hot water systems will focus on:

- system installation trends
  - type of system installed
  - average cost to the householder
  - type of system being replaced
- demographic trends
  - income band of solar hot water purchasers
  - access to reticulated gas supply
- energy consumption trends
  - effect of solar hot water system installation (electric storage and electric instantaneous replacements) on energy consumption of all participants

**HEATING WATER REPRESENTS 25% OF AN AVERAGE PERTH HOUSEHOLD'S ENERGY COSTS**

## 9.3.1 SYSTEM INSTALLATION TRENDS

### Type of system installed

The following tables show the type of solar hot water system purchased by participants in the program to date (table 9-A), and the average cost of each system type (table 9-B). The vast majority of households (98%) have purchased an electric boosted solar hot water system.

**Table 9-A: Type of solar hot water system**

| Type of system | Number | Percentage |
|---|---|---|
| Electric boosted solar | 599 | 98% |
| Gas boosted solar | 11 | 2% |
| **Total** | **610** | |

### Average cost to household

**Table 9-B: Average cost to household**

| | |
|---|---|
| Average cost – electric boosted solar | $3,557.50 |
| Average cost – gas boosted solar | $4,614.91 |

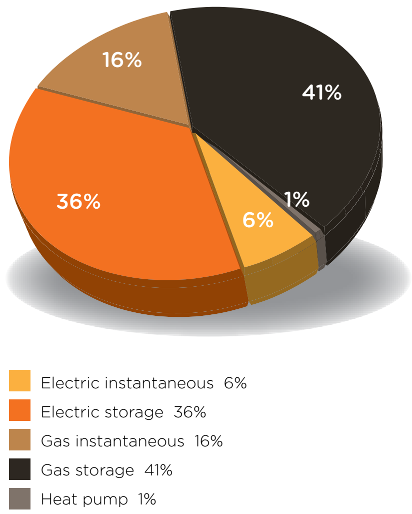
### System replacements

Gas storage and electric storage hot water systems are the most common types being replaced (table 9-C). Of the 495 systems that were installed to replace an existing hot water system (115 for new dwellings), 36% were replacing electric storage systems (image 9-B).

**Table 9-C: Solar hot water system installations by system replacing**

| System replacing | Number | Percentage |
|---|---|---|
| Electric Instantaneous | 30 | 5% |
| Electric storage | 180 | 30% |
| Gas instantaneous | 77 | 13% |
| Gas storage | 204 | 33% |
| Heat pump | 4 | 1% |
| Unknown or new home | 115 | 19% |
| **Total** | **610** | |

**Image 9-B: Solar hot water system replacement of existing hot water system by type**



### 9.3.2 DEMOGRAPHIC TRENDS

**Solar hot water system purchases by income band**

Demographic data extracted from the Program database for 610 participants (table 9-D), show that a total of 48% disclosed their annual household income level. Of the known income bands, the most common was $50,001 - $100,000 annual household income (image 9-C).

**Access to reticulated gas**

43% of participant households are not connected to reticulated gas or are connected to bottled gas (table 9-E and image 9-D).

**Table 9-D: Household income bands for solar hot water participants**

| Income band | Number | Percentage |
|---|---|---|
| $0-$20,000 | 20 | 3% |
| $20,001-$50,000 | 58 | 10% |
| $50,001-$100,000 | 110 | 18% |
| $100,001-$150,000 | 69 | 11% |
| $150,001+ | 36 | 6% |
| Unknown | 317 | 52% |
| **TOTAL** | **610** | |

**Table 9-E: Access to reticulated gas for solar hot water system households**

| Gas type | Count | Percentage |
|---|---|---|
| Bottled gas | 126 | 21% |
| Gas connection - unspecified | 32 | 5% |
| No connection | 133 | 22% |
| Reticulated gas | 313 | 51% |
| Unknown | 6 | 1% |

**Image 9-C: Known income bands**

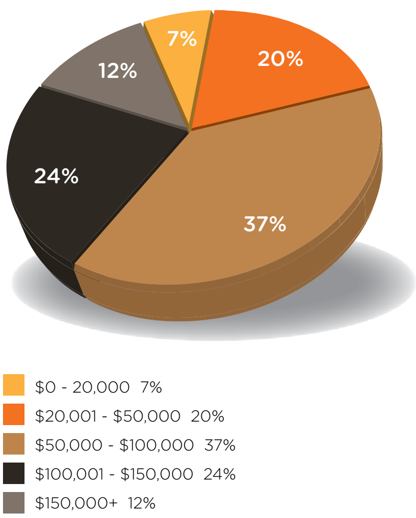
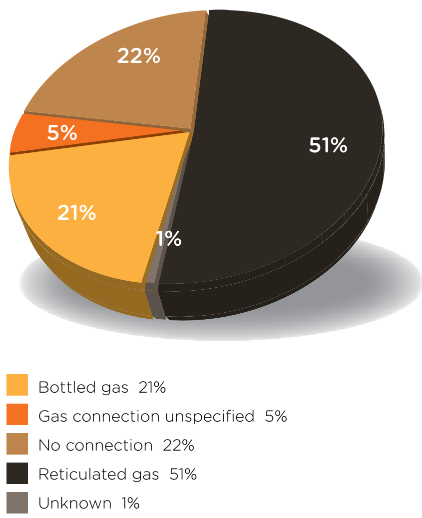



**Image 9-D: Access to reticulated gas for solar hot water system households**



### 9.3.3 ENERGY CONSUMPTION TRENDS

**Effect on electricity consumption – preliminary results**

Perth Solar City commissioned Data Analysis Australia (DAA) to provide preliminary results on the effect of the installation of solar hot water systems on electricity consumption. The analytic methodology developed and used by DAA is attached in Appendix E.

Analysis was completed for 175 participant households who had replaced an electric storage or electric instantaneous hot water system with an electric-boosted solar hot water system during the period 7 January 2010 to 30 June 2011. An average 15% reduction in electricity use is evident (image 9-E).

Image 9-E: Residential solar hot water – effect on electricity consumption

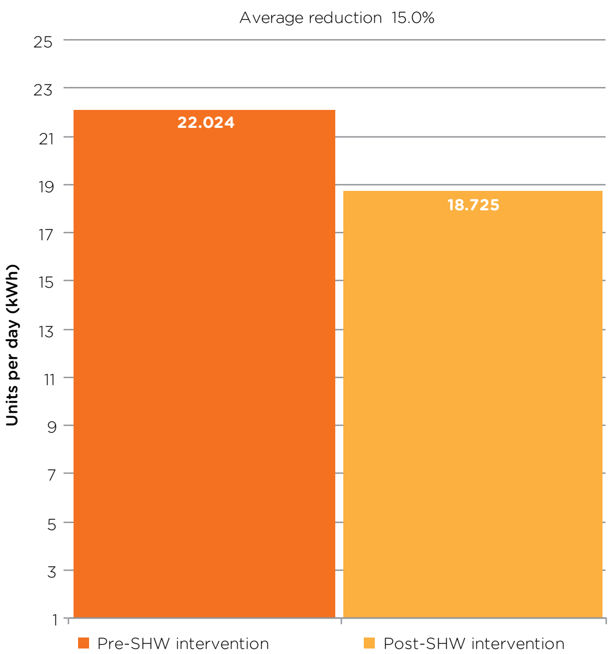



Table 9-F shows the average annual cost and greenhouse gas emission savings for the 175 participant households.

Table 9-F: Average annual cost and greenhouse gas emission savings for solar hot water households (electric to solar-electric conversion)

| Customer Group | Electricity cost savings per household ($/year)* | Greenhouse Gas savings (kg CO-e/ year)^ |
|---|---|---|
| Solar Hot Water | $263.34 | 1,120 |

* Calculation based on unit cost of $0.2187 per kWh
^ based on emission co-efficient of 0.93kg/CO2-e per kWh – National Greenhouse Account Factors July 2011

**$263.34 ELECTRICITY COST SAVINGS PER HOUSEHOLD ($/YEAR)**

## 9.4 TRANSFERRABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Installation by booster type** | BARRIER:<br>43% of households either have no access to reticulated gas or bottled gas only<br><br>Gas boosted solar hot water systems (average cost $4,614.91) are more expensive than electric boosted (average cost $3,557.50) | OUTCOME:<br>98% of solar hot water system purchases were for electric boosted solar hot water systems.<br><br>LESSON:<br>Equal value rebates for both electric and gas solar hot water systems encourage purchase of the lower-cost option. |
| **Competition with solar PV systems** | BARRIER:<br>Solar PV systems have greater incentives in the market place (state government feed-in tariff and federal government RECS multiplier) | OUTCOME:<br>Households tend to make a single major investment in solar technology, and are selecting solar PV due to perceived greater benefit.<br><br>LESSON:<br>Informational barriers as to the relative benefits of solar hot water must be overcome to achieve greater market penetration. |
| **System replacement** | BARRIER:<br>Perceived high cost of solar hot water systems combined with sunk cost of existing hot water system. | OUTCOME:<br>The Living Smart program has shown that households are waiting until their existing hot water system breaks down before replacing with solar.<br><br>LESSON:<br>Information barriers on the benefits of changing to solar are still required to be overcome. |

## 9.5 FUTURE FOCUS

Perth Solar City and Solahart will continue to work towards achieving the target of 1,200 residential solar hot water systems installed.

Re-engagement of the target community will include direct marketing (including directly to electric storage system owners) and incrementally increased incentives.

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# 10.0 MARKETING

## 10.1 OVERVIEW OF ACTIVITY

To support the Perth Solar City program, a marketing strategy was developed, utilising community-based social marketing concepts. This strategy was designed to create a shift in community energy perceptions, beliefs and attitudes and assist in enabling behaviour change.

Community-based social marketing (CBSM) draws heavily on research in social psychology which indicates that initiatives to promote behaviour change are often most effective when they are carried out at the community level and involve direct contact with people. Programs which rely heavily or exclusively on media advertising can be effective in creating public awareness and understanding of issues related to sustainability, but are limited in their ability to foster behaviour change.

The objectives of the Perth Solar City marketing strategy is to:

- create awareness of the Perth Solar City program
- promote Solar Cities as an Australian Government initiative and provide due recognition for it's leadership and funding of the program
- showcase iconic and demonstration solar PV installations
- build general knowledge of the products and services being offered under the program (without elevating one product/service or Consortium member above another), and
- create excitement about its benefits to households and the community to encourage participation

The Perth Solar City Program Office is responsible for the delivery of the marketing strategy, on behalf of the Consortium.

To assist in the delivery of the marketing strategy, the Perth Solar City campaign 'Collective Impact' was established by the Program Office.

To inform the development of the Collective Impact campaign, extensive community engagement and testing was undertaken to understand the community's understanding of energy, their energy behaviours and their values.  This research provided great insights into the needs and sentiments of the targeted community and greatly influenced the campaign design and development. Community feedback included "I want to do more, I just don't know what to do", "I want to know my actions mean something" and "there is so much information out there – where do I start"?

In addition Perth Solar City was able to identify three clear community motivators to act; to save money, to save the environment, and to feel like their actions mean something – that they are part of something greater.

### 10.1.1 COLLECTIVE IMPACT

Collective Impact, shows residents of Perth's Eastern region that their individual actions, however small, are part of something greater – a collective impact. It positions Perth Solar City as the educator and enabler on their energy efficiency journey.

#### Creative

In line with CBSM best practice, localised, personal visual media was used to best tell the story of Collective Impact and assist in empowering the community.  Local photographs, a locally shot cinema advertisement and local artwork were created for the campaign.

Photographs of local residential streets, featuring local community members were produced to provide the creative for the Collective Impact campaign (image 10-A and 10-B).  Community members who took part in the shoots included local residents, local community groups, Mayors and Councillors from across the Perth Solar City region and local small business owners.

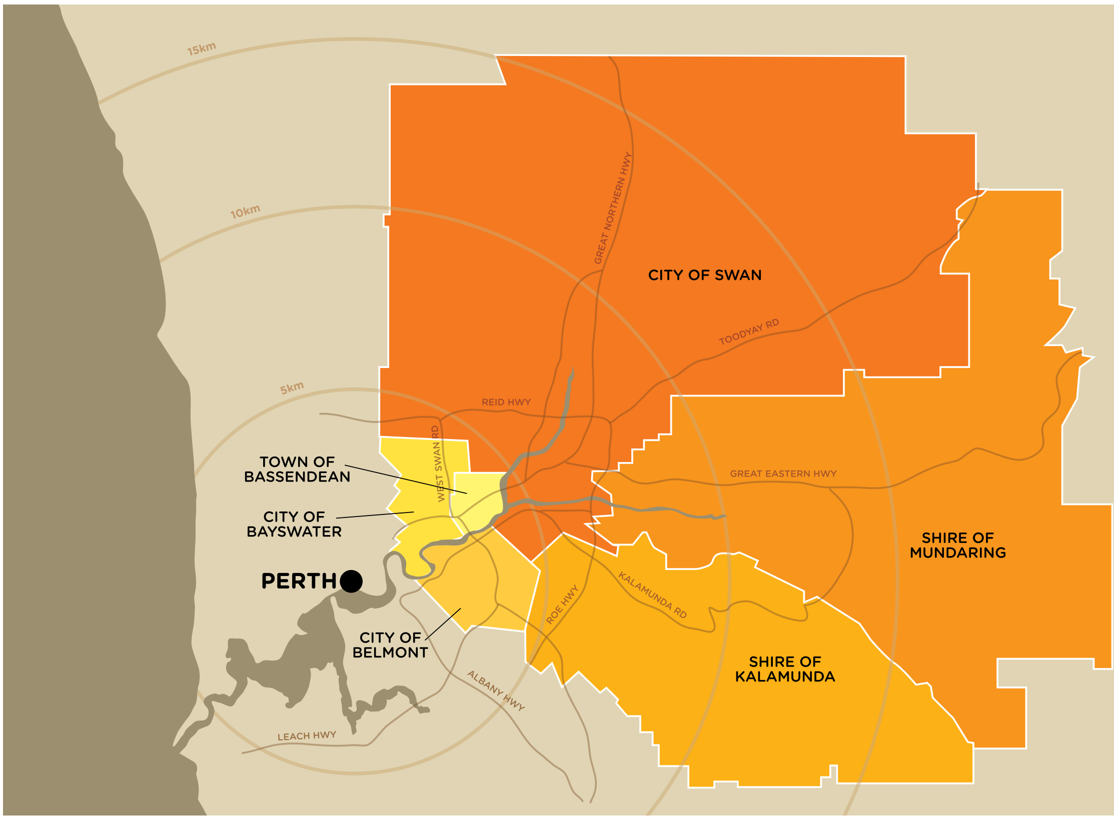
The use of these locally identifiable people and locations enhanced the community feel and ownership of the campaign, further fostering public awareness to encourage behaviour change.

Image 10-A: Residents of First Avenue, Bassendean participate in the Collective Impact photo shoot

## PERTH SOLAR CITY IDENTIFIED THREE CLEAR COMMUNITY MOTIVATIORS TO ACT; TO SAVE MONEY, TO SAVE THE ENVIRONMENT, AND TO FEEL LIKE THEIR ACTIONS MEAN SOMETHING – THAT THEY ARE PART OF SOMETHING GREATER

Image 10-B: Local Kalamunda equestrian groups and FESA teams participate in the Collective Impact photo shoot

Image 10-C: Perth's Eastern Region




The Perth Solar City program is exclusively available to approximately 120,000 households within Perth's Eastern Region (approximately 17% of Perth's population). The Region encompasses 2,100 square kilometres or around one-third of the Perth metropolitan area (image 10-C).

Engaging this relatively small, targeted section of Perth's population over a large geographical area required the use of local cinema, local newspaper and outdoor communications channels to best deliver the Collective Impact message to the right audience.

Cinema advertising, rather than television media was chosen as it enabled residents within the Region to be targeted without wasting resources engaging with wider Perth and therefore ineligible households.

The Collective Impact cinema advertisement (cini-ad) encourages residents to be part of the 'collective impact' and join Perth Solar City. This cini-ad features the voice of Perth's own Melissa George (award winning actress) and a typical home within Guildford (a suburb within Perth's Eastern Region).

Art installations were erected within the region to further highlight the collective impact undertaken by the community (image 10-D). These installations featured a 'tree' (artwork) attached to a street light in high foot-traffic areas, such as outside public libraries and recreational centres. The installations include a plaque stating "If your household took part in the Perth Solar City energy saving project and turned off your stand-by power, it would be the equivalent of planting 5 trees every year. So let's all take action and make a collective impact".

Image 10-D Andrew Blaver with City of Belmont Mayor Glenys Godfrey

# FEEDBACK FROM THE COMMUNITY AND LOCAL COUNCILS REGARDING COLLECTIVE IMPACT HAS BEEN POSITIVE, INCLUDING COMMENTS SUCH AS "IT MAKES US FEEL A PART OF SOMETHING THAT IS SPECIAL, JUST FOR US".

**Delivery**

The Collective Impact campaign was delivered in two phases to engage the community from February 2010 to August 2011; Phase I: raising awareness and Phase II: direct engagement.

**Phase I**

Phase I was delivered from February 2010 to August 2010 and was designed to introduce the Perth Solar City brand to the community, and to develop the role of a trusted educator. The Phase I campaign featured key messages Perth Solar City, its Consortium and energy efficiency concepts (table 10-A and image 10-E). The Phase I campaign also included a community artwork display (image 10-D).

Table 10-A: Collective Impact Phase I campaign breakdown

| Media description | Quantity |
|---|---|
| Newspaper advertisements | 55 |
| Cinema advertising | 460 |

Image 10-E: Phase I Collective Impact local newspaper advertising

### Phase II

Phase II was delivered from February 2011 to August 2011 and was designed to leverage the brand strength and community awareness established in Phase I to engage community members at a grassroots level. While Phase I worked at a strategic level to create a credible brand, Phase II was designed to 'take it to the community'.

A number of communications channels were utilised during Phase II (table 10-B and images 10-F to H).

**Table 10-B: Collective Impact Phase II campaign breakdown**

| Media description | Quantity |
|---|---|
| Newspaper advertisements | 180 |
| Cinema advertising | 136 |
| Billboards (high traffic local roads) | 15 |
| Adshels (bus stops and train station) | 125 |
| Festival attendance – smart cars | 6 |

Campaign executions promoted Perth Solar City commercial products and services and featured both financial and environmental motivators, such as "Turn off your second fridge, you can save $200 a year.  We can all save our environment." These executions were developed to normalise behaviours within the community, and make energy efficiency an attractive proposition.

**Image 10-G: Phase II Collective Impact bus shelter**


**Image 10-F: Phase II Collective Impact billboard**

Image 10-H: Phase II Collective Impact local newspaper advertising


## 10.1.2 DIRECT MAIL

To maintain momentum between the delivery of Phase I and II, a number of direct mail campaigns were delivered by the Program Office, on behalf of the commercial Consortium members. These campaigns promoted the Perth Solar City commercial product and service offerings of a free home eco-consultation, discounted solar PV and solar hot water systems. Segmentation was conducted for each of the campaigns to ensure that the households targeted was not on the National Do Not Call Register, had not previously participated in the program, had not previously requested a specific product referral were eligible for the specific product (for example, all multi-story dwellings were excluded from the solar PV and solar hot water system direct mail campaigns due to inability to install).

The direct mail campaigns featured sign up incentives to encourage participation, for example "Book a home eco-consultation during June and go into the draw to win one of three $200 Bunnings voucher" and a time limit to create urgency (image 10-I). Unique code words were used on each of direct mail activity to allow each individual campaign to be tracked and evaluated for impact and value.

Image 10-I: Home Eco Consultation direct mail artwork

### 10.1.3 ECO HOUSE

Aimed at educating the community, the Eco House is a showcase for sustainable living and features each Perth Solar City product and service. The Eco House demonstrates how residents can reduce their energy costs while reducing carbon emissions.

The Eco House project launched in January 2011 as a competition, encouraging residents to nominate their home to receive a $50,000 home eco-makeover, and participate in a 12 month energy efficiency education program. In return the winning household would open their home four times over 12 months to educate the community about the practicalities of energy efficiency.

Ideally, the Perth Solar City program was looking for a typical energy inefficient Perth home, to showcase to the community a range of energy efficiency actions from simple behaviour changes, to generating their own energy.

Image 10-J: Perth Solar City's Rebecca Hargrave with the Roberts family

Image 10-K: Eco House open day 11 September 2011

Perth Solar City received over 400 entries to the competition. The winning household was announced live on ABC 720 radio on 7 May 2011. They are David and Deborah Roberts and their daughters Hannah and Gemma from High Wycombe (image 10-J).

Five finalists won a fully installed solar hot water system from Solahart.

The Roberts' average electricity consumption is 35 units per day (the Perth average is 18 units), and up to 76 units on some days. The Roberts' home is quite typical of Perth home design with a large, black roof, no eaves and insufficient window coverings. The house was conducting large amounts of heat during the summer, and losing warmth during the winter. In addition, the Roberts had 45 halogen lights in high traffic areas (for example in the kitchen) drawing 50W of electricity each – 2.25kW in total. Given these factors, the Roberts were using large amounts of electricity overheating, overcooling and lighting their home.

The home eco-makeover commenced in June 2011 and focused on shading and insulation to better protect their home from the heat of the sun. The Perth Solar City Consortium provided a 2.38kW solar PV system, a solar hot water system, a fully installed smart meter and in-home display, one-on-one energy coaching, native plants and mulch for the eco-makeover. Also included was a lighting retrofit, roof insulation, roof ventilation, curtains, box pelmets and a rainwater tank.

The first open day was held on Sunday 11 September 2011 – National Sustainable Open House day (image 10-K). Over 520 adults attended the open day between 10am and 4pm and provided very positive feedback regarding the information provided.

The second open day was held on Sunday 11 December 2011. The event was themed 'Prepare your home for summer' and featured two free Living Smart workshops. Over 150 adults attended the open day from 10am and 2pm, with over 90% of visitors from within Perth's Eastern Region. Community members were highly engaged and at least 20 visitors stayed over two hours. The reduction in visitor numbers as compared to the first open day made for more meaningful engagement between the Perth Solar City and the community.

Additional open days will be held in March and June 2012.

### 10.1.4 ONLINE MARKETING AND COMMUNICATIONS

Online marketing and communications is interactive and provides instant information to a broad audience, at low cost. The Perth Solar City website was launched in December 2009 to create a link between the Collective Impact campaign, and the Perth Solar City program. All Collective Impact material directs the customer to the website for more information.

**THE PERTH SOLAR CITY WEBSITE HAS RECEIVED OVER 106,000 UNIQUE VISITORS SINCE ITS LAUNCH, WITH 356,000 PAGE VIEWS. VISITORS ARE VIEWING ON AVERAGE 3.5 PAGES PER VISIT WITH AVERAGE VIEWING TIMES OF 1:37 MINUTES**

Given the importance of online marketing in our heavily networked society, a Perth Solar City Facebook page was also created. The Facebook site has been used to communicate special offers to customers and advertise local events. In turn, customers can post comments regarding their experience with Perth Solar City, including images of their solar PV installations. Given its viral nature, Facebook has been valuable tool for the Program with its ability to reach large networks of people at no cost.

Community members are encouraged to sign up for Perth Solar City's e-newsletter to receive regular communications from the Program. Currently over 1,500 customers are subscribed and receive information quarterly.

### 10.1.5 MEDIA AND EVENTS

Media interest in Perth Solar City has been consistent, with particularly strong support from local newspapers within Perth's Eastern Region.

Regular editorial articles have been run across the six local newspapers, showing support for the Program and highlighting milestones and events.

Channel 7's Today Tonight program presented a story on the benefits of powermates – a device that

Image 10-M: Senator Penny Wong with Perth Solar City, Living Smart and Western Power

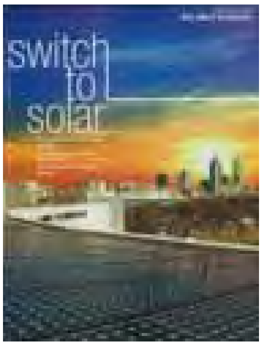



Image 10-L: Switch to Solar liftout

shows the electricity consumption of individual appliances – which are freely available to residents through local libraries as part of Perth Solar City.

ABC 720 Perth has shown significant interest in the Eco House and has invited the Perth Solar City Program Manager to appear regularly on its Saturday morning gardening and lifestyle program.

In May 2011 The West Australian won a prestigious award for their Switch to Solar liftout, of which Perth Solar City was a key contributor. The annual Pacific Areas Newspaper Publisher's Association (PANPA) awards recognise outstanding achievement in every part of the publishing industry. The Program featured significantly in the Switch to Solar liftout, which was published in November 2010 and focused on renewable energy and energy efficiency. The West Australian also elected to use an image of the Program's Central Institute of Technology iconic PV installation for the front cover (image 10-L).

A number of well attended events have been held to support the Program's engagement objectives and to highlight achievements to stakeholders. Key events included the launch of the Living Smart program with Senator Penny Wong (image 10-M), the launch of Western Power's smart grid trial with the Hon Peter Collier, WA State Minister for Energy, the Sustainable Communities Competition with the Hon Donna Faragher, former State Minister for Environment, the Department of Climate Change and Energy Efficiency's Catalyst for Change launch with Mark Dreyfus, Parliamentary Secretary for Climate Change and Energy Efficiency and iconic project launches.

## 10.2 KEY RESULTS

Key performance indicators were established as awareness of the Perth Solar City program (50%) and customer satisfaction (75%).

### Collective Impact

Market based evaluation of the Perth Solar City program and Collective Impact campaign was conducted in August 2010 and 2011, via a telephone based customer survey (2010 n=448; 2011 n=401). The objective of the research was to measure community awareness of the Perth Solar City program and its project elements. The survey also measured the customer satisfaction of those residents who have participated in the program and identified barriers to those who have not participated to date.

### Table 10-C: Customer survey results

| Measurement | 2011 | 2010 |
|---|---|---|
| Program awareness – level of awareness when prompted | 41% | 51% |
| Program recognition – level of awareness of the Program name | 73% | 49% |
| Program satisfaction – level of customer satisfaction | 81% | 80% |
| Information source – how did customers hear about the Program | | |
| • Internet | 33% | 7% |
| • Local newspapers | 20% | 20% |
| • Direct mail | 2% | 54% |
| Motivators – what motivates customers to act | | |
| • To save money | 68% | 63% |
| • To help the environment | 36% | 42% |
| Barriers – what inhibits customers to act | | |
| • Costs too much money | 44% | 52% |
| • Already energy efficient | 13% | 24% |
| Energy efficiency actions – level of community implementation | | |
| • Dry your clothes on the line, not the dryer* | 97% | - |
| • Switch to energy efficient lighting | 90% | 87% |
| • Wash your clothes in cool water | 83% | 82% |
| • Turn off standby power | 82% | 79% |
| • Install a waterwise showerhead (and shower quicker) | 75% | 69% |
| • Adjust your heating/cooling temperature | 70% | 67% |
| • Lower your hot water heater thermostat by 20 degrees* | 41% | - |
| • Turn off your second fridge | 33% | 29% |
| • Run your pool pump two hours less each day* | 16% | - |
| Information source – preferred communication channel | | |
| • Direct mail into letterbox | 65% | 65% |
| • Local newspaper | 47% | 48% |
| • Email | 38% | 27% |
| Future interest – interest in finding more about the Program | 84% | 82% |

* New question in 2011

Despite a decline in total awareness when compare to 2010, actual recognition of the Program's name increased during 2011. Customers continue to use local newspapers to gain information, with 2011 showing a significant increase in the internet as an information source. While cost is noted as the strongest barrier to energy efficiency, saving money is consistently the most common motivator to act.

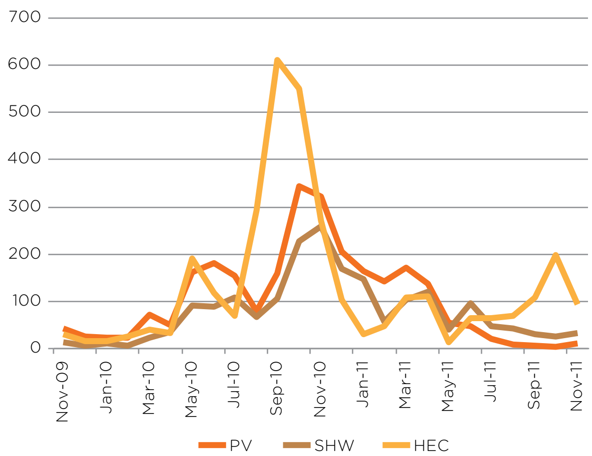
The majority of energy saving tips boast high levels of community implementation, showing strong awareness and participation rates.

Customers consistently prefer information delivered directly to them, firstly via direct mail and increasingly via email. Overwhelmingly, customers want to know more about the Program.

Community feedback included "it made me feel I could do something", "it gives a demonstration of effect" and "it makes me want to be a part of something".

In addition to the customer survey, the Collective Impact campaign was evaluated by the number of customer referrals generated for Consortium products and services. The campaigns saw sustained call volumes with an average of 12 calls per day recorded from December 2009 to November 2011 (image 10-N).

**Image 10-N: Customer call volumes to Perth Solar City call centre by product or service**




### Direct mail

The direct mail campaigns were evaluated by the number of inbound calls generated to the Perth Solar City call centre. Key word identifiers were used to track response rates to each of the campaign elements, such as individual direct mail or newspaper advertisements (for example, "quote solar").

Results for the Perth Solar City direct mail campaigns are shown in table 10-D. Industry average for direct mail campaigns is 2%.

Given the success with home eco-consultation referrals, this combination has been identified as the most successful direct marketing approach for Perth Solar City.

**Table 10-D: Direct mail results**

| Direct marketing method | Customer response rate |
|---|---|
| Direct mail | 1.7% |
| Direct mail + newspaper advertising | 2.1% |
| Direct mail + out-bound telemarketing | 10%* |

*tested for Home Eco-Consultations only

Given the success with the combination of direct mail followed by outbound tele-marketing (a personal phone call), for Home Eco-Consultation referrals, this combination will be tested for other Perth Solar City products and services.

## AS AT 30 NOVEMBER 2011, 13,764 HOUSEHOLDS WERE PARTICIPATING IN THE PERTH SOLAR CITY PROGRAM

Overall, the Collective Impact broad reach marketing campaign has been deemed successful in achieving its primary objectives of establishing the Perth Solar City brand, raising awareness regarding energy efficiency and promotion of Solar Cities as an Australian Government initiative.

## 10.3 TRANSFERABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Marketing** | BENEFIT:<br>Broad reach marketing campaigns increase Program awareness | OUTCOME:<br>Perth Solar City's Collective Impact campaign created 51% customer awareness in its first year (2010).<br><br>LESSON:<br>Broad reach marketing campaigns, such as Collective Impact, are effective in establishing brand, increasing community awareness and promoting energy efficiency and renewable energy.<br><br>Broad reach marketing campaigns utilising CBSM concepts should be used when establishing similar programs. |
| **Marketing** | BARRIER:<br>Broad reach marketing alone does not generate significant referrals | OUTCOME:<br>Perth Solar City's broad reach marketing campaign did not generate a significant number of referrals for products and services.<br><br>LESSON:<br>Broad reach marketing must be supported by a well planned direct marketing and/or community engagement strategy to leverage the awareness raised, promote the commercial products and services and generate referrals. |
| **Direct marketing** | BENEFIT:<br>No provision for marketing funds was included in Consortium Agreements | OUTCOME:<br>Individual Consortium members did not provide sufficient funds for marketing their product or service to generate the required number of customer referrals to meet contractual targets.<br><br>Consortium members continually look to the Program Office to provide support and funding to promote their product or service and generate customer referrals.<br><br>LESSON:<br>Marketing budgets to support the promotion of commercial products and services, should be clearly outlined in agreements as the responsibility of individual Consortium members. Sufficient cash and in-kind contributions must be allocated as a condition to leveraging funding. |

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Direct marketing** | BENEFIT:<br>Incentives and tracking mechanisms within direct mail campaigns | OUTCOME:<br>When direct marketing is combined with a customer incentive that creates urgency (e.g. "Book during June to win $200") increased call levels are noted.<br><br>LESSON:<br>Customer incentives that create urgency should be included in all direct mail campaigns. Tracking mechanisms (such as code words) should be used to evaluate response rates. |
| **Direct marketing** | BENEFIT:<br>Direct marketing campaigns followed by outbound calls to customers significantly increases the uptake of Home-Eco Consultations. | OUTCOME:<br>Outbound tele-marketing to households following the receipt of information-based communications material significantly increases response rates.<br><br>LESSON:<br>Direct marketing campaigns must be followed by outbound calls direct to customers to ensure maximum value of spend, and to increase uptake. |
| **Online marketing** | BENEFIT:<br>Online marketing through the Perth Solar City and social media websites | OUTCOME:<br>Online marketing enables a two-way flow of information between the Program and customers as they share feedback.<br><br>Online marketing is an effective and low cost communication tool. It allows information to be spread virally to a broad audience, directly to their inbox, at no cost. This direct communications can create an appetite for more information, which can be instantly sought from the supporting website.<br><br>LESSON:<br>The use of online marketing and social media platforms is key to the delivery of Program messages. |
| **Branding** | BARRIER:<br>Perth Solar City branding guidelines not enforced onto third-party suppliers. | OUTCOME:<br>Some third party suppliers have used the Perth Solar City brand and referenced participation in the Program in breach of the Perth Solar City marketing and communications guidelines.<br><br>LESSON:<br>Work closely with all Consortium members to ensure they understand their marketing and communications obligations under the Consortium Agreement.<br><br>Ensure that all Consortium members pass on their contractual marketing and branding obligations to all third party suppliers. |

## 10.4 FUTURE FOCUS

In order to assist the Consortium in delivering against its commercial contractual obligations, marketing and communications activities will shift their focus from broad reach, to targeted marketing and communications for the final operational year of the program.

The objectives of the targeted marketing and communications campaign during 2011/12 will be to:

- generate customer referrals for Perth Solar City commercial products and services
- promote the success of Perth Solar City participants in reducing their energy use and saving money

Activities will include direct mail, shopping centre displays and the Eco House open days.

A media and public relations campaign will be implemented to promote customer success stories achieved through their participation in Perth Solar City. These customer achievements will be promoted through a combination of online and media channels, to highlight the benefits of participating in Perth Solar City and encourage householders to sign up.


Perth Solar City's Andrew Blaver with a visitor at the Eco House open day.

# BEHAVIOUR CHANGE TRIAL

## 11.1 BACKGROUND

The Living Smart Households program (Living Smart) is the intensive behaviour change program, delivered by the Western Australian Department of Transport (in partnership with the Eastern Metropolitan Regional Council), for Perth Solar City. Living Smart empowers participating households within Perth's Eastern Region to reduce their demand for energy, water, waste services and car-based travel.

Living Smart was developed by the WA Department of Transport (DOT) to test the effectiveness of engaging households in behaviour change across broad sustainability topics including energy and water efficiency, reduced car use and improved waste management. It built upon the DOT's proven TravelSmart Household program that had delivered a 10% reduction in car trips within targeted communities of more than 200,000 households across the Perth Metropolitan area. It also drew upon the transformational Living Smart small group sustainability courses developed by the Southern Metropolitan Regional Council, City of Fremantle, Murdoch University and the Meeting Place.

A Living Smart demonstration project was delivered in 2008/09 in the Perth suburbs Joondalup and Mandurah, which achieved strong engagement with around 60% of participating households. Changes in behaviour were achieved with households reporting adopting such new actions as switching off standby power and purchasing a solar PV system.

As part of Perth Solar City, Living Smart was offered to 10,000 households across Perth's Eastern Region with over 6,000 choosing to take part in the program's interactive features from April 2010 through to April 2011. The key principles of Living Smart's telephone based eco-coaching include:

- understanding households motivations for changing their behaviour
- building effective relationships with households through coaching conversations
- facilitating self-directed conversations that provide households with the right information and advice at the right time
- setting simple and measureable targets for the household through the establishment of 'social contracts' and the provision of localised benchmarks

## 11.2 OBJECTIVES

Living Smart's objectives for Perth Solar City are to:

- act as a mechanism for referrals to other Perth Solar City products and services
- identify and understand barriers relating to the adoption of energy efficiency behaviours and uptake of energy efficiency products and services
- understand the effect of such a targeted behaviour change program on household energy consumption

## 11.3 IMPLEMENTATION METHODOLOGY

The Living Smart implementation methodology for Perth Solar City is composed of the following elements (image 11-A):

- preparation (research and materials)
- introduction to the community and recruitment of households
- delivery, feedback and coaching
- wrap-up
- program evaluation

Image 11-A: Living Smart Program Methodology

| | MONTH | PROGRAM METHODOLOGY |
|---|---|---|
| Preparation | 1 - 2 | BARRIER AND BENEFIT RESEARCH; MATERIAL DESIGN |
| Introduction and recruitment | 3 | INVITATION LETTER; MATERIAL SELECTION |
| | 4 | INFORMATION PACK DELIVERY |
| | 5 | AGREEMENT PHONE CALL |
| Delivery, feedback and eco-coaching | 6 - 13 | UTILITY METER READING |
| | 6 - 13 | FEEDBACK LETTER DELIVERY |
| | 6 - 13 | ECO-COACHING PHONE CALLS |
| | 6 - 13 | OFFER OF ADDITIONAL SERVICES |
| Wrap-up | 14 | FINAL LETTER DELIVERY |
| Evaluation | 15 - 18 | QUALITATIVE AND QUANTITATIVE EVALUATION |

Feedback is repeated five times

Each of these elements, and the associated implementation actions, are outlined overleaf.

## 11.3.1 PREPARATION

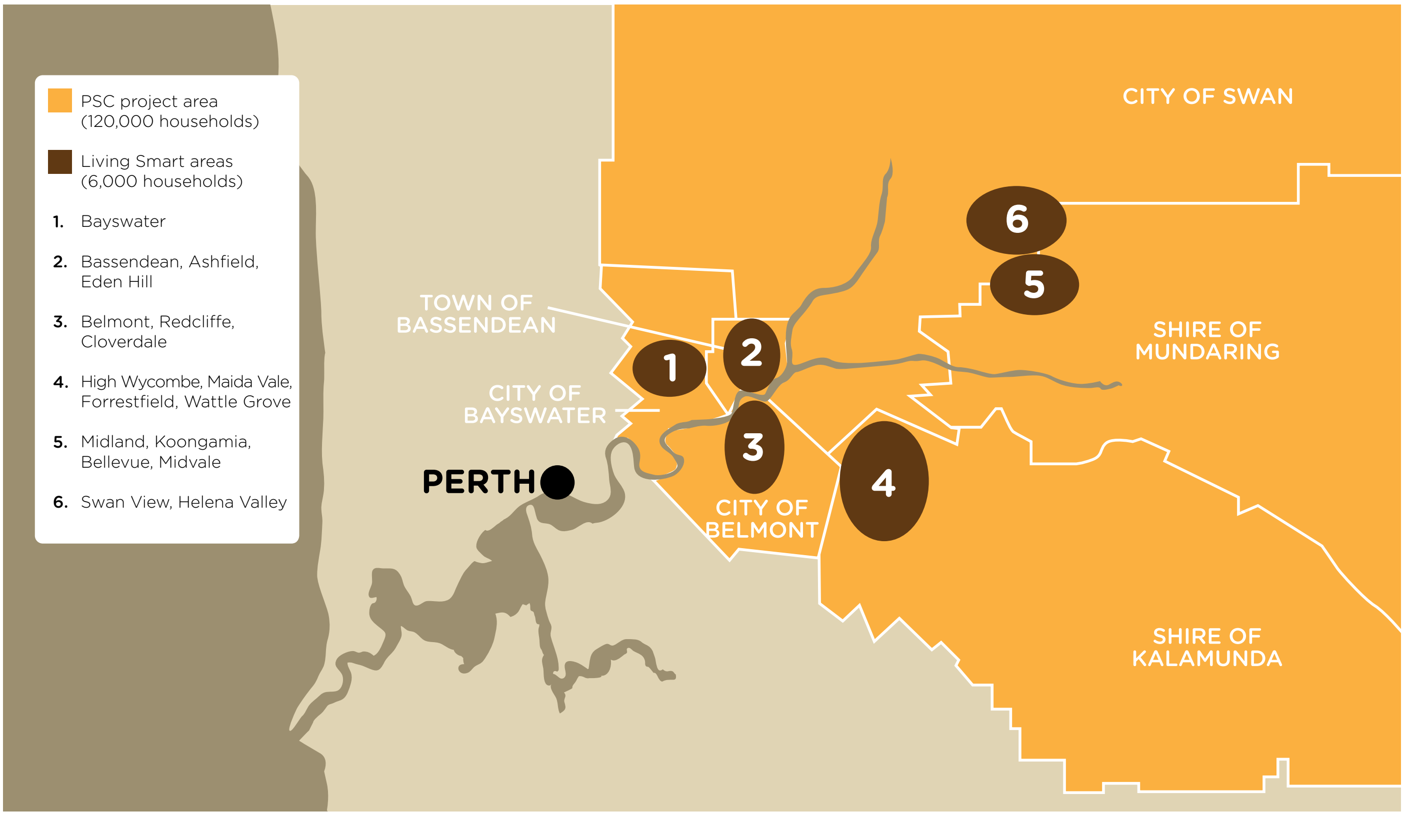
### Location selection

In the design of the program, Living Smart targeted 'hard to reach' segments of the community. Living Smart was deployed in the middle to lower socio-economic status suburbs within the Perth Solar City Region. Household incomes in this group ranged between $620 and $1,400 per week (average $960) and the proportion of rentals ranged between 11% and 46% (average 28%).

The selection of target suburbs was determined geographically by the inclusion of a relatively equal target population in each of the six local government areas within the Region. Further, locations were selected based on the physical grouping of target populations for cost effective meter readings, home information delivery and home eco-consultation visits.

As a result, six clustered locations across 17 suburbs were selected as targeted locations for the program (image 11-B). Households outside of these targeted locations were able to participate in a seven-week Living Smart course that was offered in each local government area.

Image 11-B: Living Smart targeted locations within the Perth Solar City Region



### Research

Research included the collection of baseline behaviour data on household energy, water, waste and travel use. This was conducted to identify the most likely barriers and benefits to the adoption of new behaviours by households in Perth's Eastern Region.

Comprehensive approaches were developed including personalised information and materials, eco-coaching scripts and eco-coaching skills in order to decrease actual and perceived barriers while maximising benefits to be gained by households that adopt each new behaviour.

### Eco-Coach training

A workshop was conducted by sustainability experts to develop the conversation guides for Eco-Coaches to engage and motivate households to make energy efficiency changes and to take up other Perth Solar City product and service offerings.

Training of the Eco Coaches took place in May 2010. 35 coaches participated in an intensive training course which included three days of behavioural psychology and program content training, and two days of coaching, briefing and role playing.

### Material development

Extensive work was conducted in the development of behaviour change tools (leaflets and prompts) that would contribute to energy efficiency behaviour outcomes. In addition to materials guiding specific actions, a 'pledge sticker' was developed to enable households to take stock of their sustainability actions, and make a public demonstration (on their outdoor Sulo bin) of their participation in Perth Solar City.

A total of 28 unique leaflets and prompts were created as behaviour change tools, including Solutions to stand-by power (image 11-C).

### Database development

The materials, behaviour change actions and coaching conversation guides were integrated into a project/client management system used by eco-coaches during the eco-coaching calls.

Image 11-C: Living Smart educational resource: solutions to standby power

Living Smart PERTH SOLAR CITY

The master switch can cut standby power losses

**Solutions to standby power**

**WHAT IS STANDBY POWER?**

Standby power is consumed by an appliance when it is plugged in but not in operation. Many appliances use energy even when they are not in use simply to maintain a convenient 'ready' or 'standby' state. If an appliance has a glowing light, responds to a remote or is warm to touch when not in use, then it is in standby mode and consuming power.

This includes a television switched off by remote control that is awaiting an instruction from the remote to reactivate; or a computer that is shut down, but not off at the wall switch.

**WHY SWITCH OFF?**

By simply switching off at the main switch or wall socket after each use, you could save over 600 kilograms of greenhouse gas per year – that's the equivalent of planting five trees and maintaining them for 100 years. Also, standby power is about 10% of the typical household energy bill which costs you about $150 a year for things you're not even using!

Switch off everything except your reticulation controller, DVD player and a clock and each year:

save 640 kg $CO_2$ · It's like planting 5 trees · cut your bills by $145

**HOW CAN I REDUCE STANDBY POWER?**

Manual Solutions

- If the appliance has a master switch (like the power button on the front of many television sets) switch that off.
- If there is no master switch – turn it off at the wall (no need to unplug from the socket).
- If the wall socket is hard to reach – buy a power board with individual switches that can be put in an easy to reach position.
- If several appliances have clocks on them – choose the ones to turn off (perhaps switch the microwave and radio off at the wall, but keep the oven clock on).

Government of Western Australia Department of Transport

For more Living Smart information go to: www.transport.wa.gov.au/livingsmart

Individual switches can be easier to reach than the wall switch

- Group appliances that can be switched off and those that can't on separate power boards.

TANYA'S TIP: Label your power boards and cords so that you don't accidentally turn off appliances such as computers or clocks when in use.

Automatic solutions

Several power saving devices are available from your local hardware store or by searching online.

- Remote controlled and foot pedal power boards enable you to turn standby power off easily. Although having the remote function does consume some power, the overall saving outweighs the energy usage.
- Standby power saver products are now available that detect when appliances are in standby mode and automatically switch them off after five minutes
- Check energy ratings when buying new appliances. For more on energy ratings go to www.energyrating.gov.au.

**DO I HAVE TO TURN EVERYTHING OFF?**

Wasted power is reduced by turning off everything that is not in use (such as entertainment, office, whitegoods and heating/cooling equipment). Choose to leave on just the things that are time controlled (like reticulation and video recorders).

HINT – place the Living Smart door hanger on the bathroom or front door to remind you to switch everything off last thing at night or when you go out.

During 2010/11, Living Smart will be offered to around 10,000 households in Perth's eastern region as part of the Perth Solar City program. For more information on this Australian Government initiative, please call 1300 993 268 or visit perthsolarcity.com.au. The Living Smart Ambassadors are Tanya Ha (expert in environmental living and the author of *Greeniology* and *Green Stuff for Kids*) and Josh Byrne (sustainability specialist, presenter on ABC TV's *Gardening Australia* program and author of *The Green Gardener*).The information in this brochure is provided in good faith. However the accuracy or appropriateness of the information is not guaranteed. The Living Smart brand has been developed by The Meeting Place Community Centre, the City of Fremantle, Murdoch University and Southern Metropolitan Regional Council to support a suite of programs developing capacity in community sustainability.

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## 11.3.2 PROGRAM INTRODUCTION AND RECRUITMENT

The main engagement phase of the program began with 30,000 letters of invitation sent, followed by a phone call to a target group of 10,000 households, from which 6,342 households were recruited. Each letter (image 11-D and 11-E) offered extensive energy and water saving information leaflets together with other Perth Solar City product and service offerings (not including smart meter enabled technical trials). The specific information requested by the recruited household is compiled into individualised packs (including a number of free prompts). Packs were hand-delivered by bicycle to each participating resident's front door where a short conversation was held, welcoming the resident to the program and explaining the contents of their individualised pack.

Follow-up phone conversations were positive. Over 90% of households initially recruited to the program were interested in participating further in the meter reading and eco-coaching aspect of the program.

**Images 11-D and 11-E: Living Smart invitation to participate leaflet included in original mail-out**


## 11.3.3 DELIVERY, FEEDBACK AND COACHING

The delivery, feedback and coaching stage of the Living Smart program is the key mechanism for implementing the behaviour change methodology. This methodology seeks to facilitate change in an ongoing, multi-step, self-directed manner (image 11-F).

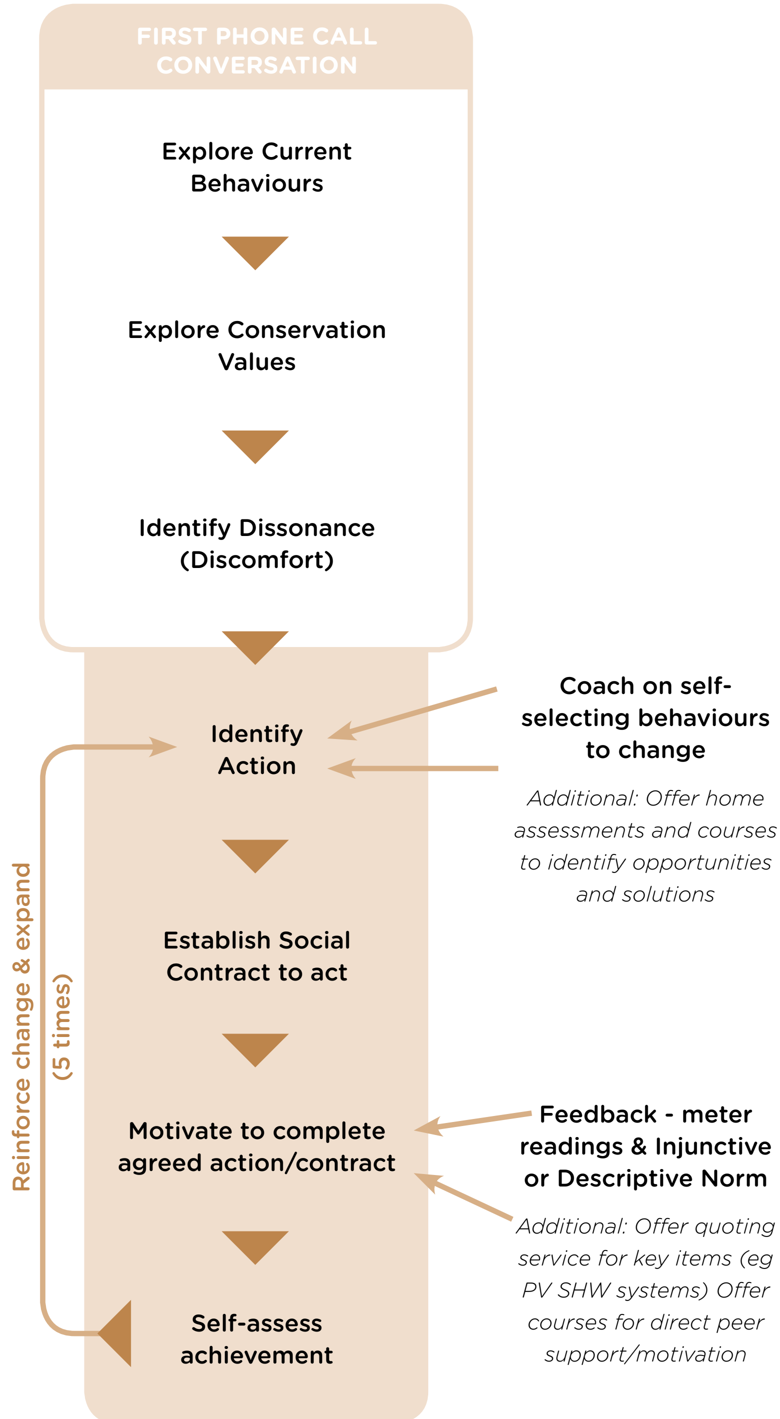
Households that opted into the eco-coaching component of the program were provided with five rounds of meter reading feedback via an individualised letter (image 11-G). The letter included the household's daily energy and water consumption levels, comparisons to the neighbourhood average, as well as the most efficient households. Motivational language and seasonal tips to reduce their use were also included.

Each letter was followed up with an eco-coaching call to discuss the benchmarked meter reading, and explore energy, water, transport and waste efficient actions that the household is motivated to implement. Eco-Coaches were trained not to suggest actions for households, they were instead to encourage households to identify their own consumption-related concerns and explore possible solutions and/ or actions.

Eco-Coaches would record the identified actions to be taken by the householder, and advise that the actions would be followed-up during the next coaching call - thereby establishing a 'social contract.' This approach builds self-efficacy and confidence in the participant, and helps to build a relationship of trust and rapport with the Eco-Coach. This in turn makes possible the adoption of further, more complicated future actions.

The meter reading feedback letters and coaching calls use benchmarking of similar sized households in the participants local area as a means of comparison. This was combined with simple communication tools (smiley faces, how to guides, active listening), to re-enforce positive behaviour change or trigger new behaviour change actions. Image 11-G shows a typical meter reading feedback letter that is received by the household prior to the coaching call.

Image 11-F: Living Smart behaviour change model for participants



### 11.3.4 WRAP-UP

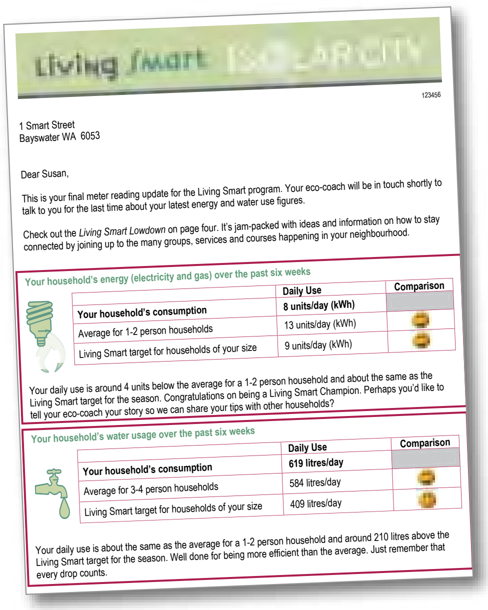
At the conclusion of the five rounds of telephone based eco-coaching, Living Smart households were provided with personalised feedback on their individual and collective community achievements over the preceding 12 months of the program. This final letter detailed each household's achieved actions, their future intended actions, and their corresponding financial and environmental savings.

Collective savings were also calculated to reinforce the fact that households were part of a larger program and their individual actions contributed to a significant outcome across the Region. Households were encouraged to join local community groups and were given another opportunity to take up Perth Solar City product and service offerings including free home eco-consultations, and discounted solar hot water and solar PV systems.

### 11.3.5 PROGRAM EVALUATION

Thorough pre-program evaluation was conducted to calculate baseline energy, water, travel and waste behaviours so as to accurately calculate Living Smart's impact. Qualitative data, such as self-reported actions, was collected throughout the program to track effectiveness and refine the implementation methodology to best suit the target community.

The Living Smart program concluded in April 2011. 250 face-to-face exit surveys are currently being compiled to measure top-line program engagement levels, as well as the overall impact of the program.


Living Smart

123456

1 Smart Street
Bayswater WA 6053

Dear Susan,

This is your final meter reading update for the Living Smart program. Your eco-coach will be in touch shortly to talk to you for the last time about your latest energy and water use figures.

Check out the *Living Smart Lowdown* on page four. It's jam-packed with ideas and information on how to stay connected by joining up to the many groups, services and courses happening in your neighbourhood.

Your household's energy (electricity and gas) over the past six weeks

| | Daily Use | Comparison |
|---|---|---|
| **Your household's consumption** | **8 units/day (kWh)** | |
| Average for 1-2 person households | 13 units/day (kWh) | |
| Living Smart target for households of your size | 9 units/day (kWh) | |

Your daily use is around 4 units below the average for a 1-2 person household and about the same as the Living Smart target for the season. Congratulations on being a Living Smart Champion. Perhaps you'd like to tell your eco-coach your story so we can share your tips with other households?

Your household's water usage over the past six weeks

| | Daily Use | Comparison |
|---|---|---|
| **Your household's consumption** | **619 litres/day** | |
| Average for 3-4 person households | 584 litres/day | |
| Living Smart target for households of your size | 409 litres/day | |

Your daily use is about the same as the average for a 1-2 person household and around 210 litres above the Living Smart target for the season. Well done for being more efficient than the average. Just remember that every drop counts.

Image 11-G: Living Smart meter reading feedback letter example

### 11.4 KEY PERFORMANCE INDICATORS AND PROGRESS

To achieve Living Smart's objectives, Key Performance Indicators (KPIs) were developed. The KPIs were established as a combination of inputs (for example letters sent to contact households) and outcomes (for example uptake of a referral to a Home Eco-Consultation). The specific KPIs for Living Smart are:.

**Table 11-A: Living Smart Key Performance Indicators – target and actual**

| Living Smart KPIs | Project Target | Actual |
|---|---|---|
| Living Smart target (engagement by letter) | 10,000 | 30,000 |
| Contact (by phone) | 9,000 | 12,253 |
| Interest | 7,500 | 7,770 |
| Participate (personalised info delivery) | 6,000 | 6,342 |
| Interactive feedback on meter read 1 | 5,000 | 4,631 |
| Interactive feedback on meter read 2 | 4,750 | 4,536 |
| Interactive feedback on meter read 3 | 4,500 | 4,244 |
| Interactive feedback on meter read 4 | 4,250 | 4,009 |
| Interactive feedback on meter read 5 | 4,000 | 3,861 |
| Interactive feedback (final letter on actions/ outcomes) | 0 | 3,831 |
| Total interactive feedback on meter readings | 22,500 | 25,112 |
| Referrals for Home Eco-Consultations | 2,000 | 2,088 |
| Referrals for solar PV systems | 1,400 | 1,146 |
| Referrals for solar hot water systems | 1,080 | 657 |
| Referrals for workshops | 250 | 1,104 |
| Exit surveys | 250 | 251 |
| Positive feedback from exit surveys | 90% | 89.4% |

### 11.5 KEY RESULTS

Key results from the Living Smart program will focus on:

- referrals to other Perth Solar City products and services
- uptake of energy efficiency actions and responses to the Living Smart services
- effect of Living Smart on electricity consumption of participants

### 11.5.1 REFERRALS TO OTHER PSC PRODUCTS AND SERVICES

As part of providing participants with the right tools (information and support) at the right time, Living Smart refers participants to other Perth Solar City products and services, including seven-week Living Smart courses (table 11-B).

The Living Smart program provided over 2,000 referrals to Perth Solar City's free Home Eco-Consultation. The Referrals converted column shows the number of households who actually participated (i.e. completed a Home Eco-Consultation). Due to the Home Eco-Consultation provider under resourcing the booking service, only 52% of referrals were converted. This is well below the 90% achieved by the Living Smart demonstration project in 2008/09.

The referral rate for the solar PV and solar hot water components of the program were high, however the actual conversion rate (uptake of the offering) was low. In total 371 participating households reported purchasing a solar PV system (57 taking up the Program offering) and 125 reported purchasing a solar hot water system (48 taking up the Program offering). Many households reported a preference for lower cost solar PV systems, and wanted to wait for their current hot water system to breakdown before upgrading to solar.

All six of the Living Smart seven-week courses were well attended, achieving a total of 238 participants. As a demonstration of the ongoing legacy of the Living Smart courses, participants from the Mundaring, Swan, Bassendean and Bayswater courses have developed 'Living Smarties' groups and continue to meet regularly to share ideas, stories, and tools and motivate one another to take action locally.

### 11.5.2 UPTAKE OF ENERGY EFFICIENCY ACTIONS AND RESPONSES TO THE LIVING SMART PROGRAM

Participating households self-report energy efficiency actions through the coaching calls (image 11-H). Self-reporting provides a valuable insight into the uptake of energy efficiency actions, to be verified by the analysis of electricity consumption data. A total of 7,782 self reported household energy efficiency actions were undertaken by Living Smart over the five coaching calls. Actions with the greatest uptake were:

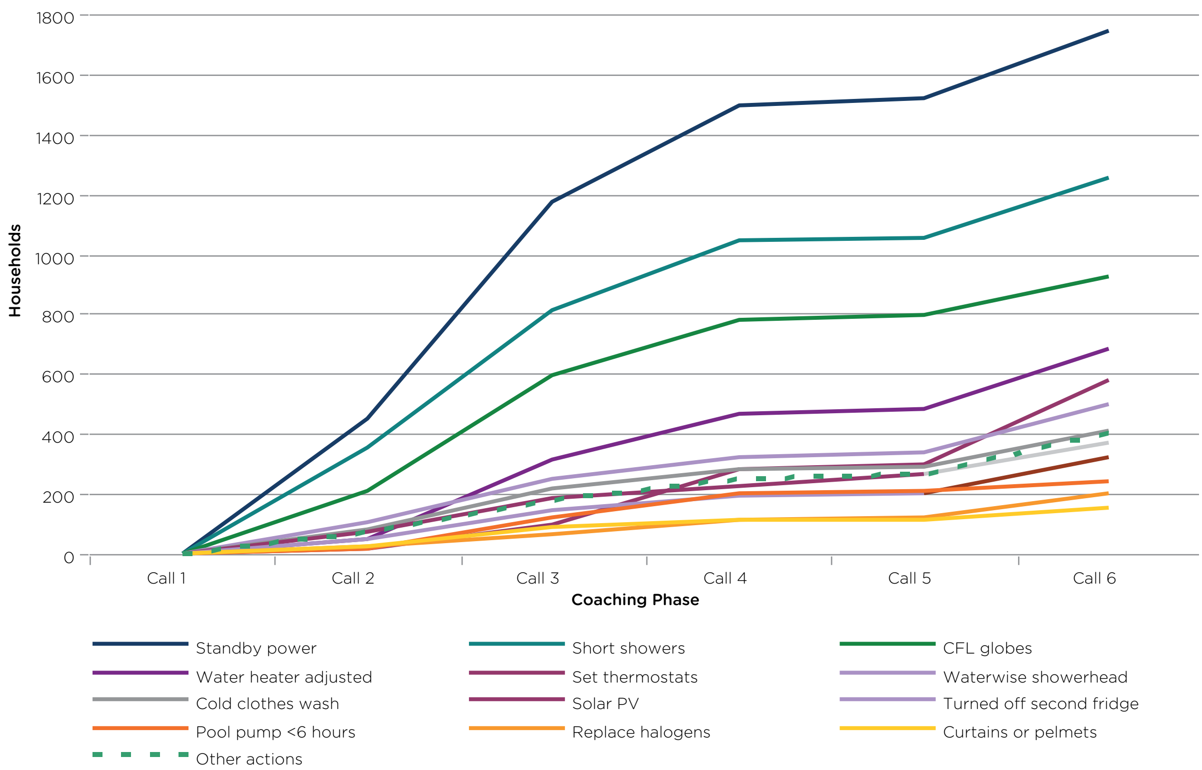
- switching off standby power – adopted by 36% of participants or 64% of those participants not already switching off standby power
- taking shorter showers (four minutes) – adopted by 25% of participants or 56% of those not already taking shorter showers
- installing CFL globes in main lighting areas – adopted by 19% of households or 52% of those that do not already have CFL globes installed
- installing a water efficient showerhead – adopted by 10% of participants or 21% of those with high flow showerheads
- setting water heater thermostats to 60 degrees or less – adopted by 14% of households or 16% of those for whom it would be possible

**Table 11-B: Referrals generated by the Living Smart program**

| Product | Referral target | Referrals achieved | Referrals converted* | Conversion% |
|---|---|---|---|---|
| Home Eco-Consultation | 2,000 | 2,088 | 1,084 | 52% |
| Solar PV systems | 1,400 | 1,146 | 57 | 5% |
| Solar hot water systems | 1,200 | 657 | 48 | 7% |
| Living Smart courses | 300 | 1,104 | N/A | N/A |

*some referred households may yet still uptake PSC product and services beyond the current reporting period

**Image 11-H: Energy Actions reported by Living Smart participants**




Validation of the self reported changes has been conducted using meter readings from participating households. Analysis to date, (table 11-C), shows that at the midway point of the program (coaching call three), the self reported actions and meter readings indicate a reduction of around 1.6 kWh per household per day.

**Table 11-C: Electricity consumption reductions for Living Smart participants - self reported actions vs actual meter reads**

| Date | May / Jun 2010 | August 2010 | Sept 2010 | Oct / Nov 2010 | Jan / Feb 2011 | Mar / Apr 2011 |
|---|---|---|---|---|---|---|
| Phase | Contact | Coaching call 1 | Coaching call 2 | Coaching call 3 | Coaching call 4 | Coaching call 5 |
| Self Reported Actions (4835 households) | 0 | -0.6 | -1.7 | -2.2 | -2.3 | -2.9 |
| Meter Reading Results (3743 households) | -0.1 | -1.5 | -1.7 | -1.6 | TBC | TBC |

A quality survey was conducted through 251 face to face interviews with a random selection of participants representing a quota sample of households. Across nine headline measures of service quality (including reliability, responsiveness, knowledge, empathy and professionalism) 89.4% of responses were positive or strongly positive. Quality survey respondents rated the individual aspects of the service highly (table 11-D).

Table 11-D: Survey response to individual Living Smart aspects

| | Relevant sample (utilised this service) | Very/ quite interesting | Very/ quite useful |
|---|---|---|---|
| Meter reading letters | 232 | 85% | 80% |
| Phone calls (coaching) | 221 | 78% | 77% |
| Home Consultation | 113 | 84% | 82% |
| Community Course | 35 | 94% | 91% |
| Final letter | 207 | 80% | 80% |

Of those participating in the meter reading and coaching feedback, 97% found the feedback letter easy to understand and 82% felt that it encouraged them to reduce their energy use. When considering the impacts of Living Smart participation overall, 87% reported that they felt they had achieved some energy reduction with 21% perceiving a 'large' reduction and 39% a 'moderate' reduction. Perceived reductions were larger for energy and water (87%) than for waste (57%) and car use (35%).

Interest in the program was motivated by 'doing the right thing by the environment' (60%), 'cost savings' (44%), 'set an example to my children' (13%), 'join in with others' (13%) and to 'find out how we are doing' (8%) – respondents could offer more than one motivation.

## 11.4.3 EFFECT ON ENERGY EFFICIENCY – PRELIMINARY RESULTS

Perth Solar City commissioned Data Analysis Australia (DAA) to provide preliminary results on the effect of the Living Smart program on electricity consumption. The analytic methodology developed and used by DAA is attached as Appendix E.

Analysis was completed for 4,768 households who had participated in the Living Smart program. An average 8.5% reduction in electricity use is evident (image 11-I).

Table 11-E shows the extrapolated annual cost and greenhouse gas savings for Living Smart participants, based on the preliminary results.

Table 11-E: Extrapolated annual cost and greenhouse gas emissions savings

| Customer Group | Electricity cost savings per household ($/year)* | Greenhouse Gas savings (kg CO-e/year)^ |
|---|---|---|
| Living Smart | $122.50 | 521 |

* Calculation based on unit cost of $0.2187 per kWh
^ based on emission co-efficient of 0.93kg/CO2-e per kWh – National Greenhouse Account Factors July 2011

**Segmentation of Living Smart participants**

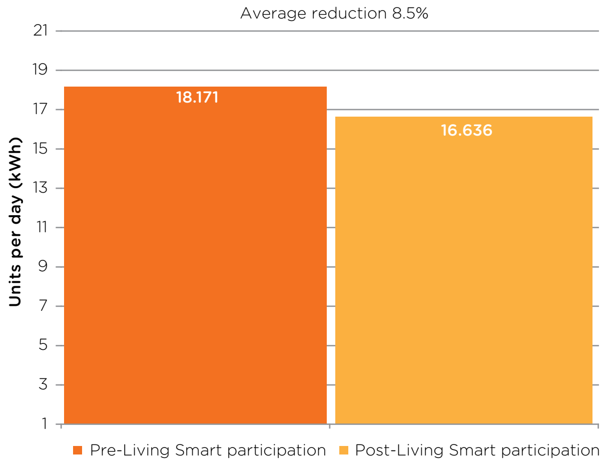
DAA completed a basic analysis illustrating electricity consumption changes of Living Smart participant segments following the commencement of the program. The analytic methodology developed and used by DAA is attached as Appendix E. Segments included are:

- top 50% of relative electricity savers – one year post-Living Smart commencement
- top 10% of relative electricity savers – one year post-Living Smart commencement

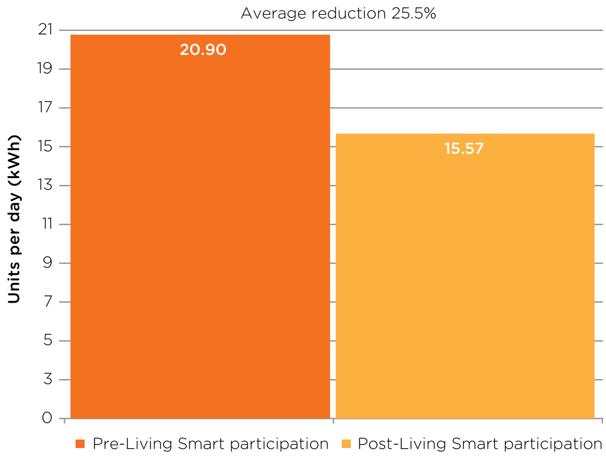
The analysis is designed to provide preliminary insights into segments of the Living Smart full participants group, and had the following limitations:

- participants that had full metering data for the period 1 May 2009 to 31 April 2011 (n = 2,919)
- analysis is limited to a two year period including one year pre-Living Smart commencement and one year following commencement
- given that the Living Smart program commenced over a six week period during April and May 2010, the start date was allocated as 1 May 2010 for the purpose of this analysis
- the Living Smart program was operational beyond this basic analysis (until early June 2011)
- control groups were not included

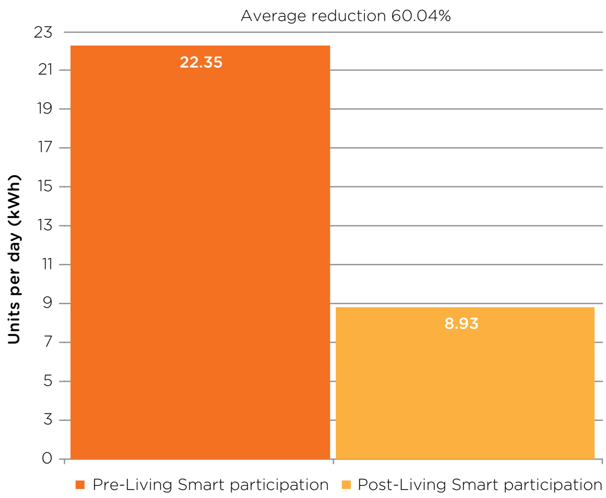
### Image 11-I: Living smart – Effect on electricity consumption




### Image 11-J: Living Smart – Top 50% of electricity savers (relative)




### Image 11-K: Living Smart – Top 10% of electricity savers (relative)




**Top 50% of relative electricity savers – one year post-Living Smart commencement**

The results show relative electricity consumption savings of 25.5% for the top 50% (n=1,459) of savers in the one year period following the commencement of the Living Smart program (image 11-J).

**Top 10% of relative electricity savers – one year post-Living Smart commencement**

The results show relative electricity consumption savings of 60% for the top 10% (n=291) of savers in the one year period following the commencement of the Living Smart program (image 11-K). It is likely that many of these participating households purchased a solar PV and/or a solar hot water system.

## 11.6 TRANSFERRABLE LESSONS

Through its implementation as part of Perth Solar City, Living Smart has:

- built community capacity to adopt energy efficiency behaviours and low cost technologies
- overcome information and motivational barriers relating to the adoption of solar technologies (photovoltaic and solar hot water systems)
- motivated and connected households to suppliers of other Perth Solar City Program offerings including home eco-consultations, solar technology products, events and workshops.

| Activity | Barrier or benefit | Outcome and/or lesson |
|---|---|---|
| **Eco-coaching calls** | BENEFIT:<br>Living Smart eco-coaching calls develop trust as the basis for creating mutually beneficial relationships | OUTCOME:<br>Households are more likely to change behaviour.<br><br>LESSON:<br>Effective and trustful relationships with participants are required to facilitate behaviour change |
| **Referrals to other Perth Solar City products and services** | BENEFIT:<br>Living Smart provides referrals to other Perth Solar City products and services | OUTCOME:<br>Significant numbers of referrals to other Perth Solar City products/services.<br><br>LESSON:<br>Large-scale, multi-product energy efficiency programs benefit from Living Smart style engagement.<br><br>LESSON:<br>Living Smart is more cost-effective than information-based broad reach marketing in creating referrals to additional energy efficiency products and services. |
| **Technical trials** | BARRIER:<br>Living Smart and the Perth Solar City technical trials were not aligned | OUTCOME:<br>The Living Smart program did not provide access to technical trials such as ACT or MAX.<br><br>LESSON:<br>It would be beneficial to test the inclusion of Living Smart style programs in achieving referrals to smart meter enabled technical trials. |
| **Reduction in electricity consumption** | BARRIER:<br>Living Smart's sustainability objectives are broad, and are not focused solely on reducing electricity consumption<br><br>BENEFIT:<br>The community is strongly engaged in water conservation, and the broad approach can be leveraged to encourage energy efficiency behaviours | OUTCOME:<br>It is unclear whether the integrated sustainability model increases or reduces the energy efficiency outcomes of coaching.<br><br>LESSON:<br>The broad sustainability frame of Living Smart attracts very high levels of engagement and reduces the risk of households declining an energy coaching program that comes shortly after a separate travel or water program. Further testing of integrated and sequential programs is required. |
| **Capacity building** | BENEFIT:<br>Living Smart provides interactive community-based sustainable living courses | OUTCOME:<br>Ongoing legacy of the Living Smart courses. Participants from Mundaring, Swan, Bassendean and Bayswater continue to meet regularly to share ideas, stories, and tools and motivate one another to take action locally.<br><br>LESSON:<br>Courses build ongoing community capacity by identifying local champions and encouraging them to adopt sustainable behaviours and build grassroots support for clean technology. |

## $122.50 ELECTRICITY COST SAVINGS PER HOUSEHOLD ($/YEAR)

TRUSTFUL RELATIONSHIPS WITH PARTICIPANTS ARE REQUIRED TO FACILITATE BEHAVIOUR CHANGE

## 11.7 FUTURE FOCUS

The key focus for Living Smart in 2011/12 will be the analysis and evaluation of program outcomes, including:

- analysis of telephone coaching records (self reported) of energy efficiency actions adopted by Living Smart participants
- analysis of meter reading data from active and non participating (internal control) households in the target group
- analysis of meter reading data from active participants and non target (external control) households
- analysis of outcomes (energy efficiency and referrals) by participant types (income, education, energy use, housing stock etc)
- qualitative research to discover participant and non-participant responses to the Living Smart service offerings and to the behaviour changes that were adopted and avoided

# HOME ECO-CONSULTATIONS

## 12.1 BACKGROUND

The energy consumption of a household is driven by the behaviour of its occupants, specifically the use of different appliances in the home. Often, households are unaware of how much electricity or gas a particular appliance requires to operate, or how the way it is used affects overall household energy consumption and subsequent costs.

As part of the Perth Solar City program, the Home Eco-Consultation (HEC) was designed to assist participants to understand their own energy consumption. The HEC provides householders with the opportunity to understand what is contributing to their current energy use. A follow up report provides participants with information on what changes to make to reduce energy use.

The HEC is delivered free to households as a once-off education–based engagement tool that seeks to help participant households to:

- benchmark their energy and water consumption based on the National Australian Building Environmental Rating Scheme (NABERS)
- understand which appliances in their home are the most energy inefficient
- understand how the residents usage of these appliances affects their energy use
- combines findings to determine the best value-for-money behavioural and structural changes that could be implemented to reduce energy consumption, save money and decrease greenhouse gas emissions

The HEC for the Program follows the Australian Standard guidelines for energy auditing, and is comprised of the following characteristics:

- two assessors present in the home
- 90 minute consultation
- reports consolidating the findings of the HEC are mailed within three weeks of the consultation being completed

The HEC also provides participants with an opportunity to understand more about the Program, including participation in other products, services and technical trials.

As a Perth Solar City Consortium member, Mojarra is responsible for the administration and delivery of the HEC to eligible households in Perth's Eastern Region. Mojarra is provided with referrals from the Program call centre, the Living Smart program, collaboration with other Consortium members and via Mojarra's own recruitment campaigns. The majority of referrals for the HEC came from the Living Smart program – 2,088 in total (77%).

Working together with the Perth Solar City Program Office, Mojarra also recruited participants through the use of 'warm' telemarketing. 'Warm' telemarketing involves sending an introductory letter to a potential participant, and following up with a phone call to solicit participation. Success rates of around 10% have been achieved for this recruitment method.

## 12.2 OBJECTIVES AND PROGRESS

Mojarra's main objective for the Program is to complete 3,500 HECs. Mojarra has also undertaken 20 school energy audits (Chapter 15).

| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| HECs | 3,500 | 2,497 | 2,536 |

Mojarra achieved 98% of the target to 30 November 2011.

To date, the total number of HEC leads recorded in the Perth Solar City database is 3,251, with 2,497 successfully converted into completed assessments. This represents a conversion rate of 71%.


## 83% OF PARTICIPANTS FOUND THE HEC TO BE EITHER EFFECTIVE OR HIGHLY EFFECTIVE

**Customer feedback**

An on-line Quality Assurance survey was developed and sent to 204 HEC participants during November 2010. The survey was completed by 71 participants, a response rate of 35%, and represented approximately 7.5% of total HEC participants at the time. The objective of the survey was to investigate participant satisfaction of the HEC, as well as individual components of the service such as scheduling options and the quality of the written audit report.

The Quality Assurance survey presented the following results:

- overall, 83% of participants found the HEC to be either effective or highly effective
- 94% of participants were satisfied or highly satisfied with the scheduling options for their HEC
- 76% of participants found the HEC report either useful or very useful
- 58% of participants were contacted within five business days
- 43% of participants received their written report within two weeks. A further 21% of participants received their written report within three weeks

## 12.3 KEY RESULTS

Key results for Home Eco-Consultations will focus on:

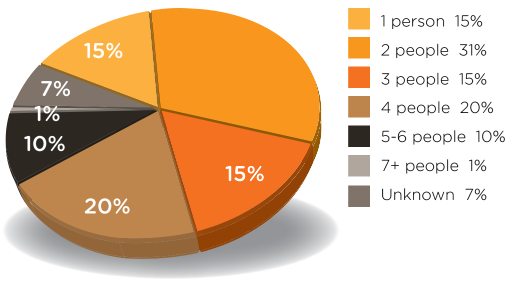
- demographic trends
  - household size
  - education level
  - employment status
  - average household income level
- electricity consumption trends
  - effect on electricity consumption – preliminary results

## 12.3.1 DEMOGRAPHIC TRENDS

**Household size**

47% of participants in the free HEC service were either single or dual occupant households (image 12-A).

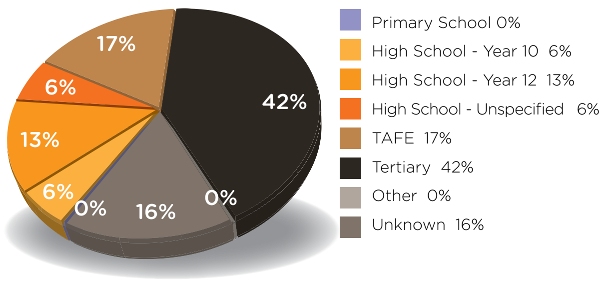
Image 12-A: HEC - Household size




**Education level**

42% of participants in the free HEC service have completed a tertiary education (image 12-B).

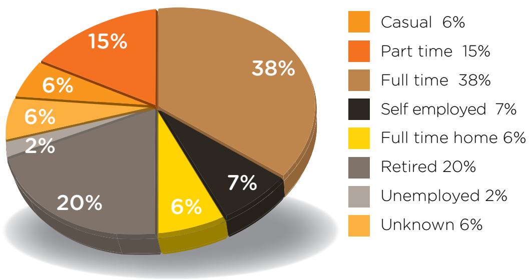
Image 12-B: HEC - Education level




**Employment status**

At 30 November 2011, 60% of participant households were employed full-time, part-time or self-employed. 20% of participant households were retired (image 12-C).

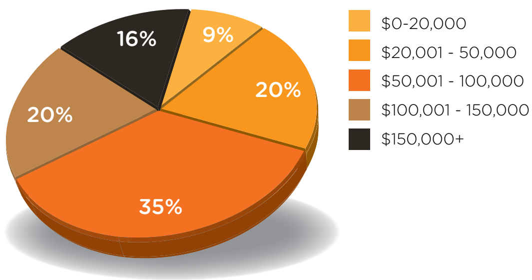
Image 12-C: HEC - Employment status




**Income levels**

Only 322 households, or 14% of HEC participants to 30 November 2011, responded when asked about their household income level (image 12-D).

Image 12-D HEC - Annual household income



## 12.3.2 ELECTRICITY CONSUMPTION TRENDS

**Effect on electricity consumption - preliminary analysis**

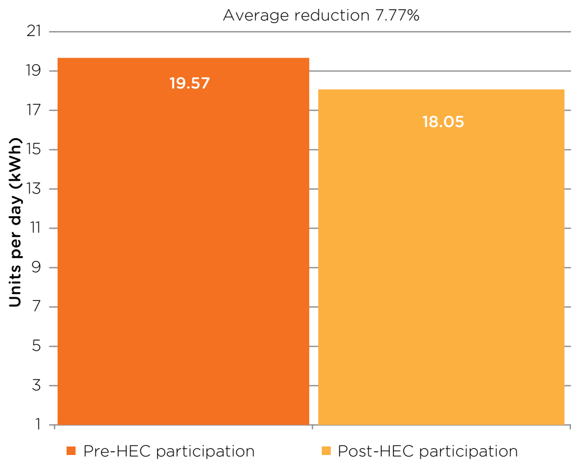
The Program commissioned Data Analysis Australia (DAA) to provide preliminary analysis on the effects of HECs on electricity consumption. The analytic methodology developed and used by DAA is attached as Appendix E.

Analysis was completed for 762 participant households who had received a free HEC in the period 4 December 2009 to 30 June 2011. In order to effectively measure the relative effects of the HEC on participant electricity use, the analysis did not include any HEC participant households who also participated in the Living Smart program. This is due to 1,084 households having signed up for a free HEC as a part of their participation in Living Smart, and as a result, electricity savings achieved have the potential to be double counted or misallocated.

The preliminary analysis shows a 7.8% reduction in the average daily electricity use of participant households (image 5-E). This reduction could be attributed to a range of energy efficiency actions (such as switching off stand-by power, installing more efficient lighting, or installing a solar PV and/or solar hot water system etc.) implemented by the participant household after completing the HEC.

**ANALYSIS SHOWS A 7.8% REDUCTION IN THE AVERAGE DAILY ELECTRICITY USE OF PARTICIPANT HOUSEHOLDS**

**Image 12-E: HEC - Effect on electricity consumption**




A more detailed analysis will be completed during 2012 to understand the differences in electricity consumption between participants in multiple product groups.

Table 12-A shows the extrapolated annual cost and greenhouse gas savings for HEC participants (non-Living Smart), based on the preliminary results.

**Table 12-A: HEC - Extrapolated annual cost and greenhouse gas emissions savings**

| Customer Group | Electricity cost savings per household ($/year)* | Greenhouse Gas savings (kg CO-e/year)^ |
|---|---|---|
| HEC (non-Living Smart) | $121.33 | 516 |

* Calculation based on unit cost of $0.2187 per kWh

^ based on emission co-efficient of 0.93kg/CO2-e per kWh – National Greenhouse Account Factors July 2011

## 12.4 TRANSFERRABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lessons |
|---|---|---|
| **Living Smart Program** | BENEFIT:<br>The Living Smart program's eco-coaching provided households with an opportunity to sign up for a free HEC | OUTCOME:<br>Living Smart has provided the majority of HEC referrals to date.<br>LESSON:<br>When compared with broad reach marketing and advertising, a targeted education-based engagement program is a more cost-effective means of generating referrals for HECs. |
| **Direct Marketing** | BENEFIT:<br>Use of 'warm' telemarketing - households receive a letter and a follow-up phone call. | OUTCOME:<br>Increased participation rate. Up to 10% of households contacted scheduled a HEC.<br>LESSON:<br>'Warm' telemarketing is an effective means of promoting HECs and recruiting participants |
| **Market saturation** | BARRIER:<br>The prominence of 'free energy audits' such as Green Loans and other audit programs appear to have nearly saturated the market. | OUTCOME:<br>It has taken longer than expected to achieve the original HEC targets, and has required active recruitment strategies such as 'warm' telemarketing.<br>LESSON:<br>The home energy audit product may need to be re-visited in order to be more relevant/attractive to households. For example collaboration with technical trials. |
| **Assessment model** | BENEFIT:<br>Utilising two assessors to conduct a HEC | OUTCOME:<br>Provides the ability for one assessor to focus on engaging the householder, whilst the second assessor can complete an appliance count. Households are generally satisfied with the service received.<br>LESSON:<br>HECs should be structured in a way that does not compromise engagement in favour of data capture. |
| **Income bands** | BARRIER:<br>Collection of household income information | OUTCOME:<br>The current method of collecting household income information employed by the HEC provider has resulted in 86% of households not providing the required information.<br>LESSON:<br>Develop other, perhaps less direct, methods of collecting household income information. |
| **Scheduling HECs** | BARRIER:<br>Underestimation by HEC provider of resources required to meet significant increase in referral volumes as a result of behaviour change program. | OUTCOME:<br>52% of referred households were converted into completed HECs.<br>LESSON:<br>Contracts need to be more prescriptive regarding performance targets (for example % conversion rates) or consider third party suppliers to cope with increased demand. |

## 12.5 FUTURE FOCUS

Perth Solar City and Mojarra will continue to work towards the completion of the remaining 1,003 HECs. To achieve this uptake, 'warm' telemarketing, advertisements in local community newspapers, as well as participation at local events, shopping centres and at Perth Solar City's Eco House will be utilised.

A Quality Assurance participant feedback survey on the HEC will be conducted during the March 2012 quarter.

Further data analysis on a larger sample size with longer post-intervention data will also be undertaken, including the segmentation of HEC participants that also participated in other PSC products and services (such as Living Smart or residential solar PV).

# ICONIC PROJECTS

## 13.1 BACKGROUND

To support the objectives of Perth Solar City, and to promote the Australian Government's Solar Cities program, five prominent solar photovoltaic (PV) installations have been installed at iconic Perth locations to maximise community engagement and promote renewable energy (table 13-A).

These larger scale solar PV installations are located at the Midland Atelier, the Central Institute of Technology, Kings Park and Botanic Garden, Perth Zoo and Perth Arena, and will provide nearly 500kW of grid connected renewable energy.

**Table 13-A: Iconic projects**

| Iconic site | Project | Consortium member | Completion date | Estimated annual energy Savings ($/year)^ | Estimated annual GHG emissions savings (t CO2-e/year)" |
|---|---|---|---|---|---|
| **Central Institute of Technology** | 49kW solar PV system | SunPower | April 2010 | $22,511 | 72,540 |
| **Midland Foundry** | 60kW solar PV system | SunPower | May 2010 | $27,994 | 90,210 |
| **Perth Zoo stage one** | 90.9kW solar PV system | SunPower | March 2011 | $34,632 | 111,600 |
| **Perth Zoo stage two** | 140kW solar PV system | SunPower | April 2012 (estimated) | $64,889 | 209,101 |
| **Kings Park and Botanic Garden** | Energy efficient education building including 15kW solar PV system | BGPA | March 2012 (estimated) | $6,636 | 21,385* |
| **Perth Arena** | 111kW solar PV system | Synergy | July 2012 (estimated) | $49,109 | 158,252 |

^Cost savings based on avoided expenditure only. Cost savings calculated at large business (M1) rate of 28.86c/kWh
"Based on emission co-efficient of 0.93kg/CO2-e per kWh – National Greenhouse Account Factors July 2011
*solar PV system only. Emissions saved as a result of energy efficient building design are to be determined

Image 13-A: Central Institute of Technology's 48.6kW system

# INSTALLED AT ICONIC PERTH LOCATIONS TO MAXIMISE COMMUNITY ENGAGEMENT

Image 13-C: Perth Zoo stage one

Image 13-D: Artist's impression of Perth Zoo stage two

**Central Institute of Technology**

The 48.6kW solar PV system at the Central Institute of Technology was launched in April 2010 (image 13-A). This 48.6kW system is made up of 162 SunPower 300W panels and will produce 73MWh annually – the equivalent to the annual electricity demand of approximately 20 homes.

The Central Institute of Technology is the major training provider in Perth for technicians installing solar PV panels. This Perth Solar City installation is connected to the grid, and will provide hands-on experience for students.

A visual display has been installed within the Central Institute of Technology's main reception area to promote the installation, including an electronic display showing live generation data from the solar PV system.

**Midland Foundry**

The 60kW solar power system at the Midland Foundry launched in May 2010 and powers artisans working within the Atelier (image 13-B). This important Western Australian state heritage site is over 100 years old, and offers an exciting juxtaposition of old industry with renewable solar technology.

The SunPower system was installed on the rooftops of the old Foundry and Pattern Shop buildings, and the electricity generated is distributed to the buildings in the Workshop's creative industries precinct to run lighting and equipment needed by the resident artisans. The installation will reduce up to 94 tonnes of carbon dioxide being released into the atmosphere per year.

Image 13-B: Midland Foundry's 60kW solar PV system

Image 13-E: Artist's impression of the education facility in Rio Tinto Naturescape Kings Park

**Perth Zoo**

The 90.9kW installation at Perth Zoo is the largest solar site in Perth, and is stage one of a two-stage $2.7 million project funded by the WA State Government and Commonwealth Government under Perth Solar City (image 13-C).

As part of stage one, 303 panels have been installed across eight Zoo buildings including the elephant barn, Reptile Encounter building, conference centre, reception building, retail shop, operations building and maintenance workshops. Stage one was launched in March 2011 and is expected to produce over 120,000kWh of energy per year.

Stage two of the Perth Zoo solar site will be constructed on top of a custom built shade structure outside the Zoo on Labouchere Road in South Perth (image 13-D). This unique system, provided by SunPower, is due to be completed in April 2012, and is anticipated to increase the total Zoo solar site size to approximately 230kW.

Perth Zoo attracts over 630,000 visitors each year, and is well positioned to showcase sustainable ways of living.

An integral part of this iconic project will be the providing of supporting educational material, including on-site and website-based information, on solar energy, and real-time displays of solar energy production at Perth Zoo.

**Rio Tinto Naturescape Kings Park**

As part of the Rio Tinto Naturescape Kings Park, Perth Solar City has partially funded the design and construction of an education building (image 13-E). The building incorporates energy efficient design, smart metering and a 15kW solar PV system, and will be used to host energy, environment and sustainability education sessions for school groups. The building is expected to be completed in March 2012.

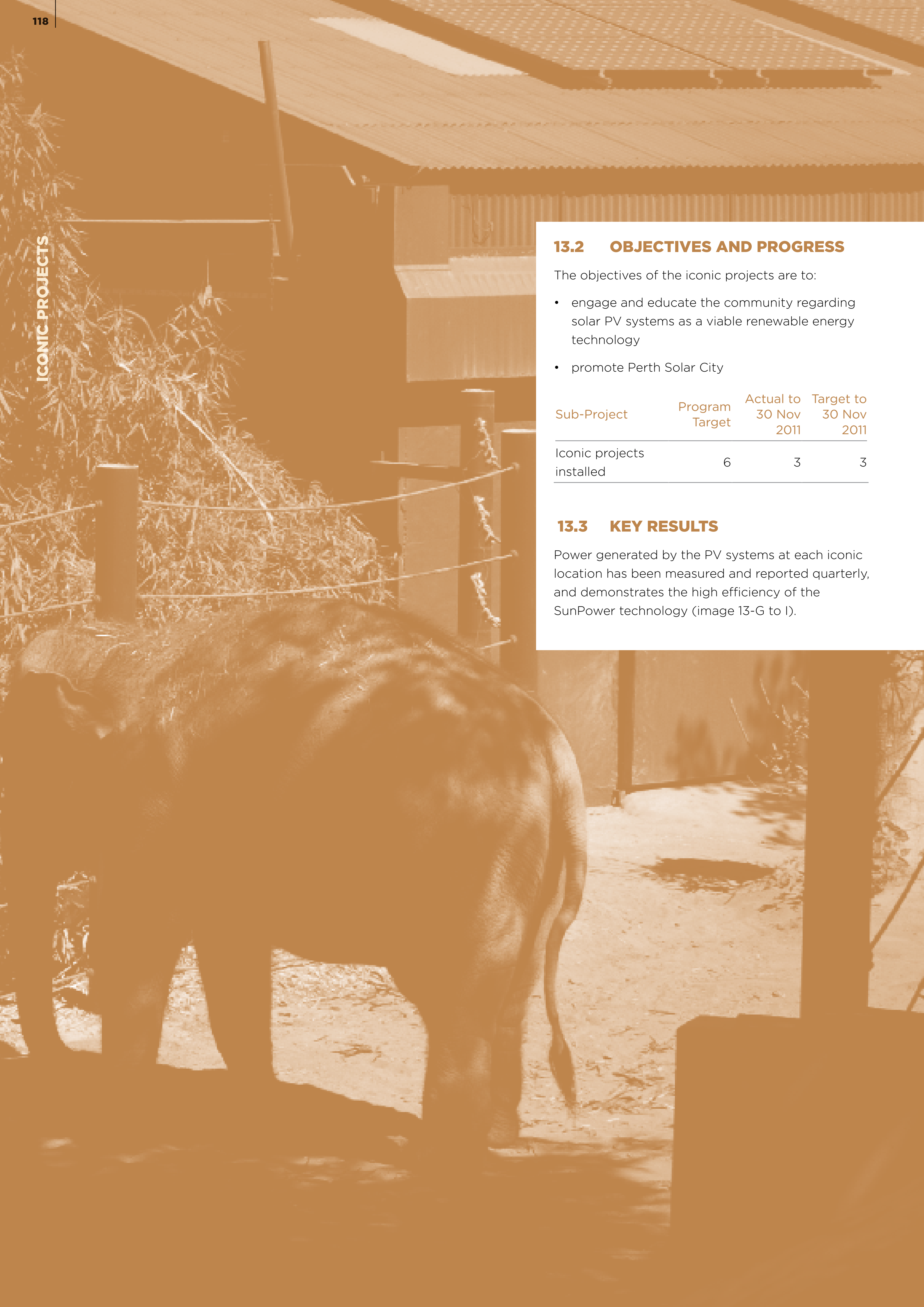
**Perth Arena**

The new Perth Arena will be an iconic building providing a world class facility attracting national and international sporting and entertainment events to Perth (image 13-F).

This new state of the art indoor sporting and entertainment arena is expected to be completed in the third quarter of 2012. Its prime location within the Perth CBD provides an excellent opportunity to showcase the benefits of solar energy, and Perth Solar City.

An 111kW solar PV system will be installed on the new Perth Arena by Synergy, as part of their contribution to Perth Solar City.

Image 13-F: Artist's impression of Perth Arena



## 13.2 OBJECTIVES AND PROGRESS

The objectives of the iconic projects are to:

- engage and educate the community regarding solar PV systems as a viable renewable energy technology
- promote Perth Solar City

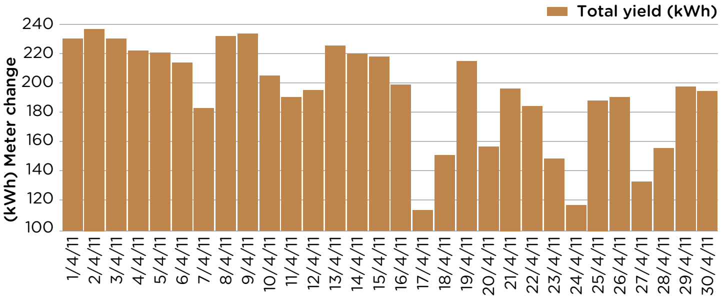
| Sub-Project | Program Target | Actual to 30 Nov 2011 | Target to 30 Nov 2011 |
|---|---|---|---|
| Iconic projects installed | 6 | 3 | 3 |

## 13.3 KEY RESULTS

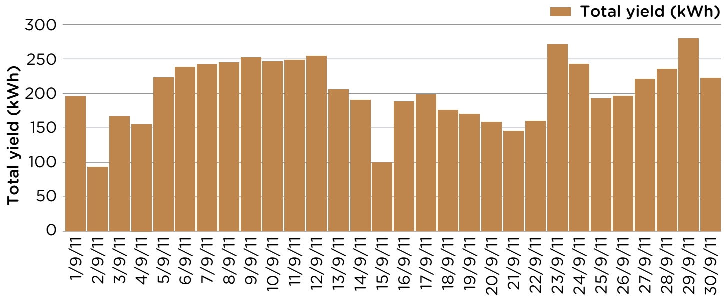
Power generated by the PV systems at each iconic location has been measured and reported quarterly, and demonstrates the high efficiency of the SunPower technology (image 13-G to I).

## Image 13-G: Central Institute of Technology installation performance

**April 2011**

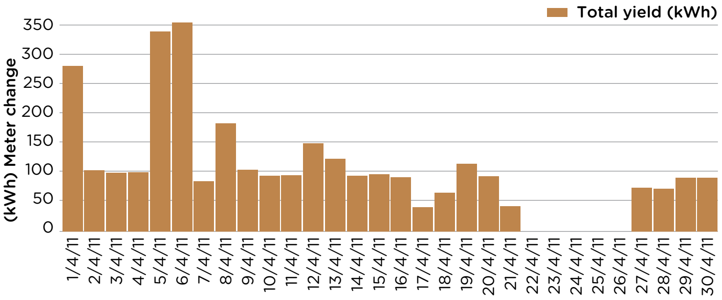



**September 2011**

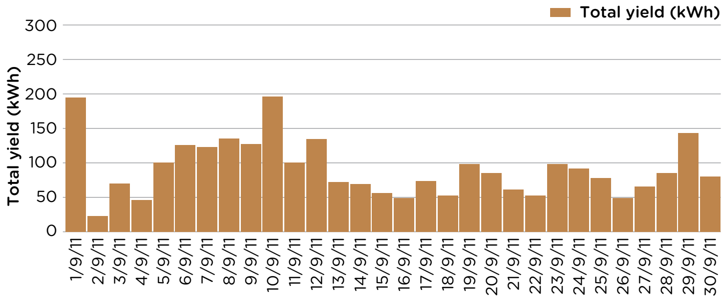



## Image 13-H: Midland Foundry installation performance

**April 2011**

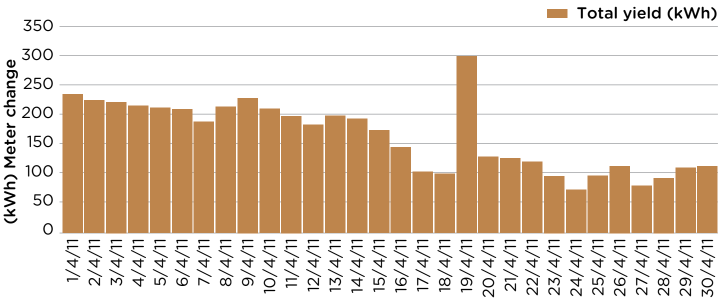



**September 2011**

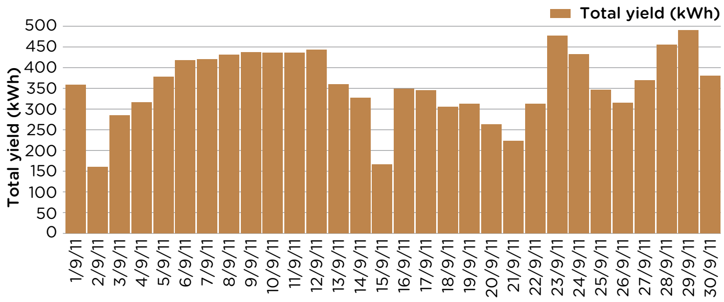



## Image 13-I: Perth Zoo stage one installation performance

**April 2011**




**September 2011**



## 13.4 TRANSFERRABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lessons |
|---|---|---|
| **Community engagement** | BENEFIT:<br>Iconic solar PV installations are an excellent opportunity to engage and educate the broader community about the benefits of solar energy as well as the Perth Solar City program. | OUTCOME:<br>Larger scale solar installations at iconic Perth locations have attracted significant attention from the community, key political stakeholders and the media.<br>LESSON:<br>Iconic projects are a key tool to engaging and educating the community, and should be used in similar programs. |
| **Larger-scale PV connection process (>30kW)** | BARRIER:<br>Lack of streamlined or clear processes within and between electricity distribution and retail organisations for processing PV connection applications for systems larger than 30kW (particularly systems which seek to export excess power to the network). | OUTCOME:<br>Confusion and misunderstanding for applicants which have resulted in delays to projects.<br>LESSON:<br>Trials such as Perth Solar City are critical to uncover and resolve process gaps for the integration of new technology. |

## 13.5 FUTURE FOCUS

The key focus in 2012 will be the completion and launch of the remaining three Perth Solar City iconic projects: Perth Zoo stage two, educational building at Kings Park and Botanic Garden and Perth Arena.

To enable the collection of interval data a smart meter will be installed at each of these iconic sites. This point-to-point metering solution will profile interval consumption data, and gross solar PV system output to better understand each site's load profile.

**TRIALS SUCH AS PERTH SOLAR CITY ARE CRITICAL TO IDENTIFYING AND RESOLVING BARRIERS TO THE INTEGRATION OF NEW TECHNOLOGY**

Central Institute of Technology's 48.6kW system

# 14.0 DEMONSTRATION PROJECTS

9 kW Solar PV Tracking System at Red Hill Waste Management Facility

## 14.1 BACKGROUND

To engage the local community within Perth's Eastern Region about the benefits of energy efficiency and renewable energy, fifteen demonstration projects were implemented by the Eastern Metropolitan Regional Council (EMRC) as part of Perth Solar City. While varied in scope and size, all are located within the community and mostly on public access buildings.

The EMRC represents the six Local Government Authorities (LGAs) located within Perth's Eastern Region: the Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan.

The demonstration projects allow the community to see energy efficiency in action within their community, and assist local councils to actively understand and reduce their energy expenditure and environmental footprint. Each project includes interpretive displays and engagement materials to promote energy efficiency as well as the Perth Solar City program.

LGAs have also made a number of Power Mates available for loan through local libraries. These energy efficiency meters allow residents to measure the electricity consumption of individual appliances, to better understand and potentially change their electricity consumption behaviour.

## 14.2 OBJECTIVES

The overall objectives of the demonstration projects are to:

- engage the community on energy efficiency and renewable energy
- promote Perth Solar City
- contribute to energy efficiency and greenhouse gas savings in local government facilities

In order to demonstrate a range of energy efficiency opportunities, projects included solar PV system installations (fixed and tracking), solar water heating and energy efficiency lighting retrofits.

As at 30 November 2011, thirteen of the fifteen demonstration projects had been completed (table 14-A).

**DEMONSTRATION PROJECTS ALLOW THE COMMUNITY TO SEE ENERGY EFFICIENCY IN ACTION WITHIN THEIR COMMUNITY**

16kW solar PV system at Mundaring Administration Centre

### Table 14-A: Demonstration projects

| No. | Name of Demonstration Site | Project | Completion date | Est. annual energy savings ($/year)^ | Est. annual GHG emissions savings (t CO2-e/year)* |
|---|---|---|---|---|---|
| 1 | Bassendean Memorial Library | 3.6kW PV system | July 2010 | $1,493 | 5,320 |
| 2 | Ashfield Reserve | 4kW PV system | July 2010 | $1,697 | 6,045 |
| 3 | Maylands Multi-Purpose Centre | 15kW PV system | June 2010 | $5,849 | 24,726 |
| 4 | Ruth Faulkner Library | 4kW PV system | June 2010 | $1,697 | 6,045 |
| 5 | Belmont Oasis Leisure Centre | Solar water heating<br>Energy efficient lighting retrofit | Dec 2010<br>May 2011 | $117,604 | 383,510 |
| 6 | Midland Public Library | 1kW PV system | June 2010 | $476 | 1,527 |
| 7 | Ellenbrook Community Library | 2kW PV system | June 2010 | $952 | 3,055 |
| 8 | Altone Park Leisure Centre | 10kW PV system<br>Energy efficient lighting retrofit | June 2010 | $4,288 | 113,000 |
| 9 | Mundaring Administration Centre | 16.1kW PV system | June 2010 | $6,893 | 25,770 |
| 10 | Kalamunda Administration Centre | Energy Management System | June 2011 | TBD | 73,000 |
| 11 | Red Hill Waste Management Centre | 9.1kW tracking PV system | April 2011 | $4,592 | 18,070 |
| 12 | EMRC Administration Centre | 9.1kW PV system | March 2011 | $3,281 | 13,900 |
| 13 | Swan View Youth Centre | 5kW solar PV system | August 2011 | $2,144 | 7,638 |
| To be completed | | | | | |
| 14 | Kalamunda Library | 2.1kW solar PV system<br>Solatube daylighting system | Dec 2011 | $1,337 | 4,823 |
| 15 | Hazelmere recycling centre | Solar PV system – size TBD | March 2012 | TBD | TBD |

^estimated figures provided by the EMRC – electricity tariffs vary by council/project
*estimated figures provided by the EMRC utilising National Greenhouse Account Factors July 2011

## 14.3 KEY RESULTS

Each demonstration project has targeted energy cost and greenhouse gas emissions savings (table 14-A). The largest demonstration project, the City of Belmont – Oasis Leisure Centre, is featured as a case study.

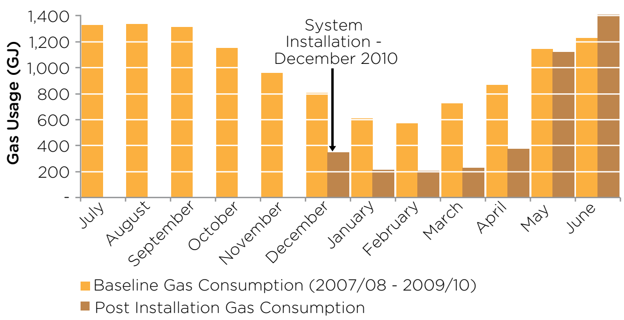
### 14.3.1 CASE STUDY: CITY OF BELMONT - BELMONT OASIS LEISURE CENTRE SOLAR POOL HEATING PROJECT

The Belmont Oasis Leisure Centre solar pool heating project is the largest of the Perth Solar City demonstration projects. It included the installation of 177 coil-panels (HC40) for the 50 meter Olympic sized indoor pool, and the installation of 36 panels (HC50) for the lagoon pool. The coil-panels (image 14-A) provide base-load water-heating for the swimming pools during the warmer months and are augmented by a gas-booster when required.

**Image 14-A: Belmont Oasis Leisure Centre solar water heater**

Table 14-B shows the gas consumption for water heating in the facility before and after the installation of the solar pool heating system.

**Table 14-B: Gas consumption of Belmont Oasis Leisure Centre**




The yellow bars indicate the baseline gas consumption for the three financial years 2007/08 through to 2009/10. The brown bars show actual gas usage following the installation of the solar water heating system in December 2010.

The installation has resulted in up to 69% reduction in gas consumption in the facility during the warmer summer months. Table 14-C highlights the actual cost and estimated future cost and greenhouse gas savings for the facility, as well as an indicative simple payback period for the project.

**Table 14-C: Energy cost and greenhouse gas measures for Belmont Oasis Leisure Centre**

| Measurement | Annual total |
|---|---|
| Baseline Gas Consumption (GJ, 2007/08 - 2009/10) | 11,991 |
| Actual savings to date (GJ, Dec 2010 – June 2011) | 2,238 |
| Actual cost savings ($, Dec 2010 – June 2011)* | $30,271.38 |
| Greenhouse gas emissions savings to date (kg of CO2-e)^ | 114,894 |
| Estimated annual greenhouse gas emissions savings (kg of CO2-e per year)^ | 139,327 |
| Extrapolated annual energy savings (GJ/annum) | 2,714 |
| Extrapolated annual cost savings ($/annum)* | $36,700 |
| **Total System Cost** | **$257,825** |
| **Estimated Payback Period** | **7.02 years** |

* Calculation based on unit cost of $13.52407 per GJ
^ based on emission co-efficient of 51.33kg/CO2-e per GJ – National Greenhouse Account Factors July 2011

**THE BELMONT OASIS LEISURE CENTRE SOLAR POOL HEATING PROJECT RESULTED IN UP TO 69% REDUCTION IN GAS CONSUMPTION IN THE FACILITY DURING THE WARMER SUMMER MONTHS**

## 14.4 TRANSFERRABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lessons |
|---|---|---|
| **Local government tender processes** | BARRIER:<br>Extensive tender process relative to project scope and value | OUTCOME:<br>Response to LGA tenders for solar PV system demonstration projects was limited, particularly at times of high PV demand.<br><br>LESSON:<br>LGAs should consider refining or simplifying procurement processes to achieve greater rates of response from solar PV system suppliers, |
| **Community engagement** | BENEFIT:<br>Demonstration projects engage and educate the local community about energy efficiency and renewable energy. | OUTCOME:<br>Renewable energy installations within the local community have provided ongoing engagement opportunities with local residents.<br><br>LESSON:<br>Demonstration projects are a key tool to engaging and educating the local community, and should be part of similar programs. |
| **Installation of small scale renewable energy systems** | BENEFIT:<br>Demonstration projects assist local councils to actively understand and reduce their energy expenditure | OUTCOME:<br>The installation of renewable energy systems on LGA buildings has reduced the associated operational expenditure on energy (for example, City of Belmont's 69% reduction in gas consumption).<br><br>LESSON:<br>Demonstration projects should be part of similar programs. |

## 14.5 FUTURE FOCUS

The key focus for 2011/12 will be the completion of the remaining two demonstration projects at the Kalamunda Library and Hazelmere Recycling Centre.

Further case studies will be completed including relative electricity cost and GHG-e savings for other EMRC demonstration projects.

# 15.0 SCHOOLS ENGAGEMENT

## 15.1 BACKGROUND

The energy consumed by schools is considerable and often challenging to reduce. In many cases a split incentive exists whereby the occupants of the building are not responsible for the costs of the energy used. Public schools in particular are generally not incentivised to reduce energy costs, as the proceeds from reducing consumption are not directly received by the school.

Furthermore, schools use energy during the 200 school days of the year, and often little consideration is given to how energy is used during non-school hours or during school holidays.

Perth Solar City designed a schools engagement program that seeks to provide schools with the tools and ongoing engagement required to understand, and subsequently reduce, their energy consumption. Promotion of energy efficiency within the school environment also aims to further educate the broader school community, as well as promote the Perth Solar City program.

Perth Solar City specifically targeted its three school programs at reducing energy consumption and greenhouse gas emissions within schools. These three programs were:

- energy auditing for 20 schools
- a school-based documentary focused on student environmental 'champions' (Eco Superstar)
- an energy saving competition (Bring It Down) which gave participating schools access to real-time electricity consumption displays

## 15.2 PROGRESS

### 15.2.1 SCHOOL ENERGY AUDITS

**Recruitment**

Perth Solar City targeted a total of 20 schools within Perth's Eastern Region to receive a free school energy audit. Schools were also provided with the opportunity to participate in energy efficiency workshops to facilitate the implementation of the energy saving opportunities identified during the audit. All 125 schools within the Perth Solar City target area were sent letters inviting them to participate in the audit program. As a result, 20 schools of various types were recruited:

- government primary school - 11
- non-government primary school - 3
- government high school - 5
- non-government high school - 1

**Completion of school energy audits**

Mojarra, a Perth Solar City Consortium member, was engaged to complete the school energy audits. The audit involved a certified assessor examining the school's historical energy consumption, general patterns of electricity use by students and staff, as well as an audit of appliances such as air-conditioners.

An audit report was compiled, highlighting high energy consuming areas within the school (for example lighting, heating or cooling), and recommended the most cost effective actions to reduce energy consumption and improve energy efficiency. Information from the audits can also be used to apply for state and federal government grants which further assist schools in becoming more energy efficient.

### Energy efficiency workshop

The schools were invited to participate in a workshop aimed at assisting them to access state and federal government Solar Schools grants, and to discuss the energy efficiency opportunities identified in the school energy audits. Unfortunately, despite engaging all schools to schedule suitable times and locations, representation from the twenty schools was low. Competing curriculum activities and the generally time-poor nature of school staff were identified as a major barrier for school participation in such energy efficiency programs.

Two additional incursion workshops focusing on energy efficiency were held for student groups (years 8-10) at Mundaring Christian College upon request from the school.

Image 15-B: Website excerpt

## 15.2.2 ECO SUPERSTAR DOCUMENTARY

Prospero Productions, a Perth Solar City Consortium member, was engaged to design and produce a high school-based documentary focussed on finding an environmental champion. Eco Superstar promoted awareness of energy efficiency, broader environmental issues, as well as the Perth Solar City program. In order to engage students, Prospero Productions designed the documentary with reality-TV style approach and branding (image 15-A), pitting students in a competition to determine an environmental champion.

For the chance to become the first Eco Superstar, students from schools in Perth's Eastern Region were invited to submit a short film highlighting their passion for the environment. The competition was launched at three different schools during March 2010, and was supported by online media tools such as social networking sites and a dedicated website. The Eco Superstar website (www.ecosuperstar.com.au) was the key hub of the competition. It included videos, blogs, photos, tweets, and comments from high school students in the region, as well as the short film entries (image 15-B).


Image 15-A: Eco Superstar logo

Eco Superstar finalists were judged online by the community, based on their environmental message, their creativity and ability to inspire. The subsequent Eco Superstar documentary follows the two finalists during their two-week challenge to make their school and home more eco-friendly, reduce their energy use (benchmarked daily on the Eco Superstar website) and organise an eco-event.

After some fierce competition, Perth Solar City was pleased to announce Sarah Brown from Mundaring Christian College as the winner of Eco Superstar 2010. Through the two-week challenge Sarah engaged the school in switching off unused lighting and standby power, and challenged her family to reduce their energy consumption by taking shorter showers. For her eco-event, Sarah organised a recycling and rubbish collection competition for the junior school students. She also lobbied her local council to construct a new footpath, and invited a spokesperson from Keep Australia Beautiful to talk to the students about recycling. The eco-event was so successful that the school has committed to making it an annual event.

Nate Wood from Helena College was the Eco Superstar runner-up. Nate's claymation video entry was a standout, and through the challenge he banded together with classmates to turn off standby power, and switch off unused lighting and appliances. Nate held an eco-disco that raised money for a school vegetable patch.


Image 15-C: Host John Robertson and the two finalists at the premiere

The Eco Superstar documentary premiered on 20 October 2011 at the Astor Theatre, with over 200 people in attendance.

The Eco Superstar DVD can be used as an education tool for junior to middle secondary classes including environmental studies, media studies and society and environment. Prospero Productions worked with the Australian Teachers of Media to develop a study guide to accompany the Eco Superstar DVD. Using the resource will help students be better able to:

- identify environmental issues in the community
- decide how these environmental problems might be addressed at the personal and local levels
- apply the ideas and values of Eco Superstar to their own homes and school communities

### 15.2.3 BRING IT DOWN ENERGY CHALLENGE

Schools in Western Australia currently receive an electricity bill approximately every 60 days. This is considered a limiting factor in a school's ability to better manage their energy use. Western Power designed and implemented Bring It Down as a school-based electricity reduction challenge to test the response to providing access to real-time electricity consumption information. The competition between schools focused on achieving energy reductions through the use of real-time electricity consumption information via a web-based display.

The competition structure included the following components:

- entry was open to a minimum of five and a maximum of eight schools
- the competition ran for seven weeks towards the end of term three and early term four (12 September to 31 October 2011), which included a two-week school holiday period
- participation was free for all schools – all display and monitoring equipment was installed and will be provided to schools beyond the life of the competition through to 30 June 2013
- the competition used a weekly points structure as a means of maintaining motivation throughout the competition
- schools were benchmarked based on school energy consumption for the same seven week period over the previous three years
- the winning school would receive $10,000 of energy efficiency upgrades, as identified in their Perth Solar City school energy audit

Image 15-D: Bring It Down branding

BRING IT DOWN
ENERGY CHALLENGE

Image 15-E: Bring It Down web-based display


### Real-time electricity consumption display

The real-time energy display formed the key technology component of the competition. It allowed schools to see what their energy use was on a daily basis in comparison to their own benchmarks, as well as the performance of other competing schools. Additionally, by using time-based intervals, schools were also able to understand their electricity consumption during non-school hours and weekends. As a result, schools were able to identify areas for energy efficiency during these periods.

The display technology provides real time energy consumption information to users via a web-based dashboard (image 15-E) on the Bring It Down page of the Perth Solar City website. The web-based dashboard can be viewed on any computer connected to the Internet, allowing teachers, students and parents to view the dashboard from the classroom or home.

### Competition rules and structure

The Bring It Down energy challenge was a point-based competition in which schools earned points over each of the seven weeks. Schools were ranked each week based on their percentage energy reduction against the pre-determined benchmark (table 15-A).

Table 15-A: Bring it Down points structure

| Ranking | Points (week 1-5) | Points (week 6-7) |
|---|---|---|
| 1 | 100 | 200 |
| 2 | 90 | 180 |
| 3 | 75 | 150 |
| 4 | 60 | 120 |
| 5 | 45 | 90 |
| 6 | 30 | 60 |
| 7 | 20 | 40 |
| 8 | 10 | 20 |

The competition was run weekly from Monday to Sunday between 12 September 2011 and 31 October 2011, including two weeks of school holidays.

### Implementation

The competition was launched on 12 September 2011 with seven schools in Perth's Eastern Region participating, including:

- Upper Swan Primary School
- Ballajura Community College
- Woodbridge Primary School
- Mundaring Christian College
- Hillside Christian College
- Swan View Senior High School
- Weld Square Primary School

This provided a mix of lower and secondary schools, including Ballajura Community College (middle and upper high school). Ballajura is one of the largest schools in Western Australia with over 2,000 students, and an annual energy cost in excess of $220,000.

### Engagement

Schools were supported by ongoing engagement during the competition to focus on energy saving initiatives, and help them to utilise the real-time display. Support for participating schools included:

- a technology user guide and briefing pack to prepare for the competition
- weekly updates about the progress of each competing school
- weekly tips on how to potentially reduce energy use
- competition posters with energy saving tips
- a post competition evaluation on the schools performance including insight into energy use trends over different time periods (including weekend and school holiday periods)

### Competition winner

Mundaring Christian College won the competition (table 15-B), winning all seven rounds. This included a 60% reduction in their benchmarked electricity use in the final week of the competition. Their total energy savings over the seven week duration of the competition was 7,601kWh, representing a 54% reduction or over $1,900 of electricity savings.

Mundaring Christian College was able to achieve significant electricity savings through the following initiatives:

- switching lights off in empty rooms, and placing a notice next to the light switch
- taking out one fluorescent tube from double tube fixtures where practicable
- making sure that all overnight security lights were set correctly, and not switching on during daylight hours
- ensuring all desktop computers were switched off at the wall overnight
- an incentive for staff to be aware of heater/air-conditioner use and to be efficient without compromising student comfort
- switching all photocopiers and electrical equipment off at the wall over night or through the holiday period saving on residual power when these are normally left in sleep mode
- teachers removing posters from their windows to let natural light into the classroom,
- students being given monitor roles to switch lights off in empty rooms and inform the teacher of the error of their ways
- continually telling the Principal to turn his light off when he was not in his office

**Table 15-B: Bring It Down competition final scores**

| Rank | Team Name | Overall Score |
|---|---|---|
| 1 | Mundaring Christian College | 900 |
| 2 | Hillside Christian College | 810 |
| 3 | Swan View Senior High School | 645 |
| 4 | Upper Swan Primary School | 555 |
| 5 | Woodbridge Primary School | 365 |
| 6 | Weld Square Primary School | 275 |
| 7 | Ballajura Community College | 230 |

**Image 15-F: Terry Myers, Principal, Mundaring Christian College, receiving the Bring It Down award with Hon Peter Collier, WA State Energy Minister and Andrew Blaver**

## 15.3 KEY RESULTS

Key results focus on the electricity savings achieved through the Bring It Down challenge. Table 15-C shows the consolidated results for all participating schools over the seven weeks of the competition.

It is worth noting that while Ballajura may have placed last in the competition, they in fact reduced their energy consumption by over 23,000kWh and saved over $5,800. This was the largest total saving achieved in the competition.

The total combined energy savings of all schools amounts to over 64,000kWh, or over $16,000. This is the equivalent average energy production of a 313kW solar PV system over the same time period.

**Table 15-C: Overall results**

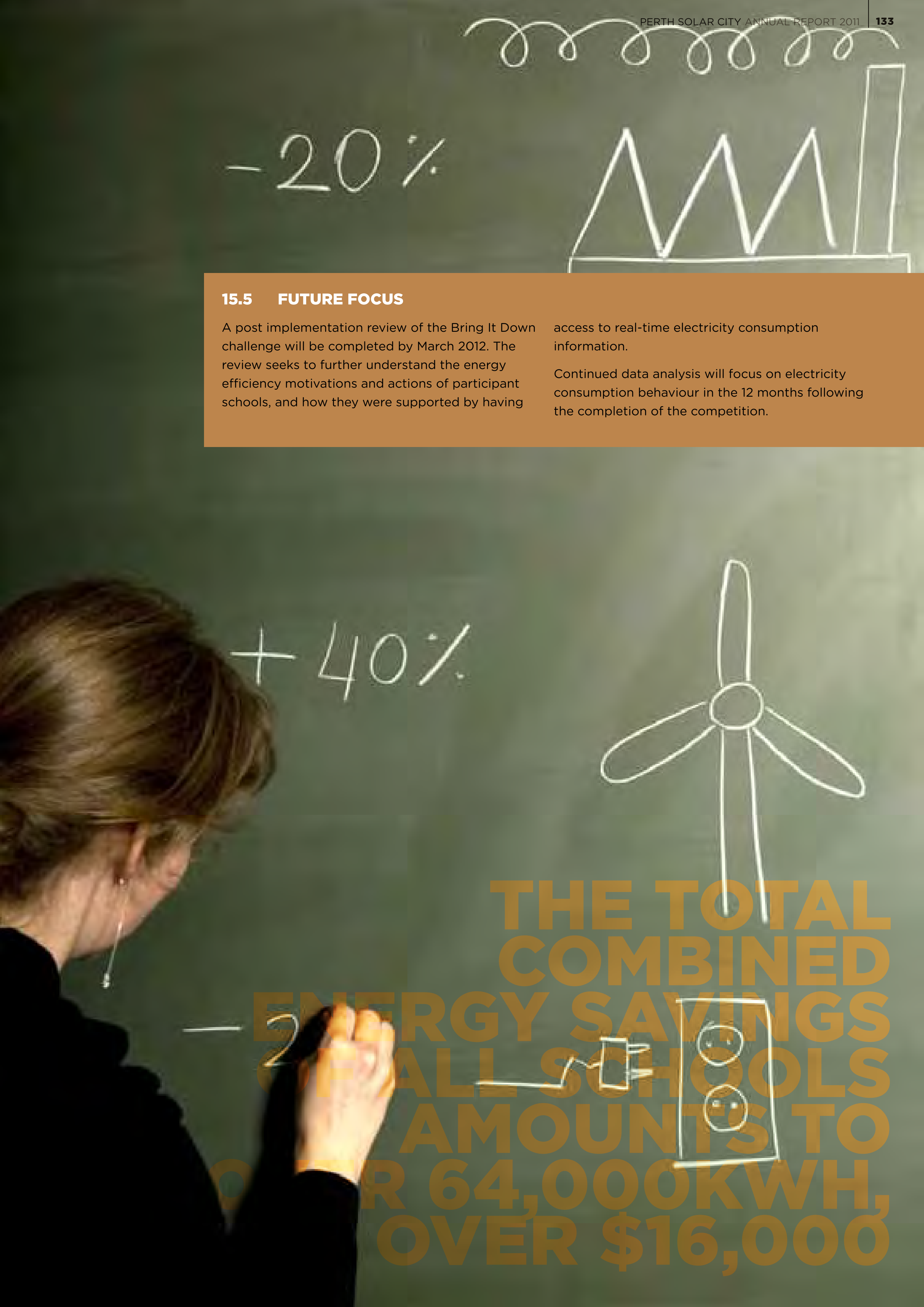
| School | Benchmark (kWh) | Actual (kWh) | Saving (kWh) | % Reduction | Cost saving ($) |
|---|---|---|---|---|---|
| Mundaring | 14,200 | 6,599 | 7,601 | 54% | $1,900.37 |
| Hillside | 9,570 | 5,237 | 4,333 | 45% | $1,083.22 |
| Swan View | 46,840 | 29,829 | 17,011 | 36% | $4,252.72 |
| Upper Swan | 17,150 | 11,501 | 5,649 | 33% | $1,412.13 |
| Woodbridge | 16,360 | 12,198 | 4,162 | 25% | $1,040.46 |
| Weld Square | 10,400 | 8,219 | 2,181 | 21% | $545.33 |
| Ballajura | 146,300 | 122,740 | 23,560 | 16% | $5,889.92 |
| TOTAL | 260,820 | 196,323 | 64,497 | 25% | $16,124.14 |

Notes: Savings based on a rate of $0.25c/kWh

## 15.4 TRANSFERRABLE LESSONS

| Activity | Barrier or benefit | Outcome and/or lessons |
|---|---|---|
| **School energy competition** | BENEFIT:<br>Access to real-time electricity consumption information within a competition setting | OUTCOME:<br>Energy savings were significant.<br>LESSON:<br>The provision of real-time electricity consumption data, with historical benchmarks, is a useful tool in helping schools to understand, and then reduce, their electricity use. |
| **Grant facilitation** | BARRIER:<br>Competing curriculum activities and the time-poor nature of school staff | OUTCOME:<br>Accessing energy efficiency grants appears to be a low priority among schools.<br>LESSON:<br>Even with significant school engagement, information and time barriers remain. |
| **Bring It Down competition structure** | BARRIER:<br>Large schools participating in Bring It Down made significant electricity savings however, as a proportion of their electricity consumption, these savings were relatively low. | OUTCOME:<br>Larger schools with high electricity consumption benchmarks were disadvantaged in the competition.<br>LESSON:<br>Future competitions should include recognition of both relative savings and absolute savings. |

**THE PROVISION OF REAL-TIME ELECTRICITY CONSUMPTION DATA, WITH HISTORICAL BENCHMARKS, IS A USEFUL TOOL IN HELPING SCHOOLS TO UNDERSTAND, AND THEN REDUCE, THEIR ELECTRICITY USE**




## 15.5 FUTURE FOCUS

A post implementation review of the Bring It Down challenge will be completed by March 2012. The review seeks to further understand the energy efficiency motivations and actions of participant schools, and how they were supported by having access to real-time electricity consumption information.

Continued data analysis will focus on electricity consumption behaviour in the 12 months following the completion of the competition.

**THE TOTAL COMBINED ENERGY SAVINGS OF ALL SCHOOLS AMOUNTS TO OVER 64,000KWH, OVER $16,000**

# APPENDIX

MINISTERIAL COUNCIL ON ENERGY

NATIONAL MINIMUM FUNCTIONALITY FOR SMART METERS

| Functionality | | Description |
|---|---|---|
| 1-8 | Core functions | 1. Half hourly consumption measurement & recording<br>2. Remote reading<br>3. Local reading – hand-held device<br>4. Local reading – meter display.<br>5. Communications and data security.<br>6. Tamper detection.<br>7. Remote time clock synchronisation.<br>8. Load management at meter – dedicated control circuit. |
| 9 | Daily read | Daily remote collection of the previous trading days energy data |
| 10 | Power factor phase | Half-hour reactive interval energy measurement and recording on single and three phase meters. |
| 11 | Import Export | Records active energy flows both into the electricity grid and out, where the customer has installed local generation (eg, solar cells). |
| 12 | Remote connect/ disconnect | Allows the power to a customer's premise to be connected or disconnected remotely |
| 13 | Supply capacity control | Provides the ability to limit power to individual customers, for example in recovery from a black out to manage stability and allow recovery power for emergency services. |
| 14 | Load management at meters – dedicated control circuit | Supports existing arrangements for load control of electric storage water heating and space heating systems. This functionality allows more rapid and flexible use of load control than in the core case. |
| 15 | Home Area network | The capability to interface with an in-home display or other in-home device via a home area network (HAN) using an open standard |
| 16 | In home display | An in-home display, provided as part of the national roll-out, provides a communications interface with the home owner. |
| 17 | Water and gas metering | Gas and water meters would be able to be read remotely, via a communications interface in the electricity meter. |
| 18 | Quality of supply and other event recording | Enables meters to record information in relation to quality of supply and other events (eg: outage). The event log could then be read remotely. |
| 19 | Loss of supply detection and outage alarm | Enable a loss of supply to the meter and system outages to be detected. |
| 20 | Real time service checking | The meter can be "pinged" remotely in real time in order to check the presence of supply to a meter. |

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# Smart Grid Cost Benefit Analysis Report

# Executive Summary

| Date published | 16 September 2011 |
| --- | --- |

# 1. Executive summary

## 1.1 Introduction

The Smart Grid has the potential to provide significant benefits to Western Australia from energy conservation, improved security of supply and reduced network and generation investment whilst assisting with the evolution to a cleaner and more sustainable energy economy.

The next steps in a transition to a Smart Grid will require significant investments in the key building blocks of smart meters, enhanced IT systems, and a pervasive communications network. Further, a range of smart grid capabilities enabled by this infrastructure such as Direct Load Control of air-conditioners, innovative customer tariffs, in-home-displays and customer information portals will need to be established and supported by a comprehensive customer engagement and education program.

This project was established to understand whether there is a positive societal benefit for Western Australia from the introduction of these Smart Grid capabilities. It assumes a rapid but practical timeframe for implementation with the infrastructure rolled-out over an eight year period commencing in mid-2011[1]. It is based on the incremental costs and benefits arising from the deployment of Smart Grid, with a conservative approach to valuation of benefits applied throughout the modelling.

The assessment is undertaken on a societal basis, recognising that the benefits do not accrue sufficiently to one stakeholder to justify an individual investment. The modelling assigns all costs and benefits to different stakeholders based on where they are first incurred (for costs) or realised (for benefits). Stakeholders assessed include generators, the distributor, the transmission business, retailers, Government and customers.

## 1.2 Results

**The overall societal net present value (NPV) from the smart grid is estimated at $208m over 20 years.** If the value assessment period was extended to 25 years this NPV would increase to $403m.

The key costs relate to the infrastructure required to enable the smart grid capabilities including the smart meters and associated IT. However, recognising the importance of customer engagement significant costs have also been allocated for customer education and

[1]Alternative roll-out options were also modeled to confirm the impact these would have on the cost benefit assessment.

marketing. The key benefits are avoided T&D investment, generation investments (capacity credits) and energy conservation. This is shown in Figure 1-A.

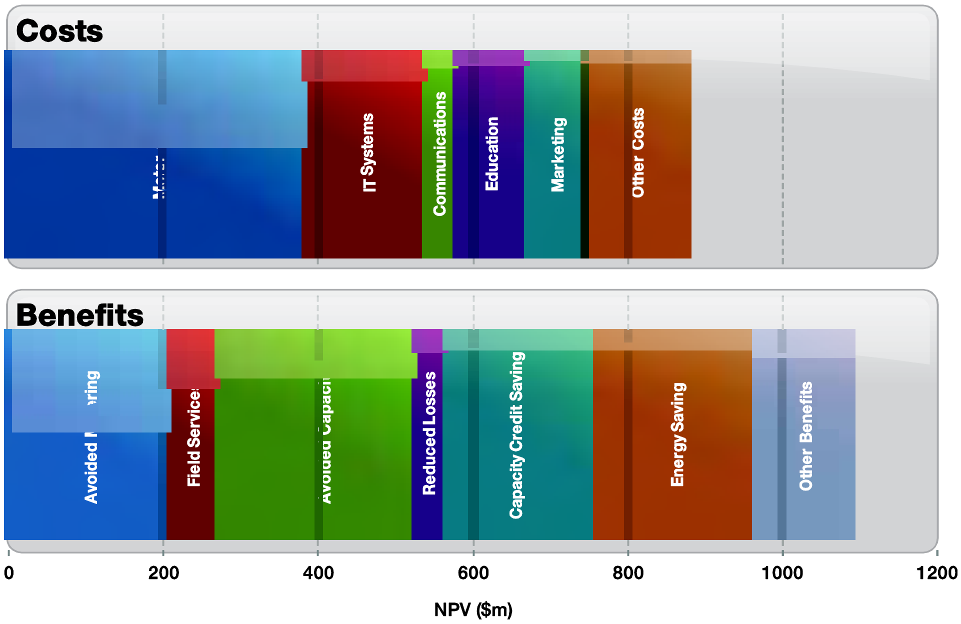



**Figure 1-A Summary of key cost benefits**

### 1.2.1 Stakeholder Benefits

The results of the modelling are shown in Figure 1-B. This demonstrates that the distribution business has the largest negative position as it is assumed to be primarily responsible for investment in the Smart Grid. The customer is the largest beneficiary through reduced consumption, incentives for DSM and unserved energy. The retailer only receives a small net gain despite the avoided capacity credit benefits due to its required IT investment.

Whilst the modelling indicates that there is a societal gain from the introduction of Smart Grid it does not address the distribution of this gain or the individual incentives for investment in the Smart Grid. In order to avoid excess risk to Western Power, it will be imperative that any Smart Grid investment has Government / Regulatory support to confirm this is prudent expenditure that can be allocated to the regulatory asset base.

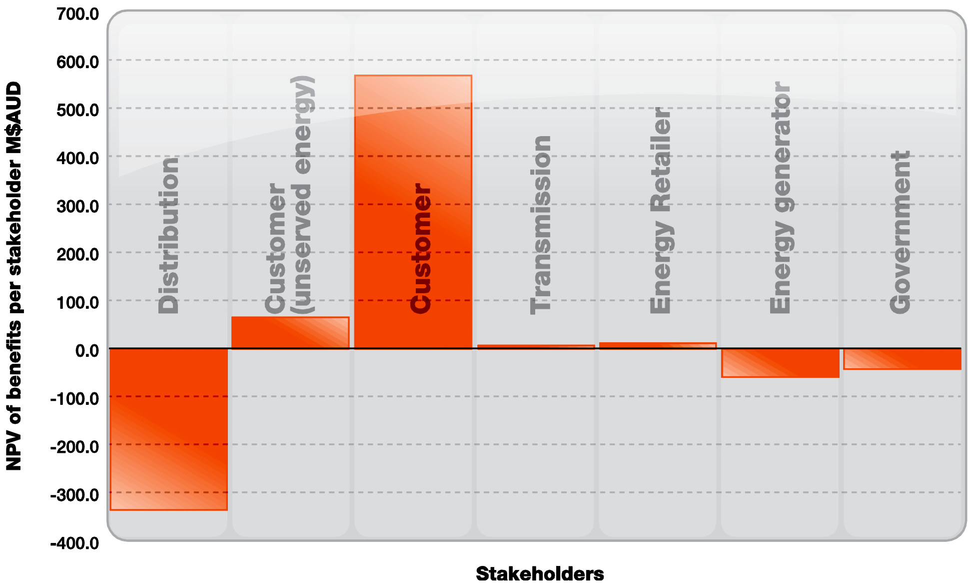



**Figure 1-B Initial stakeholder allocation of NPV benefits**

### 1.2.2 Potential Range of the Benefits

The modelling included both sensitivity analysis and Monte-Carlo analysis in order to understand the potential range of outcomes.

The sensitivity chart, Figure 1-C indicates the impact on the NPV of moving a single parameter from its expected value to the high or low point that were considered feasible. The main purpose of this analysis is to illustrate the areas of uncertainty in the modelling and suggest where further research may be needed. The analysis demonstrates the duration of assessment, EV take up rate and parameters on the take up and savings from DLC have the largest impact on NPV. However, changing any one parameter will still leave the NPV as strongly positive.

The Monte-Carlo analysis was undertaken for a fixed value assessment period of 20 years using 1,000 runs. The key observation from this simulation is that the mean NPV increases to $235m compared to $208m predicted by using the likeliest value of each parameter. There is a 65% chance that the NPV will be higher than $200m and a 95% chance that the NPV will be between $69m and $402m. This distribution is shown in Figure 1-D.

APPENDIX B

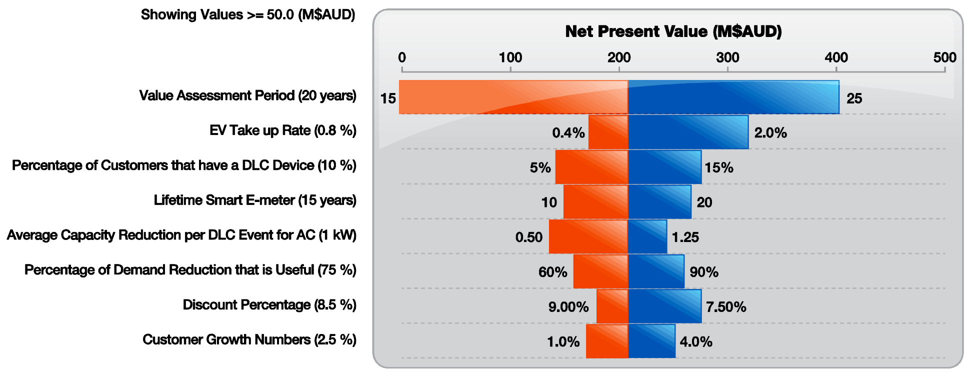



**Figure 1-C Sensitivity chart for the smart grid model**

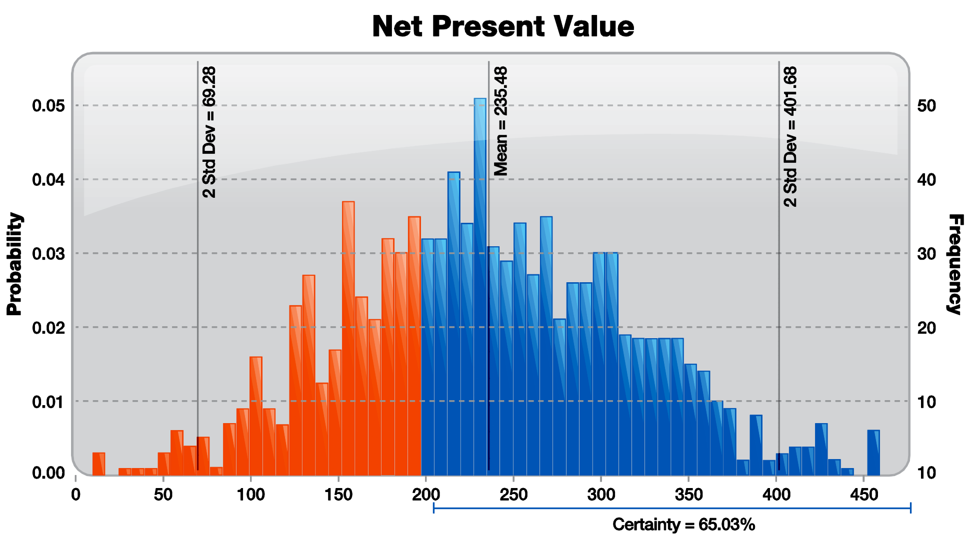



**Figure 1-D Probability distribution chart for the roll-out of smart grid**

### 1.2.3 Cash Flow Chart

The cash flows for the Smart Grid roll-out are shown in

**Figure 1-E Cash flows from the roll out of Smart Grid**

. These are sharply negative in the initial period as full benefits do not accrue until several years after the roll-out is complete. The worst case position is shown to be negative $332.6m occurring in 2018/19. After this date the benefits grow rapidly through avoided network augmentation and a reduced requirement to purchase capacity credits with the NPV becoming positive in 2026/27.

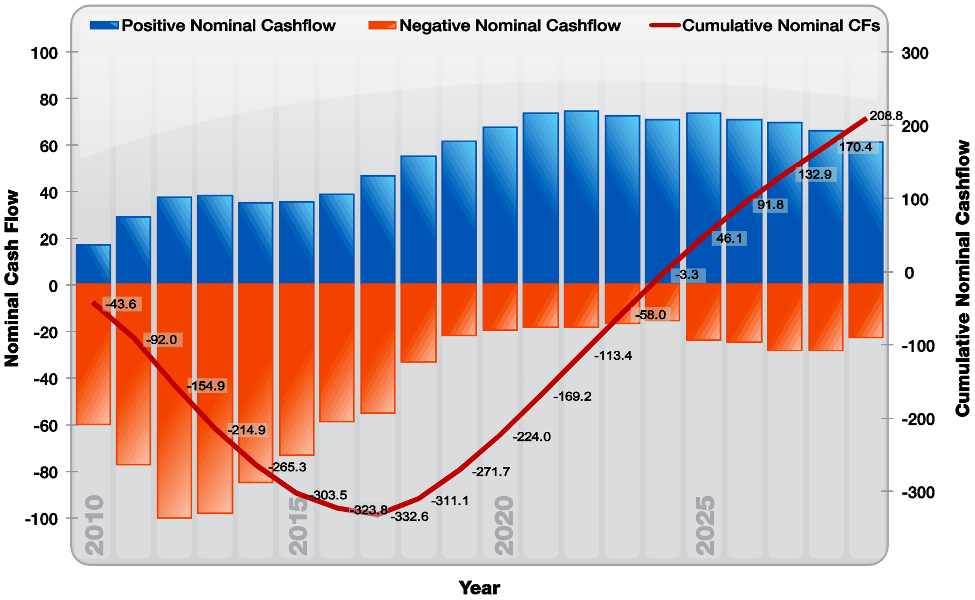



**Figure 1-E Cash flows from the roll out of Smart Grid**

### 1.2.4 Alternative Scenarios for Smart Grid Roll-Out

The modelling indicates that the most significant benefit requires a full roll-out of smart meters over a short time period. This captures the full business process improvement and minimises the impact of running duplicate business processes. It also quickly addresses customer 'equity' issues with the same level of service being available to all customers. However, the modelling does show that a full-scale roll-out requires significant funding with a large negative cash flow position before benefits are realised.

A number of alternative options for start dates and completion dates were assessed in the model[2]. All these options continued to deliver strongly positive NPVs with less demanding cash flow requirements. These alternative options and the debt implications should be considered when determining the most appropriate roll out strategy for the SWIS region.

[2] Only one alternative is presented within the report, but the assessment process included different start dates, completion dates and delays to the introduction of communications technology.

### 1.2.5 Conclusions and Recommendations

The cost benefit analysis modelling demonstrates strong positive societal benefits from the roll-out of the Smart Grid in Western Australia under all assessed scenarios. The suggested next steps to progress the Smart Grid are therefore as follows:

- **Stakeholders Engagement-** A number of key stakeholders need to be engaged to ensure their understanding and acceptance of the selected smart grid strategy, including the Office of Energy, ERA and consumer groups. This should prevent obstacles to implementation that may otherwise arise and impact on the benefits;
- **Detailed Implementation Plan** - The modelling considered a number of alternative deployment scenarios with high level costs for each option modelled. A more detailed implementation plan should be produced for the preferred option with any revised costing reflected in the CBA;
- **Review Assumptions** - The CBA was based on a number of assumptions, which were widely discussed within Western Power and considered national and international experience. If these assumptions change or new supporting data becomes available (particularly from the Smart City trials) then the model should be updated to remain consistent with the latest available data;
- **Review Impact on AA3/AA4 Expenditure** - There is a need to confirm how AA3 / AA4 operational and capital funding requirements will be impacted by the smart grid roll-out scenario chosen and ensure this is reflected in the regulatory submissions;
- **Framework for Required Transfer Payments -**The modelling indicates that there are not sufficient benefits for any one participant to justify the roll out alone without agreement on cost recovery from other participants. A framework should be developed to support the necessary transfer payments ensuring all stakeholders gain from the introduction of smart grid.

<firstname> <surname>

<address 1>

<address 2> WA <postcode>

Insert date

Dear <firstname>

<site address>

**Good news! You have been selected to take part in the Perth Solar City program**

You have been chosen by Western Power to receive a new smart meter which will be installed in the coming weeks at no cost to your family.

Perth's Eastern Region has been chosen to host Western Australia's only Solar City. As part of the Australian Government's $94 million Solar Cities program, one Solar City is being established in each mainland state. This exciting program offers a new era of sustainable energy use.

Everyone who lives or owns property within the Eastern Metropolitan Regional Council (EMRC) has the opportunity to benefit from this exciting initiative, designed to help households better manage their energy use, make cleaner, greener choices and save money.

This includes over 106,000 households within the Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan.

Western Power is leading Perth Solar City with the support of an experienced Consortium, including Botanic Gardens and Parks Authority, the Eastern Metropolitan Regional Council (EMRC), Mojarra, Prospero Productions, Solahart, Sunpower and Synergy.

**What's in it for you and your family?**

As a resident of Perth's Eastern Region, you and your family are part of the Perth Solar City program.

You may have seen the new solar panels that have been installed on the rooves of the Central Institute of Technology and the Midland Foundry. This is all part of the Perth Solar City program. There are also advertisements screening in your local cinemas and local papers called 'Collective Impact' which encourage people to become involved in the Perth Solar City program. If you are interested you can access:

- a FREE home eco-consultation to help you understand and better manage your energy use
- a discounted solar hot water system and solar photovoltaic (PV) system to help you save money on your power bills. These systems will enable residents to create and use their own energy!

**In addition to these offers, your household has been selected by Western Power to receive a smart meter, at no cost to you. It will replace your current electricity meter.**

What is a smart meter?

A smart meter is a much more sophisticated type of electricity meter than the one currently servicing your home. The smart meter will do the job of the old meter and record your home's power use, but it will also provide greater benefits to you such as:

- improved meter reading accuracy
- the early detection of power quality issues
- the early detection of faults so they can be fixed quicker

**In the very near future, Western Power will be writing to you to advise when they are installing your new smart meter. I would like to reiterate that there will be no charge to you for either the smart meter or the cost of installation.**

If you have any questions about your new smart meter, please call Western Power on 13 10 87.

If you wish to know more about Perth Solar City, or want to know more about the free home eco-consultation or discounted products and services, simply call 1300 993 268 or visit perthsolarcity.com.au.

Sincerely,

Mark de Laeter
General Manager
Western Power

**AMRS (08) 9359 8251**

Date: ***Xth April 2010***

«Customer_Name»
«Postal_Address»
«Suburb1»

Dear Sir/Madam,

**Planned Electricity Supply Interruption for Installation of SMART METER**

**RE: «Address»**
**«Suburb» «Post_Code»**

Smart metering is one of the initiatives of the Perth Solar City project. A smart meter will enable a number of improved services, including automated reading of your meter. Later stages will enable interested parties to have equipment installed in their home which will provide the household with specific consumption readings/measurement of selected electrical appliances.

Being connected to a smart meter should be undetectable to you, except that you might notice that you do not receive visits from meter readers any more.

One of our technicians will visit your premises between **xxxxday, 99 Month 2010** and **xxxxday, 99 Month 2010** to exchange your existing meter for a smart meter. This work will result in having to turn OFF your electricity supply for up to 60 minutes on the day of the visit. We will endeavour to keep this outage to a minimum.

It is not necessary for you to be present during the maintenance work. If your meter cannot be accessed without you being home please phone AMRS Call Centre on **(08) 9359 8251** between **8:30am** and **4:00pm Monday** to **Friday** to arrange a suitable time for our technician to visit.

If this planned service interruption will create any health or safety issues for you or any other occupants please notify AMRS as soon as possible on our call centre number as listed below.

All enquiries relating to this meter change should be directed to our call centre on **(08) 9359 8251**.

Yours faithfully

**Zane Webb**
**Manager**
**AMRS (Aust) Pty Ltd**
**Authorised Contractor for Western Power**

DM#: 6909903v1

Dear householder,

Today Western Power installed a new electronic meter at your home as part of the Perth Solar City program. This meter is part of a trial of smart meters, also known as advanced metering infrastructure (AMI), and will provide two-way communication between your electricity meter and Western Power.

Your smart meter will measure and record the electricity usage in your home in half hour intervals, as well as the total consumption. The information will be uploaded daily to Western Power via a communication module contained within the meter.

Immediate benefits of your smart meter will include improved accuracy of meter readings by removing human error, early detection of power quality issues like power surges or voltage drop and improved monitoring of power outages to assist maintenance crews in reducing restoration times.

Future benefits include the ability to install:

- An in-home display (IHD) to help you monitor your energy use
- A Home Area Network (HAN) to help you manage the use of air-conditioners, pool pumps and other electrical devices.

## Contact Information:

For further information about your smart meter please visit the Western Power website at: www.westernpower.com.au/yourmeter

Or alternatively call our Customer Service Centre on: 13 13 51
TTY Users (Speech or Hearing Impaired) 1800 13 13 51

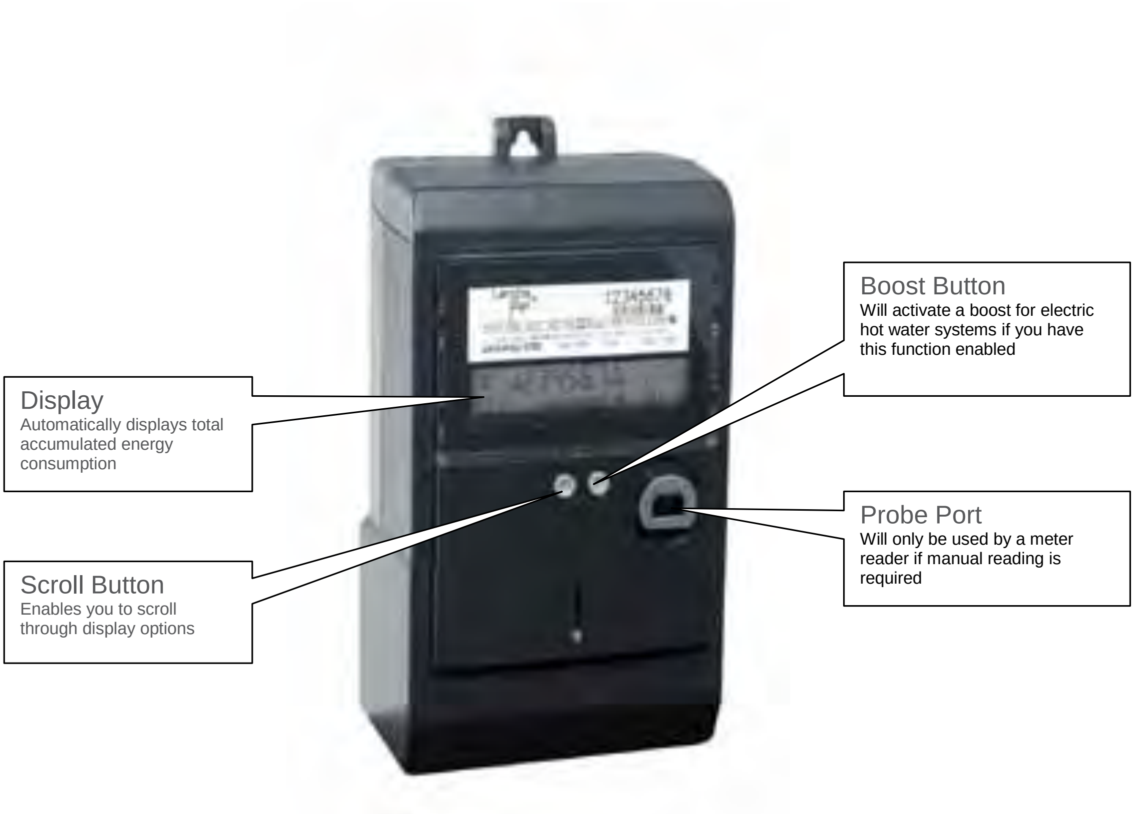
For information on the Perth Solar City visit:
**http://www.perthsolarcity.com.au/**

DM#: 7009675v1

westernpower SOLAR CITY

# YOUR NEW SMART METER

Western Power has installed a smart meter at your home.
Please see below for a guide to your new meter's functions




Please see over for more information on your smart meter, its benefits and functions.

DM#: 7009675v1

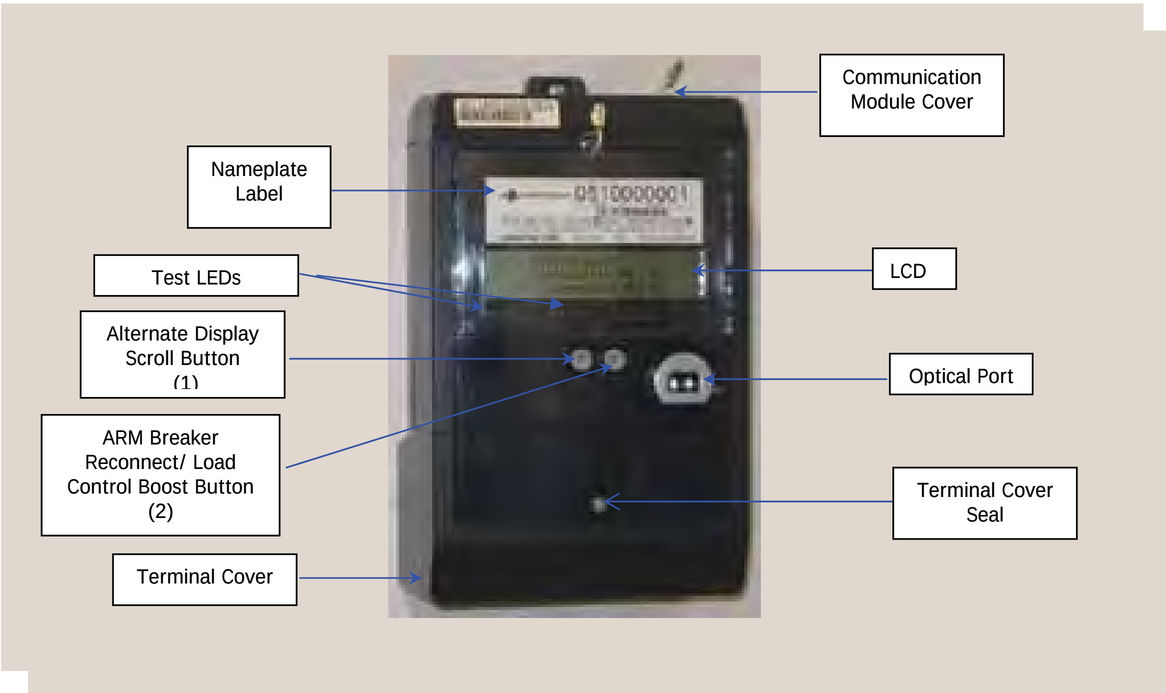

The U1200 electronic meter is Western Power's trial meter as part of a trial of the use of smart meters, also known as advanced metering infrastructure (AMI). It is a single-phase meter for direct metering installations with a capacity of up to 100 amperes.

This smart meter is capable of two-way communication between the meter and Western Power. The smart meter will also provide improved accuracy of meter readings, early detection of power quality issues, remote disconnection of power and improved monitoring of power outages to assist maintenance crews in reducing restoration times.

The first four digits of the serial number for this type of meter start with **0510xxxxxx**.

This meter has a liquid crystal display (LCD) to show the electricity consumption that is being recorded. It is also capable of storing interval data (load profile) that can be downloaded.

The meter is programmable for time-of-use (TOU) metering, and is capable of bi-directional (import - export) measurement and recording of energy.




**1. Test LEDs (Wh and VArh)**
The light (LED) will pulse (on & off) when electricity is being used, and these pulses get faster as electricity consumption increases.

**2. Optical Port**
This is the meter's infrared (IR) device, where authorised Western Power personnel download the data from the meter using an optical probe cable connected to a handheld unit (HHU).

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How to Read Your Single-Phase AMI Smart Meter
*(For Meter Code 0510)*

fact sheet

**3. LCD**
This is the display which shows the total electricity consumption, and for the smart power tariff, it will also display the electricity consumption of the different tariff rates. The meter is also programmed to display the time and date.

**4. Nameplate Label**
Gives the basic technical information about the meter and its serial number. Each meter is assigned a unique individual serial number, and the first four digits are the meter code followed by a six digit serial number.

**5. Terminal Cover Seal**
The meters are sealed on the main cover at the manufacturing plant. This seal prevents unauthorised personnel from accessing the internal components of the meter.

**6. Alternate Display Scroll Button**
This button is used to scroll the register displays in the sequence that they have been programmed in the meter. Each press of the scroll button will show the next register display.

**7. ARM Breaker Reconnect/ Load Control Boost Button**
This is used to control or reconnect the meter after disconnection of supply. It is also used as a load control boost button for overriding or connecting controlled loads such as hot water systems.

**8. Terminal Cover**
It protects the live meter terminals and screws from unauthorised access and safety of customer and personnel.

**9. Communication Module Cover**
It protects the communication module of the meter, and provides easy access for technician during maintenance.

This comes with a default program suitable for A1 and SM1 tariffs. The terms import and export are defined from the customer's point of view. Therefore, import means delivered by the network to the customer, and export means received by the network from the customer. As such;

**A. Standard All Time (A1)/ Smart Power (SM1) Tariff Meter for Uni-directional (Import) Measurement**

- The meter is programmed with normal display suitable for both A1 and SM1 tariffs.
- The LCD display registers scroll automatically every 6 seconds. If you wish to skip the current display, you simply press the left hand grey button (**1**) to skip to next display. For each press of the button, the display scrolls/ moves to the next one.
- For A1 tariff, simply read the LCD display reading on channel "**07**". The SM1 requires you to read channels "**10, 20, 30 and 40**".
- The display sequence and corresponding information are listed below;

APPENDIX D

westernpower

How to Read Your Single-Phase AMI Smart Meter
(For Meter Code 0510)

fact sheet

| Channel/ Display ID | Channel | Meter Display |
|---|---|---|
| 04 | Time | hh:mm |
| 05 | Date | dd:mm.yy |
| 07 | kWh Import Total | 000000 |
| 10 | kWh Import Total Current Rate A | 000000 |
| 20 | kWh Import Total Current Rate C | 000000 |
| 30 | kWh Import Total Current Rate B | 000000 |
| 40 | kWh Import Total Current Rate D | 000000 |
| 88 | Test Display | $888888 |

**B. Standard All Time (A1)/ Smart Power (SM1) Tariff Meter for Bi-directional (Import/ Export) Measurement**

- The meter is programmed with normal display suitable for both import and export measurement on A1 and SM1 tariffs.
- The exported energy from the network is referred to as KWh delivered (**Customers Import**), and the imported energy to the network is referred to as KWh received (**Customers Export**).
- This can be used for customers with embedded generation such as solar or photovoltaic (PV) panels.
- The LCD display registers scroll automatically every 6 seconds. If you wish to skip the current display, you simply press the left hand grey button (**1**) to skip to next display. For each press of the button, the display scrolls/ moves to the next one.
- The customers import registers/ channels are programmed and displayed on the *normal display mode,* whilst the customers export registers/ channels are programmed and displayed on the *alternate display mode.*

**For A1 tariff:**

- Simply read the LCD display reading on channel "**07**", which is your Total kWh Import on *normal display mode,* and in order to read the Total kWh export, press the left hand grey button (1) on the meter and hold for two seconds until "**Alt 1**" is displayed on the LCD display, which is the *alternate 1 display mode.* Once the "**Alt 1**" is displayed, the meter will start to scroll through the different export channels automatically pausing briefly for approximately six seconds on each one so that you can read the display. Record the reading on channel "**47**", which is your Total kWh Export.

**For SM1 tariff:**

- The SM1 requires you to read channels "**10, 20, 30 and 40**" from the *normal display mode*. In order to read the Total kWh export registers/ channels, press the left hand grey button (1) on the meter and hold for two seconds until "**Alt 1**" is displayed on the LCD display, which is the *alternate 1 display mode.* Once the "**Alt 1**" is displayed, the meter will start to scroll through the different customer export channels automatically pausing briefly for approximately six seconds on each display so that you can read the display readings. SM1 customer export registers are channels "**50**, **60**, **70** and **80**".
- The display sequence and corresponding information are listed below;

| Channel/ Display ID | Channel | Meter Display |
|---|---|---|
| 47 | kWh Export Total | 000000 |
| 50 | kWh Export Total Current Rate A | 000000 |
| 60 | kWh Export Total Current Rate C | 000000 |
| 70 | kWh Export Total Current Rate B | 000000 |
| 80 | kWh Export Total Current Rate D | 000000 |

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# How to Read Your Three-Phase AMI Smart Meter
## *(For Meter Code 0530)*

# fact sheet

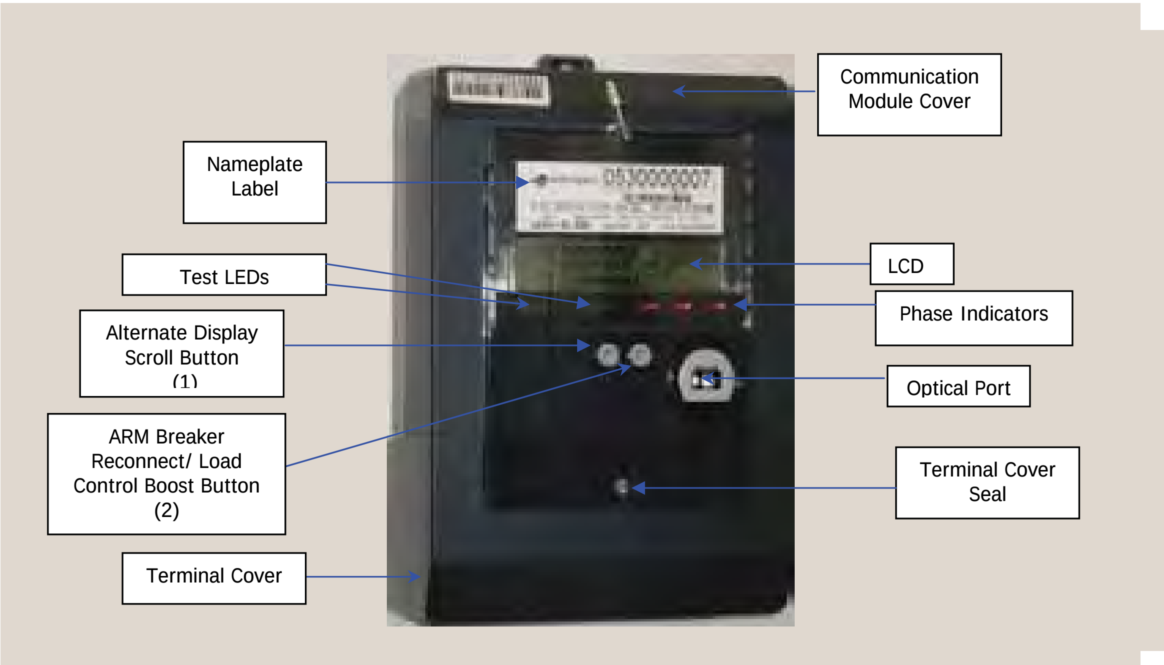
The U3300 electronic meter is Western Power's trial meter as part of a trial of the use of smart meters, also known as advanced metering infrastructure (AMI). It is a three-phase meter for direct metering installations with a capacity of up to 100 amperes.

This smart meter is capable of two-way communication between the meter and Western Power. The smart meter will also provide improved accuracy of meter readings, early detection of power quality issues, remote disconnection of power and improved monitoring of power outages to assist maintenance crews in reducing restoration times.

The first four digits of the serial number for this type of meter start with **0530xxxxxx**.

This meter has a liquid crystal display (LCD) to show the electricity consumption that is being recorded. It is also capable of storing interval data (load profile) that can be downloaded.

The meter is programmable for time-of-use (TOU) metering, and is capable of bi-directional (import - export) measurement and recording of energy.




**1. Test LEDs (Wh and VArh)**
The light (LED) will pulse (on & off) when electricity is being used, and these pulses get faster as electricity consumption increases.

**2. Optical Port**
This is the meter's infrared (IR) device, where authorised Western Power personnel download the data from the meter using an optical probe cable connected to a handheld unit (HHU).

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# How to Read Your Three-Phase AMI Smart Meter (For Meter Code 0530)

fact sheet

**3. LCD**
This is the display which shows the total electricity consumption, and for the smart power tariff, it will also display the electricity consumption of the different tariff rates. The meter is also programmed to display the time and date.

**4. Nameplate Label**
It shows the basic technical information about the meter and its serial number. Each meter is assigned a unique individual serial number, and the first four digits are the meter code followed by a six digit serial number.

**5. Terminal Cover Seal**
The meters are sealed on the main cover at the manufacturing plant. This seal prevents unauthorised personnel from accessing the internal components of the meter.

**6. Alternate Display Scroll Button**
This button is used to scroll the register displays in the sequence that they have been programmed in the meter. Each press of the scroll button will show the next register display.

**7. ARM Breaker Reconnect/ Load Control Boost Button**
This is used to control or reconnect the meter after disconnection of supply. It is also used as a load control boost button for overriding or connecting controlled loads such as hot water systems.

**8. Terminal Cover**
It protects the live meter terminals and screws from unauthorised access and safety of customer and personnel.

**9. Communication Module Cover**
It protects the communication module of the meter, and provides easy access for technician during maintenance.

10**. Phase Indicators**
These indicate the active voltage presents of each phase. A, B and C.

This meter comes with a default program suitable for A1 and SM1 tariffs. The terms import and export are defined from the customer's point of view. Therefore, import means delivered by the network to the customer, and export means received by the network from the customer. As such;

**A. Standard All Time (A1)/ Smart Power (SM1) Tariff Meter for Uni-directional (Import) Measurement**

- The meter is programmed with normal display suitable for both A1 and SM1 tariffs.
- The LCD display registers scroll automatically every 6 seconds. If you wish to skip the current display, you simply press the left hand grey button (**1**) quickly to skip to next display. For each press of the button, the display scrolls / moves to the next one.
- For A1 tariff, simply read the LCD display reading on channel "**07**". The SM1 requires you to read channels "**10, 20, 30 and 40**".
- The display sequence and corresponding information are listed below;

westernpower

# How to Read Your Three-Phase AMI Smart Meter (For Meter Code 0530)

fact sheet

| Channel/ Display ID | Channel | Meter Display |
|---|---|---|
| 04 | Time | hh:mm |
| 05 | Date | dd:mm:yy |
| 07 | kWh Import Total (Tariff A1) | 000000 |
| 10 | kWh Import Total Current Rate A | 000000 |
| 20 | kWh Import Total Current Rate C | 000000 |
| 30 | kWh Import Total Current Rate B | 000000 |
| 40 | kWh Import Total Current Rate D | 000000 |
| 88 | Test Display | $888888 |

**B. Standard All Time (A1)/ Smart Power (SM1) Tariff Meter for Bi-directional (Import/ Export) Measurement**

- The meter is programmed with normal display suitable for both import and export measurement on A1 and SM1 tariffs.
- The exported energy from the network is referred to as KWh delivered (**Customers Import**), and the imported energy to the network is referred to as KWh received (**Customers Export**).
- This can be used for customers with embedded generation such as solar or photovoltaic (PV) panels.
- The LCD display registers scroll automatically every 6 seconds. If you wish to skip the current display, you simply press the left hand grey button (**1**) to skip to next display. For each press of the button, the display scrolls/ moves to the next one.
- The customers import registers/ channels are programmed and displayed on the *normal display mode,* whilst the customers export registers/ channels are programmed and displayed on the *alternate display mode.*

**For A1 tariff:**

- Simply read the LCD display reading on channel "**07**", which is your Total kWh Import on *normal display mode,* and in order to read the Total kWh export, press the left hand grey button (1) on the meter and hold for two seconds until "**Alt 1**" is displayed on the LCD display, which is the *alternate 1 display mode.* Once the "**Alt 1**" is displayed, the meter will start to scroll through the different export channels automatically pausing briefly for approximately six seconds on each display so that you can read the display reading. Record the reading on the channel "**47**", which is your Total kWh Export.

**For SM1 tariff:**

- The SM1 requires you to read channels "**10, 20, 30 and 40**" from the *normal display mode*. In order to read the Total kWh export registers/ channels, press the left hand grey button (1) on the meter and hold for two seconds until "**Alt 1**" is displayed on the LCD display, which is the *alternate 1 display mode.* Once the "**Alt 1**" is displayed, the meter will start to scroll through the different customer export channels automatically pausing briefly for approximately six seconds on each display so that you can read the display readings. SM1 customer export registers are channels "**50**, **60**, **70** and **80**".
- The display sequence and corresponding information are listed below;

| Channel/ Display ID | Channel | Meter Display |
|---|---|---|
| 47 | kWh Exported Total (Tariff A1) | 000000 |
| 50 | kWh Exported Total Current Rate A | 000000 |
| 60 | kWh Exported Total Current Rate C | 000000 |
| 70 | kWh Exported Total Current Rate B | 000000 |
| 80 | kWh Exported Total Current Rate D | 000000 |

DATA STATISTICS

ANALYSIS MATHEMATICS

AUSTRALIA INFORMATION

STRATEGIC INFORMATION CONSULTANTS

# Perth Solar City Data Analysis Plan

**Phase 1**

December 2011

*Project:* WPNETWORKS/13

# Perth Solar City Data Analysis Plan

## Phase 1

December 2011

*Client*: Western Power

*Project*: WPNETWORKS/13

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# 1. Introduction

The Perth Solar City (PSC) program has multiple objectives and has both a design and a data collection program to evaluate progress towards these objectives. The program will also provide valuable research information in the area of energy efficiency relevant to Australian conditions. Data Analysis Australia has been contracted to develop and implement an analytic methodology to measure progress against these objectives. The basic statistical question relates to whether a change that occurs in a group of households affected by PSC is different from changes observed in households not expected to be impacted by PSC.

Data Analysis Australia's overall approach to the analysis is to use linear modelling to answer the bulk of the key analysis questions. However, some of the questions, particularly those relating to profiling high usage customers and high energy savers, as well as some specific questions associated with the Time of Use (TOU) analysis, do not fit the linear modelling framework and require different approaches.

This analysis plan outlines an approach that seeks to provide both immediate and longer term answers to key questions. The immediate need is to provide initial results for the December 2011 reporting of the PSC (Phase 1), while the longer term need is to have a more comprehensive analysis for reporting in late 2012 (Phase 2).

# 2. Aims

Overarching aims of the analysis are to investigate the impacts of PSC on reducing overall electricity consumption and peak demands, as well as to profile households who were top energy users or top energy savers.

Specific questions to be answered in the immediate term are:

1. Compared with controls, how have:
   i. Living Smart;
   ii. Home Eco-Consultations;
   iii. Smart Meters;
   iv. In Home Displays;
   v. Solar Hot Water system; and
   vi. Solar PV system

   participant households changed their behaviour as measured by the average consumption per day?
2. Compared with controls, how have households changed their behaviour, as measured by the average consumption per day, when the analysis is restricted to top 50% or top 10% of households? (Top 50% and top 10% households are defined based on pre-intervention average daily consumption.)

   Related to this is the requirement to consider the segments defined as customers who have made the greatest savings.

3. Compared with appropriate controls, have TOU tariff participant households changed their energy use *at peak times*?

The above statement of aims combines a number of individual questions of the brief since the most appropriate analysis is able to answer many of the questions together. The statement of aims also focuses on the issues that have been identified as critical to Phase 1. Further analysis that might assist future targeting of households is suggested for Phase 2.

The analysis does not attempt to directly make inferences that can be applied beyond the region covered by the PSC project. We note that this area has particular demographic, economic and climatic properties and no attempt is made to consider how it may be representative of Perth as a whole. This extension may be considered as part of Phase 2.

# 3. Data Considerations

## 3.1 Consumption Data

The primary metering data is of two types, half hourly and two monthly. The first is approximately 3,000 times more dense than the second. This difference creates special challenges.

While the differences in the metering is largely associated with the types of meter (newer electronic meters capable of logging consumption over short intervals versus older electromechanical meters that could only accumulate total consumption), the current convention in describing the metering relates to the standardised formats (NEM 13 and NEM 12 respectively) for recording such information. Outside of the context of PSC the NEM 13 format is sometimes used to record data collected on electronic smart meters (for example with the Smart Power tariff).

### 3.1.1 Standard (two monthly) meter readings (NEM 13)

For households with older style (electro-mechanical) meters, the data is in the form of standard meter readings as collected for billing purposes. Standard meter readings are typically of the order of 60 days apart.

Exceptions to this are:

- additional or special meter readings are made when there are suspected meter problems or at the customer request, for example at a change in tenancy
- sometimes a meter cannot be accessed and an estimated meter reading is used instead to meet billing requirements. In general such estimated values should be flagged as such and possibly excluded from any analysis

A key property of the standard metering data is that the older meters are simple cumulative devices and the meter reader records the total consumption from (typically) when the meter was first installed. An error in reading the meter will lead to an error in the measured consumption for the period up to the reading, but this will usually be compensated by an equal and opposite error for the next period.

The low data density means that in the analysis it may be necessary to:

- Aggregate explanatory variables such as the weather; and
- Where an intervention starts or finishes within a metering interval, to consider the fraction of the interval affected.

### 3.1.2 Interval meter readings (NEM 12)

For households with newer electronic meters, the data is in the form of half hourly measurements. These will be referred to as interval meter readings. The half hourly data matches standard time intervals used in many areas of electricity generation and distribution. In particular, for most purposes peak demands are defined in terms of peak half hourly consumption. Hence this data provides direct measures of contributions to system peaks. Phase 1 analysis is only concerned with peak times as defined by the TOU load shift tariff intervals. If analysis is required at more targeted peak intervals, this can be discussed in Phase 2.

Since this data requires the use of an electronic meter of the type used for TOU tariffs, this data is usually available for all households on TOU tariffs[1]. While originally these meters were largely restricted to those on such tariffs, part of the PSC design was to include control households with interval meters.

From an analysis point of view, interval data has several advantages:

- where a household accepts an intervention on a specific date, the data can be readily divided into pre- and post-intervention
- other explanatory variables such as the weather can be utilised in full, since they typically have similar or lower density

The volume of this data and the expected autocorrelation at the household level (the consumption in an interval being similar to that of the preceding interval) means that some aggregation of this data will be undertaken for the analysis. This is discussed in more detail in later sections of this Analysis Plan.

[1]We understand that, at least historically, electronic meters had surprisingly small memory and if they were not cleared monthly then some interval data would be lost while aggregated consumption in certain time periods would still be maintained. In particular, TOU data was retained in aggregated bands, corresponding to the intervals used for SM1 tariff purposes. Such customers, while on a TOU tariff therefore do not have this information available. Customers on the PSC TOU tariff do have this information available at the 30 minute level.

### 3.1.3 Standard Smart Power data

Smart Power is a TOU tariff that has been available to residential customers for a number of years and is not a consequence of PSC. While there may be limited Smart Power data available, no data has been explicitly identified as such in the data provided to us. Even if available, its use in analysis is likely to be limited for a number of reasons. However, for completeness, it is still discussed here.

Smart Power data is derived from smart meters that have not been programmed to retain the interval data but which accumulate consumption in four registers that are usually read on a standard approximately 60 day cycle. The current definition of the Smart Power bands are as follows:

| Tariff band | Times | When |
|---|---|---|
| Off Peak | 9PM to 7AM | All year, all days |
| Weekend shoulder | 7AM to 9PM | All year, weekends |
| Shoulder | 7AM to 11AM and 5PM to 9PM<br>11AM to 5PM | Summer weekdays<br>Winter weekdays |
| Peak | 11AM to 5PM<br>7AM to 11AM and 5PM to 9PM | Summer weekdays<br>Winter weekdays |

For the Smart Power tariff, summer is defined as October to March and winter as April to September. Note that this does not match the structure of the TOU tariff used in the PSC trial and will not be considered in Phase 1. If Smart Power data is encountered for the Phase 2 analysis, it will be aggregated to the total consumption for analysis purposes but will be flagged.

### 3.1.4 Other Consumption Data Issues

In general *estimated* meter readings should be excluded from the analysis. Where possible, the estimated readings should be excluded by aggregating over time periods, but if aggregation is not possible, the period should be dropped. *Note that while this advice in relation to excluding estimated readings is appropriate for the linear modelling components of analysis, consideration will be given to the appropriateness of doing this for the supporting analysis on an individual analysis basis.*

Since the impact of an intervention may change significantly when a household changes, ideally account change information should be available and analysis should be restricted to a single household. The restriction to a single household can be achieved by excluding data *prior* to a change in account holder in the pre-intervention period, and excluding data *post* a change in account holder after the intervention has taken place. The data available to enable this is not available for Phase 1, however will ideally be available and made use of for Phase 2 analysis.

The NEM13 data provided appears to make use of the time of day the meters were read since the length of billing periods is recorded to fractions of a day. It is not clear whether this can be used. This might be investigated in Phase 2.

Particular attention needs to be given to households with PV systems installed. The NEM12 data provides separate records for energy exported from the grid to the household and imported to the grid from the PV systems, on a half hourly basis. The NEM13 data similarly provides separate records for PV energy imports and exports, aggregated to the corresponding metering period (i.e. aggregated to approximately 60 day totals). The energy consumed by the household from its own PV systems is not recorded. The net energy consumption is then calculated by summing the imports (negative values) and exports (positive values) and this net energy consumption is used in the analysis.

## 3.2 Data Exclusions

Initial review of the data indicated a small contamination by non-residential customers with very much higher demand[2]. In addition, there is the expected positive skewness in the distribution of consumption per day. Since for reasons outlined below the proposed analysis is essentially linear, this skewness will not be corrected by a transformation. These effects suggest excluding extreme customers from the regression analysis, setting an upper limit on average daily consumption and excluding all records which exceed that limit. For Phase 1, customers with an average daily consumption exceeding 100 kWh, about five times the average, were excluded; however this threshold may be reviewed for Phase 2.

For the analysis of high energy users and high energy savers, the threshold for exclusion was increased to 150 kWh.

There are also some households with very low consumption. These may include dwellings that are vacant for part of the time or simply be small households with gas for hot water and cooking. Statistically these will have little impact on the analysis (one of the benefits of the linear analysis) and it is proposed to leave them in at this stage. This will simplify the application of the results of the analysis since it will not be necessary to consider the population of non-vacant houses.

These thresholds will be reviewed as part of Phase 2.

## 3.3 Other Relevant Data

It is useful to include variables that may assist in explaining consumption to reduce the noise component:

- electricity demand is strongly affected by the weather. In particular, the summer peak demands are essentially driven by several days of high temperatures and humidity, leading to high air conditioning loads
- gas connection is highlighted as particularly relevant

[2] Where customers could be explicitly identified as non-residential they were removed from the data, however, there was the possibility that some non-residential customers remained unidentified as such at the time of completing Phase 1 analysis.

# 4. Statistical Issues

The basic statistical question will be whether a change that occurs in a group of households affected by PSC is different from changes observed in households not expected to be impacted by PSC.

## 4.1 Household Selection

The aim of many studies such as PSC is to understand how the interventions may work if applied to the whole population. That is, the information from the sample is used to infer the expected behaviour of the population.

Implicit in this is the assumption that the sample is representative of the population of the region, or at least that any biases are known and can be accounted for in the analysis. To consider this there is a need to have some clarity on what the population might be. The details of this are best examined in Phase 2, but simple summary analysis should be used in Phase 1 to ensure there are no major problems to the extent that data is available – that is, between treatment and control groups. No consideration in Phase 1 will be given to expanding the results from the PSC area to the SWIS. However, this may be considered as part of Phase 2.

## 4.2 BACI Analysis

The analysis must consider how the differences between the intervention (or impact) group and the control group changes at the time of the intervention. This requires data before and after the intervention, as well as the two groups of households. Such an analysis is often termed a Before-After Control Impact[3] (BACI) analysis and is illustrated in Figure 1.

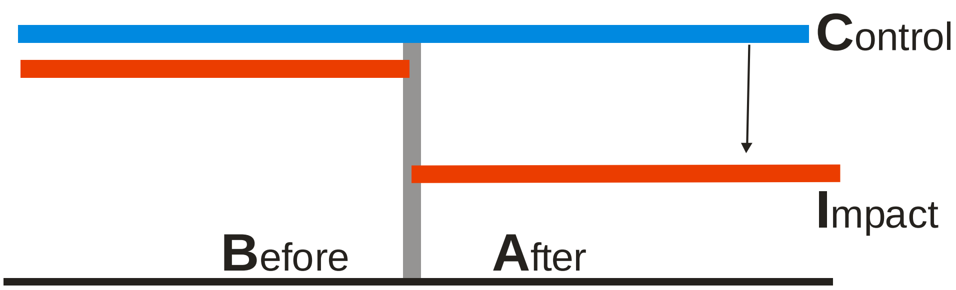


**Figure 1.Schematic of the BACI analysis. The blue line represents the behaviour of the Control group before and after the intervention and the red line represents the behaviour of the Impact (or Intervention) group before and after the intervention.**

Note that it is not necessary for the control group to precisely match the intervention group, but it is assumed that except for the effect of the intervention the two groups will tend to change in synchrony.

[3]The term 'impact' is synonymous to 'intervention' in this context.

A key aspect of any such analysis is the type of effect that is considered possible. The effect displayed in Figure 1 is only one possibility, albeit the simplest. Two alternatives are illustrated in Figure 2

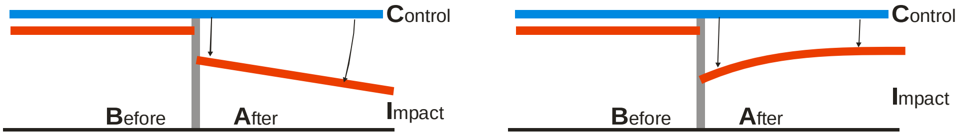


**Figure 2.Alternative possibilities for intervention effects. The left hand diagram illustrates a combination of both an immediate effect and a change in the longer term trend. The right hand diagram illustrates a less favourable situation where there is a significant immediate effect but this wears off over time, although there is possibly some residual long term effect.**

Statistically the BACI analysis considers the interaction between the time period and the groups. That is it looks at the difference over time at the differences between the control and intervention groups.

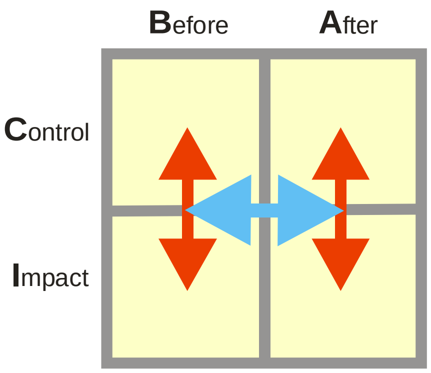


**Figure 3. BACI analysis as an analysis of the interaction between the time period and the groups.**

For some of the interventions in this project where the intervention is prolonged, it will be necessary to consider the before, during and after times. Logically the during and after periods should be compared with the before period.

For Phase 1 it is suggested that only simple transitions (such as in Figure 1) be considered but more complex but potentially more accurate models be considered in Phase 2.

## 4.3 Linear Model Analysis

The simplest approach to analyse the change in consumption as a result of the PSC interventions uses linear regression. In the simplest case it might be a model of the form:

$$c_{it} = b_i + d_t + w_t + s_{it} + g_i + e_{it}$$

where

$c_{it}$ is the consumption of the $i$ th household at over the time interval $t$ ;

$b_i$ is the baseline consumption associated with household $i$ ;

$d_t$ is the purely time related effects at time $t$ ;

$w_t$ is the weather at time $t$ ;

$s_{it}$ is the PSC effect on household $i$ at time t;

$g_i$ is an indicator of whether household $i$ is a participant or a control; and

$e_{it}$ is the error or random effect for household $i$ at time $t$ .

The actual detail of a model is more complex than this, with each of the above terms being a composite of several terms that will need to be developed. However, the following comments can be made in advance:

- the $d_t$ term represents the calendar effects at time $t$ , particularly the time of year and the numbers of each day of the week in the period $t$ . The experience of Data Analysis Australia is that the time of year effects are best modelled by a low order Fourier series
- the $w_t$ term represents the effect of weather in the period $t$ . Typically this will use maximum and minimum temperatures, rainfall and humidity. The most relevant Bureau of Meteorology station would be Perth Airport
- the $s_{it}$ terms are the effect of each of the PSC interventions on the $i$ th household at time $t$ . This is assumed to be zero for all households before the interventions and zero for all times for the households not receiving an intervention. For those households that do have an intervention, it is the number of days in the relevant metering period for which that intervention was in place
- the $e_{it}$ term is the remainder or residual variation in consumption that cannot be explained by the model. This is assumed to be essentially random.

Each of these terms will be a set of explanatory or independent variables, each multiplied by a coefficient that will be estimated. The test of significance of the interventions will therefore be a test of whether the coefficients associated with each $s_{it}$ are statistically different from zero.

To estimate the full flow on effect of overarching programs, such as Living Smart, the model can be fitted to a subset of data retaining the control group and participants of the overarching program only. This enables the flow on effects of PV and other such interventions to be attributed to the Living Smart program. While a similar approach was attempted to estimate the effects of HEC, the data was too limited to provide meaningful results in Phase 1 and a simple average of HEC participants' percentage change in average daily consumption pre and post intervention (trimming the top and bottom 5%) was performed instead.

While this example is very simple, it can be readily expanded to incorporate additional complexity. In general the aim should be to include as many terms as are reasonable to explain the variation in consumption. Doing this will ideally increase the statistical precision and reduce the correlations between data values.

Since the dependent variable in this regression is consumption, if the independent variables have units of days then the coefficients will naturally have units of consumption per day, fitting with the format of most of the questions being asked. For example, if an independent variable for a particular intervention has the value of the number of days in a metering period for which the intervention applied, then the estimated regression coefficient for that variable will be the estimate of the average impact of that intervention in kWh/day. A statistical test for the significance of the coefficient will be a valid test for the statistical significance of the intervention itself.

It is recognised that the skewness of the consumption data suggests that the usual assumption that the residuals of the regression model have a normal distribution might not be correct. Our experience is that a Gamma distribution may be more appropriate. While commonly available software can fit models assuming a Gamma distribution – they are a special case of generalised linear models – it is common to use them in conjunction with a logarithmic link. If Gamma models are used here then the identity link should be used to maintain the linearity essential for the aggregated approach described below. Since this can give rise to computational problems, it is suggested that Gamma models be investigated in Phase 2, and any potential limitations of the linear model be accepted for Phase 1.

## 4.4 Controls

Implicit in the BACI analysis is the existence of appropriate controls – that is, comparable households who have not received the intervention of interest.

We understand that two sets of controls have already been defined:

- internal controls – a random sample of households within the target area who did not receive any intervention but may still have been exposed to some of the community programs
- external controls – a random sample of households in selected comparable suburbs

In addition there might be a number of special control groups. For example, the households that received a Smart Meter but did not otherwise participate in PSC may be a valid control group for some purposes.

The important feature of controls is that it is assumed that they are not subject to the intervention and that they are influenced by external factors in the same manner as the treatment group. It is not essential that they be precise matches, (for example, they don't need to have similar distributions or consumption patterns), but in the case where they are not precise matches, the analysis must take the differences into account. The linear models as we have suggested for the analysis appropriately take the differences into account, which is one of the key attractions of that approach.

The linear model approach can allow for several control groups that might be different from each other by including parameters for these differences. In fact, provided that the model is sufficiently comprehensive, *every* household not receiving the intervention (formal control or not) acts as a control for the households receiving the intervention.[4]

A more complex issue is whether it is necessary to utilise more specific controls. The extreme example of specific controls is where each intervention is matched with a control household and the differences in consumption are analysed. An intermediate approach is to cluster households, perhaps geographically such as by suburb, and to allow clusters to be different from each other using a random effects model. Such approaches are complex and could only be carried out in Phase 2.

## 4.5 Multiple Interventions

Participating households in PSC can have several simultaneous interventions. In fact some interventions can only take place when an earlier intervention has been made. For example, the In Home Display can only function with a Smart Meter.

The linear model analysis suggested above can readily include indicators for each intervention. Where there are multiple interventions, the model will typically assume that these have an additive effect unless additional terms are introduced to handle interactions between interventions (such as Smart Meter and IHDs where the hierarchy in the Solar Cities program structure means that it is nonsensical to consider IHD on its own).This may be explored more fully in Phase 2.

We recommend this approach since it largely eliminates the need for identification of control groups specific to each intervention and enables the use of all the data available.

For the analysis which does not use linear models, households with multiple interventions may simply be excluded for Phase 1 or other appropriate action may be taken. Irrespective of the action taken to deal with multiple interventions, any limitations of the analysis must be stated.

## 4.6 Intention to Treat

With trials such as this there is always a question of the degree to which participants actually participate. This includes situations where a participant may be physically unable to take advantage of some interventions even when willing. This can lead to the temptation to restrict the definition of participants to those passing an additional threshold, causing artificially inflated positive results to be obtained.

However, the general approach must be to include *all* formal participants, since this is likely to reflect the levels of participation that would achieved in practice outside a trial. This principle is often termed "intention to treat", coming from the clinical trials area.

The only exceptions to this are where outside the trial such limited participants would either be excluded in advance or the limitations would not be present. That is,

[4]Our initial review of the data has highlighted a (possibly small) group of "participants" who did not receive and interventions. It is not clear whether these should be treated as controls.

the departure from intention to treat should be to make the trial more like a non-trial situation.

One particular example of this problem is the solar hot water system intervention. The aim of this was to understand the impact of replacing existing hot electric water systems with electric boosted solar systems. We understand that some of the systems replaced were in fact gas powered. If the future roll out of such an intervention was to follow a similar procedure to the trial and permit some substitution of gas systems, then it would be appropriate to analyse the full set of data. If the future roll out was to prevent such a recurrence, then it would be appropriate to analyse the data limited to conversions of existing electric systems.

## 4.7 High Consumption and Top Energy Saver Households

It is reasonable to consider whether high consumption households have correspondingly higher savings associated with interventions. It is also attractive to consider the characteristics of the households that appear to save the greatest amount of energy due to an intervention. These issues are statistically closely related and, unless care is exercised, can be subject to problems generally termed ‘regression to the mean”.

### 4.7.1 High Consumption Households

Provided that the identification of households uses data *prior* to the intervention to define “high consumption households”, it is statistically valid to analyse subsets of the data to consider such groups. In general it would be good practice to use a whole year of data to cover all seasons, and ideally the same whole year for all households to avoid exposure to different weather. Hence it may be appropriate to use the year (say) April 2009 to March 2010.

Note that it is critical that the definition of high consumption households be applied to both the treatment groups and the controls. This is one of the few areas of analysis where a difference in the mean consumption of the treatment and control groups may impact upon the analysis is the same threshold (in kWh/day) is applied to both. Hence we recommend the subsets be defined as the top 50% (10%) of the treatment groups and the top 50% (10%) of the control groups.

In analysing such subsets, the same regression approach described above should be used.

### 4.7.2 Top Energy Saver Households

The identification of “top energy saver” households is more problematic:

- the presence of multiple interventions impacting upon a single household will mean that it is generally not possible to identify the top energy savers associated with a particular intervention
- assuming that top energy savers are identified using workable definitions of before and after consumption, it is likely that at the individual household level

this will have a substantial amount of noise. Any consequent estimates of savings will then be significantly biased

For Phase 1 it is proposed that the definitions of energy savings at the household level will be based simply on average consumption per day before and after the intervention, ideally using a full year of data in each case. For Phase 2 it may be worth refining this through the use of the consumption model to adjust for weather and calendar effects, potentially giving a more reliable classification.

Once the top energy savers are identified, care has to be taken in the following statistical analysis. In general, it is not appropriate to compare the *savings* of top energy savers with the rest of the households since the definition of this segment would introduce substantial biases. However it is appropriate to compare the top energy savers with the rest of the households using other variables such as:

- total energy consumption
- the socio-economic status (or surrogates for this such as the suburb)
- appliances in the household
- the interventions

We recognise that at this stage we have only limited information on each household. While the differences in terms of interventions can be analysed in Phase 1, much of this analysis may be delayed till Phase 2.

## 4.8 Mixed Period Consumption Data

The mixture of 30 minute and two monthly consumption data and the lack of uniformity in meter reading dates mean that any analysis must be able to cope with this irregularity.

The appropriate method is to develop a model based on the more frequent version of the data and treat the less frequent data as sums of such data. Provided that both the dependent and independent variables are summed in the same manner, the principle of linearity allows the same model to be fitted to both.

For example, if rainfall is to be incorporated as an explanatory variable in the regression model, and information for some accounts is only available for a 60 day metering interval, the total rainfall across that same 60 day period will be used as the explanatory variable. Care has to be taken in developing the model structure, such as including additional terms such as the count of each day of week in the 60 day period.

This is a valid and tested approach to maximising the available data, given the constraints. The only complexity comes through the impact it has on the error term in the linear model. However, this only affects the optimality of the analysis and simple assumptions on the error term will not introduce a bias. It is proposed that this issue be further explored in Phase 2.

## 4.9 Consumption Periods

Most of the research questions are concerned with total consumption rather than TOU. Furthermore, much of the data is not suitable for TOU analysis. Hence it is appropriate to consider two distinct paths in the analysis and these will have different approaches to data management.

### 4.9.1 Total Consumption Analysis

The 30 minute interval data is unnecessarily detailed for this, especially since many of the possible explanatory variables (including exposure to an intervention) are only defined on a daily basis. It seems appropriate to aggregate this data to the daily level. This will reduce the volume of the data by a factor of 48 and remove the need to consider how within day variation is handled.

Such an aggregation requires a definition of a day – is it a calendar day, midday to midday or some other definition? There are several considerations here:

- when consumption data is matched against external data such as public holiday indicators or the weather, that external data is almost always based on calendar days
- two monthly metering data is based upon meter readings made sometime during the day, suggesting that a midday to midday approach may be useful. However, reliable time of day information is not always available and this differentiation is perhaps too fine a level of detail to be warranted
- experience has shown that the most variable component of consumption is in the afternoon and evening

These considerations suggest the use of calendar days, and the assumption that a meter reading for NEM 13 data is made at the start of the day. Hence a NEM 13 consumption record from 26 September 2011 to 21 November 2011 will be assumed to start at the beginning of 26 September and finish at the end of 20 November.

Where part of a day is missing we suggest omitting the entire day (Phase 1) or possibly imputing values (Phase 2, if at all).

### 4.9.2 Peak Demand Analysis

The peak demand analysis required for Phase 1 is limited in scope – simply the reduction in consumption during the peak period. This is of interest for the households on the PSC TOU tariff.

The PSC TOU tariff has a simple structure with the following periods:

| Tariff band | Times | When |
|---|---|---|
| Off Peak | 10PM to 7AM | All days |
| Peak | 7AM to 2PM and 8PM to 10PM<br>7AM to 10PM | Weekdays<br>Weekends |
| Super Peak | 2PM to 8PM | Weekdays |

We understand that the peak time of interest is what is termed "Super Peak" in this tariff. (What is called "Peak" on this tariff might be termed a shoulder in other contexts.)

The relevant data for this is all in the NEM 12 format. This suggests that when this data is aggregated into a daily form, as well as the total consumption being obtained for each day the consumption in the following time bands also be obtained:

| Band | Times |
|---|---|
| 1 | 10PM to 7AM |
| 2 | 7AM to 2PM and 8PM to 10PM |
| 3 | 2PM to 8PM |
| 4 | 8PM to 10PM |

For Phase 1 the analysis is there restricted to Band 3. Precisely the same analysis discussed above for total consumption can then be applied to this band. However, some practical issues may arise:

- since this data is only available for households with smart meters, it will streamline the analysis and data management if a restricted data set of only the smart meter data is used
- while the Band 3 data is defined for all days of the week, the analysis should be restricted to week days
- the smaller data set may mean that a number of the terms in the total consumption model cannot be estimated. Just how the linear model estimation software handles this is uncertain – some restriction of the models may be required to avoid singularities. However, in principle the same models should be applied where possible

The analysis of the cost impact of the TOU tariff the daily costs under the TOU tariff and the standard A1 tariff can be readily computed from the Bands described above. For Phase 1, the analysis will be limited to those customers on the TOU tariff and will compute the estimated cost of their actual consumption (post intervention) using both the TOU tariff and the flat rate tariff. This approach has the limitation that it assumes total consumption hasn't changed as a result of the tariff, so will be refined for Phase 2.

### 4.9.3 Autocorrelation

Repeated measures of consumption at the household level are likely to be correlated with each other, even in the residuals. Full modelling of autocorrelations is a Phase 2 issue, but a simple adjustment is suggested for Phase 1. This simple adjustment involves adjusting the estimates of statistical significance of terms in the regression model, but not adjusting the coefficients of the estimates themselves. If the one step autocorrelation is $\rho$ then the standard deviation for coefficients representing medium to long term effects should be inflated by a factor of $\frac{1}{1-\rho}$.

# 5. Summary of Analysis Steps

1. Consolidate data:

   i. Define a daily data record structure with fields of customer number, Start date, end date, total consumption, Super Peak consumption, group (participant, internal control etc.), the intervention status as a count of the number of days for which the intervention was active in the period (for each intervention), weather and seasonal terms, and other explanatory variables as appropriate.

   ii. Aggregate the NEM12 data into this form to provide daily records, using calendar days. Where any interval in the day is missing, set the result to missing.

   iii. Copy the NEM 13 data into this form, leaving the peak consumption as *missing*.

   iv. Set up the intervention variables as the number of days the intervention was active in a period.

   v. Set up the other explanatory variables – time of year, day of the week, trend and weather.

      - time of year should use standard Fourier terms, say up to 6$^{th}$ order
      - counts for the days of the week
      - linear trend
      - maximum minimum temperatures, degrees above 25$^{\circ}$, Dewpoint at 6PM

2. Establish high consumption and high savings groups.

   i. Calculate average consumption (kWh/day) for all customers before intervention period (1 April 2010) and after period. Possibly take consumption over a one year period (or close to that.)

   ii. Initially define high consumption customers as those with above median and above 90% quantile levels of average daily consumption pre-intervention.

   iii. Initially define high savers as those with saving above median and 90% quantile savings, post-intervention.

3. Generate appropriate summary statistics.

4. Regress total consumption in each period on suitable explanatory variables. This will provide estimates of the effect of each intervention and provide a test of statistical significance. Special points:
   i. It is likely to be necessary to weight based upon the length of the periods. This should be explored via the variances of the residuals to get a reasonable relationship to period length. This will be considered in Phase 2.
   ii. Assuming that the data records are in chronological order, a simple one step autocorrelation can be calculated, ignoring discontinuity between customers. Can use this to adjust significance.
   iii. Repeat the process for the high consumption groups.
5. Regress Super Peak consumption (aggregate, not percentage) on suitable explanatory variables. This is limited to records based upon NEM 12 data and hence excludes most of the control data. It can however be used to compare the effect of TOU tariff against existing tariffs.
   i. The same statistical issues will apply as for the total consumption analysis, with caution to be used if the software cannot correctly identify terms no longer estimable.
6. For the TOU tariff group, calculate summary statistics on costs under both the TOU and the flat rate tariff structures and cost savings in moving from one to the other.
7. For the high saver groups versus non-high savers, tabulate interventions, etc. For Phase 1 this should be kept relatively simple, with further analysis reserved for Phase 2.

## ACRONYM GLOSSARY

ACT - Air-Conditioner Trial

CBSM - Community Based Social Marketing

CT - Current Transformer

DCCEE - Department of Climate Change and Energy Efficiency

DLC - Direct Load Control

DRED - Demand Response Enabling Device

EOI - Expression Of Interest

ERA - Economic Regulation Authority

HAN - Home Area Network

HW - High Voltage

IHD - In Home Display

kW - Kilowatt

kWh - Kilowatt Hour

KPIs - Key Performance Indicators

LMC - Last Mile Communication

LV - Low Voltage

MAX - MAXimise your savings

MCE - Ministerial Council on Energy

MW - Megawatt

MWh - Megawatt Hour

NMI - National Meter Identifier

NMS - Network Management System

PQ - Power Quality

PV - Photovoltaic

RF - Radio Frequency

SLA - Service Level Agreement

SSN - Silver Springs Network

SWIS - South West Interconnected System

THD - Total Harmonic Distortion

TOU - Time Of Use

UIQ - Utility IQ Product Suite (Network Management System)

V - Volts

W - Watt

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