Alkimos Eglinton District Structure Plan. Appendix 1 Sustainability Strategy.

ALKIMOS EGLINTON

December 2010
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Report for Alkimos Eglinton District Structure Plan

Sustainability Strategy

September 2006

Contents

Table Index

Attachments

1. Background

1.1 Sustainability in Urban Development

Humans have had a large impact on the earth. Continuing with business as usual is clearly not sustainable. Urban development and buildings in particular contribute significantly to the negative impact we are having on our environment. It has been estimated that buildings consume 32% of the world's resources including 12% of the world's water and up to 40% of the world's energy. Buildings also produce 40% of waste going to landfill and 40% of air emissions.

At a time when the onset of climate change is no longer questioned, when water quantity and quality is in decline and when animal and plant extinctions in Australia are occurring at an unprecedented rate the concept of Sustainability is not an option but all of our responsibility.

Ecologically Sustainable Development therefore, represents one of the biggest challenges facing Australia's governments, industry, business and the community at large.

In Western Australia this is particularly so as it faces an unprecedented rate of economic growth and a projected population increase of 52% by 2031 over the 2001 population. With about 90% of the Western Australian population living in towns and cities, the quality of the urban environment is important in relation to our wellbeing. The movement towards sustainable communities takes the recognition of the need for environmentally sustainable forms of development a step further towards the need to ensure that a community is socially sustainable. A sustainable community, also described as a "healthy" or "liveable" community, maximises quality of life for its residents and is more environmentally and economically sustainable.

The key to achieving a sustainable community is to address issues in an interconnected manner and ensure that all the key dimensions of the planning process are strongly integrated throughout the process. This integration involves the development of an urban form strongly informed by the following issues:

» Environmental protection (or remediation)

» Land use planning that takes account of demographic trends, living, employment and leisure needs

» Transport and access requirements

» Energy and water efficiency objectives

» Market and development trends

» Regional planning objectives

1.2 State Sustainability Strategy

The State Sustainability Strategy defines sustainability as "meeting the needs of current and future generations through an integration of:

» environmental protection,

» social advancement and

» economic prosperity

In recognition that development must occur in a way that creates a more enduring future, the State Sustainability Strategy (2003) sanctions the goal that we “plan and provide settlements that reduce the ecological footprint and enhance our quality of life”.

The Strategy’s overall vision for settlements in WA is that they ‘are among the most attractive places to live in the world, constantly becoming more innovative and efficient in their use of resources and management and use of wastes while simultaneously being more liveable and equitable’ (SSS 2003). This underpins the concept that sustainability is about process as well as product and as new technologies are developed and society’s values change the sustainability of urban developments also increase.

1.3 Smart Growth

Many of the constraints and challenges that the City of Wanneroo faces were examined in a Scoping Paper, entitled "Setting the Scene", prepared in June 2003. Smart Growth seeks to manage growth more effectively to improve the outcomes of development for new and existing communities.

Smart Growth represents a local approach to state sustainability. The Smart Growth Strategy complements the Foundation Principles, visions and goals of the State Sustainability Strategy.

PRINCIPLE 1 LIFESTYLE AND HOUSING CHOICE

Smart Growth encourages the provision of a variety of housing types and the enhancement of lifestyle options.

PRINCIPLE 2 EFFECTIVE USE OF LAND AND INFRASTRUCTURE

Smart Growth supports the effective use and development of land and buildings for the benefit of the local area.

PRINCIPLE 3 LONG TERM HEALTH OF THE ENVIRONMENT

Smart Growth promotes development that minimises environmental impact, together with practices that conserve and enhance natural areas

PRINCIPLE 4 IDENTITY, EQUITY AND INCLUSIVENESS

Smart Growth is creating opportunities to enhance and develop the identity of our places and our people, and to improve equity and inclusiveness within our community.

PRINCIPLE 5 LONG TERM ECONOMIC HEALTH

Smart growth supports opportunities that enhance industry growth and promote job creation within our region.

PRINCIPLE 6 PEOPLE AND GOVERNMENT

Smart Growth encourages citizen and stakeholder participation in governance and development decisions.

The Smart Growth Assessment Tool (SGAT) was designed to assist developers in preparing their structure plans to reflect the Smart Growth.

1.4 The Approach to Sustainability at Alkimos Eglinton

Sustainability objectives and key priorities have been developed for Alkimos Eglinton using the State Sustainability Strategy, and the SGAT for guidance.

A District Structure Plan is a high level document, used to guide subsequent levels of more detailed planning, subdivision and eventual development. It is recognised that in order to implement sustainability at Alkimos Eglinton, clear implementation paths will be necessary.

Accordingly Implementation Plans have been developed, and will be the mechanism by which the sustainability objectives will be operationalised.

2. Priority Sustainability Outcomes

2.1 SGAT objectives

The SGAT effectively mainstreams sustainability into the development planning process. The SGAT objectives are organised under the following headings:

- Lifestyle and Housing
- Land and Infrastructure
- Environmental Health
- Sustainable Building Design
- Identity, Equity and Inclusiveness
- Employment
- Economic Benefits
- Economic Health
- People and Government

The District Structure Plan addresses every element of the SGAT, as this will be reflected in a SGAT assessment document separate to the District Structure Plan.

In this section of the report we have outlined the priority sustainability categories being; water, energy and greenhouse, ecosystem health and community development.

2.2 Priority Objectives

The following section outlines those sustainability objectives that should be considered a priority in relation to planning within this region, and the measures that will be taken to achieve these objectives. These are described below and summarised in Table 3.

2.2.1 Community Development

Community development objectives are a key focus of the overall sustainability strategy for Alkimos Eglinton. There are four key strategies that will play an important role in the effective roll out of the community related sustainability objectives. These are set out in detail in Sections 9 and 11 of the District Structure Plan and summarised below.

<u>Infrastructure: Community Services Strategy</u>

As development proceeds, there will be a staged approach to collaboration between key service agencies including schools and educational institutions, community and cultural service providers, shops, and other human service agencies to explore all opportunities for co-location and sharing, that will result in the earliest, most effective service provision possible.

<u>Community Development Strategy</u>

In the first three years of each neighbourhood's life, Community Development workers will work in partnership with local residents to pursue the vision and objectives outlined in the Community Development Strategy in Section to of the District Structure Plan. They will pursue 4 broad processes:

- Community visioning and engagement (incorporating a Stakeholder Engagement Plan)
- Events and activity development
- Local Economic Development
- Community based place management and design

Economic Development and Employment Strategy

Alkimos-Eglinton is identified in the City of Wanneroo's Economic Development Strategy as a "Major Regional Centre". A critical element of economic development within the district is the timely identification of appropriate sites for employment nodes.

Tourism Strategy

The development of tourism within Wanneroo is addressed in the City of Wanneroo's Tourism Strategy.

From these strategies, the following priority sustainability objectives / measures have been identified.

Investment promotion

The creation of economic activity in areas in and adjacent to Alkimos Eglinton is a critical issue for creating a sustainable settlement. The priority components of this from the viewpoint of the sustainability strategy are:

» **Marina and tourism associated development at Eglinton with a resort centre and hotel**

» **Regional commercial and employment centre at Alkimos**

Communications infrastructure supporting home-based work

Home-based work is an important element of the sustainability strategy in terms of both creating community and reducing car dependence.

The development of adequate communications infrastructure at Alkimos Eglinton to facilitate fast broadband is required to ensure the opportunities are realised. The Engineering Infrastructure report (Appendix 5 of the District Structure Plan) provides specific details about a strategy for implementing broadband services.

Diversity of Housing

» **Housing sizes that match emerging demography**

The average number of occupants in Australian households has been dropping steadily for many years. From 1990 to 2001 the number dropped from 2.8 to 2.6 people across Australia and the figures are similar for Perth. In the same period, the size of housing increased by some 30 m^2 to an average of around 210m^2. This represents an increase in housing size of some 25% per person over the decade to 2001.

In recent times houses with 4 to 5 bedrooms plus separate lounge, family rooms and theatres have become increasingly common. Notwithstanding the implications for energy efficiency and greenhouse emissions, there are also questions about the quality of the investment in such houses over the long term given that 30% of households in Perth now house only couples or individuals (up from 25% in 1991).

Reducing the size of new housing to suit the real needs of families and individuals, now and in the future would have many benefits including housing affordability, maintenance of housing values and energy efficiency (embodied and operational).

» **Wide range of housing types**

The other consequence of the changing demographics is the need for a more diverse housing product that can cater to singles living alone or in groups, families (including extended families) and "empty-nesters".

Alkimos Eglinton will strive to set a new benchmark in housing diversity to cater for the 21st century demographic.

Affordable Housing

» **Affordable housing initiatives for both sale and rent**

Purchasing a house is becoming increasingly difficult for Perth families. Accordingly strategies are needed that facilitate entry into the ownership market, as well as meet the needs of those who either cannot, or don't wish to become homeowners.

Alkimos Eglinton will seek to promote initiatives to achieve both objectives.

Encourage social cohesiveness and civic participation

» **Indoor and Outdoor Spaces for community and social activity and interaction**

The Community Development Strategy highlights the role of planning in community development. One important element of this is the creation of both indoor and outdoor spaces for Community and Social activity and interaction.

The creation of informal public spaces and 'transitional' spaces (such as 'liveable' front yards) that create opportunities for unplanned social interaction will be a focus for design at Alkimos Eglinton.

Promote the provision of community facilities and services that meet the needs of the community

The Community Services Strategy highlights the following initiatives which are seen as key to the sustainability strategy for Alkimos Eglinton.

» **Early provision of essential services**

» **Community services structured around Alkimos and Eglinton District Centres, Coastal Villages, Neighbourhood Centres/Nodes, "bus-stop" nodes**

2.2.2 Water

A high level integrated water cycle management study has been undertaken for the Alkimos Eglinton study area and is included as Attachment A.

This study identifies the potential for meeting the objectives through a combination of the following measures:

Water efficiency

» **Water efficient fixtures and fittings in homes and other buildings**

» **Water efficient irrigation systems**

» **Low water requirement plantings (xeriscaping)**

Integrated Water Management (IWM)

» **Water sensitive urban design to replenish the superficial aquifer**

Water sensitive urban design seeks to incorporate stormwater drainage into the urban fabric in a manner that ensures the protection of surface and groundwater quality, and enhances the opportunities for reuse of stormwater.

Alkimos Eglinton will be developed in accordance with the Department of Water's stormwater management objectives.

» **Alternative water supply for non-drinking water uses**

The IWM study conducted by GHD identifies the potential for substituting drinking water with non-potable sources including:

– rainwater
– groundwater
– recycled wastewater

These approaches could lead to 70-80% savings on scheme water in comparison to existing and projected demand patterns.

The IWM options identified require further analysis, and consultation with a wide range of stakeholders, including the Department of Water, the Water Corporation, the City of Wanneroo, landowners and the community.

It is recommended that this initial study be used as input into a wider Integrated Water Cycle Study for the north west corridor. It is recommended that this study:

» Incorporates all existing relevant data and studies that would inform the development of an IWM approach, including environmental, groundwater;

» Further develops the IWM options proposed here;

» Collaboratively develops a suite of social, economic and environmental criteria to guide assessment of the options with a view to achieving the core IWM objectives, ie:

– Efficient use of water from all sources for all purposes
– Protection (or reinstatement) of the ecosystem health of receiving waters
– Protection of human health and amenity
– Economic efficiency
– Minimisation of energy consumption and greenhouse gas emissions

» Undertakes the necessary investigation, catchment modelling work and engineering work necessary to complete a full sustainability assessment of the options;

» Engages in the necessary consultation and engagement with stakeholders to ensure transparency and legitimacy;

» Develops a comprehensive IWM strategy for the north west corridor that incorporates the potential for Managed Aquifer Recharge in the future.

The results of this study would then feed into the infrastructure planning for Alkimos Eglinton and into Local Structure Planning.

2.2.3 Energy & Greenhouse

A number of measures have been considered to minimise energy use and contribute to greenhouse mitigation in Alkimos Eglinton.

Transport emissions

» **Integrated rail/ AE-CAT/ bus systems**

An Alkimos-Eglinton Connector Area Transit system (AE-CAT) is proposed to provide links between Alkimos regional centre (and Alkimos train station), the three proposed coastal villages (including Eglinton Marina and Coastal Village) and connect through to Eglinton district centre and Eglinton train station. Refer to the Sinclair Knight Merz report *Alkimos – Eglinton Structure Plan: Transport and Access,* August 2006.

» **Integrated land uses providing for more walk/ cycle use**

Integrated land use planning using Transit oriented Development (TOD) principles will reduce reliance on private cars for local trips. Refer to the Sinclair Knight Merz report *Alkimos – Eglinton Structure Plan: Transport and Access,* August 2006.

Emissions arising from energy embodied in construction materials (EE)

Very significant amounts of energy are used in the manufacture, transport and assembly of building materials into their final form on site. For example the average Perth house has approximately 680 GJ of energy embodied in its construction. This represents around 17 years of the energy consumed in operating the house. Given the level of housing activity, embodied energy in construction is a major greenhouse source.

It is proposed to address this greenhouse source through the following measures:

» **Recycled construction and demolition waste in road base and low grade concrete (kerbs, driveways etc)**

The basic sub-divisional works (roads, pavements, kerbs, retaining structures) will incorporate a proportion of materials from recycled construction and demolition waste. A specific study will be required to establish the opportunities and technical and economic feasibility. This should incorporate the Water Corporation's study of the excavation required for the Wastewater Treatment Plant.

» **Requiring housing to have a proportion of lightweight materials**

Building materials with low embodied energy, including lightweight external cladding systems will be selected - based on supplier specific data.

» **Concrete utilising low EE cement replacement materials (fly ash and blast furnace slag)**

Concrete for the project will be specified to contain a proportion of blast furnace slag or fly ash as substitute to cement (which has very high embodied energy).

Emissions arising from the operation of buildings

» **5 star energy efficient housing**

The Building Code of Australia 2006 (Volume 2) includes a requirement for housing to achieve 5 star energy efficiency in respect of heating and cooling loads:

V2.6.2.1 Verification using stated value

A building must have an energy rating of not less than 5 stars determined using a thermal calculation method that complies with the ABCB Protocol for House Energy Rating Software.

Housing that meets this standard will achieve significantly lower greenhouse emissions than the average Perth house. The savings are estimated at 1.1 tonnes CO_2eq per house per annum (around 16% of total household emissions).

» **Energy efficiency requirements for other buildings**

The Building Code also contains performance requirements for non-residential buildings which will deliver energy efficiency for those buildings.

Increasing Renewable Energy

» **Greenhouse efficient (eg gas boosted solar hot water) in homes and other buildings**

The best performing hot water systems (gas or electric boosted solar) would reduce energy consumption by around 9,000 MJ per annum in comparison to average consumption on hot water. This translates to greenhouse savings of between 0.5 – 2.5 tonnes CO_2eq per house per annum, depending on whether replacing electric or gas systems.

It is proposed that greenhouse efficient hot water systems are required as a component of Design Guidelines for housing at Alkimos Eglinton. In the initial stages this requirement will specify gas boosted solar hot water. However in the future other technologies may arise that are similarly greenhouse efficient, and so the requirement should relate to greenhouse performance.

» **Promotion of grid connected photovoltaic installation in homes**

A study of the cost and greenhouse impact of grid connected photovoltaic (PV) systems has been undertaken and is included as Attachment B.

This study concludes that significant greenhouse savings could be achieved through quite small installations, eg a 0.6 kW system would save around 1 tonnes CO_2eq per house per annum (about 16% of average household emissions). The study explores the incentive that would be required (in addition to government rebates) to create a business case for householders to invest in a PV system, assuming presently available technology and costs. The results of this study are set out below.

Table 1 Cost benefit of residential PV Systems

PV (kW)	0.6	1	1.5	2	3
Annual Power Output (kWh)	1,084	1,806	2,709	3,611	5,417
% Electricity Savings	20%	33%	49%	66%	99%
Capital ($)	7,840	13,050	19,450	25,625	37,600
Incentive required ($)	4,381	7,503	13,120	18,452	28,482
Federal Govt Rebate ($)	2,400	4,000	4,000	4,000	4,000
Net Capital Cost to homeowner ($)	1,059	1,547	2,330	3,173	5,118
Annual Maintenance Costs ($)	39	65	97	128	188
Energy Savings ($)	152	253	379	506	758

PV (kW)	0.6	1	1.5	2	3
Net Annual Savings ($)	113	188	282	377	570

Although the results indicate that a significant incentive would presently be required to provide a business case to homeowners there are a number of factors that could improve the situation in the future.

Firstly new technologies are being developed for PV systems that will likely reduce the capital costs. A new product identified in the study (not yet proven or commercially available) would require no incentive to produce a business case to homeowners for a 1 kW system (reducing emissions by 37%). Hence any additional incentive provided (eg by landowners) would be attractive.

Secondly it is likely that carbon trading will be introduced in Australia in the next 5 years. Depending on the details of such a system, and value of emissions created, it is likely that this would reduce the incentive required by between $300 - $1,500 for the systems investigated.

Thirdly, the analysis assumes grid connected PV systems that import energy from the grid when the output from the PV system is not sufficient to meet the electrical load. Conversely when the output exceeds the load, energy is exported to the grid. The analysis above assumes that the import and export tariff are the same. In fact at present, the export rate is slightly less than the import rate. However in future it is possible that to incentivise grid connected renewables, the export tariff could rise. If this occurs, this would further reduce the incentive required to create a business case for the homeowner.

Given the present economics, it is not proposed that grid connected PV systems are required at Alkimos Eglinton in the early stages of development. However it is recommended that due to the significant greenhouse benefits, PV systems are promoted, and that the economics are continuously reviewed to determine the point at which incentives (eg by landowners) could feasibly be considered.

» **Green Energy Purchase**

All energy retailers in Australia offer a green energy electricity product. Under this scheme, consumers can elect to be supplied with electricity generated from renewable sources. Locally this scheme is offered by Synergy under the title Natural Power.

Under this scheme Synergy guarantees the total amount of energy supplied to Natural Power customers will be sourced from renewable sources and will increase the overall amount of renewable energy in the grid to do so if necessary. The scheme presently attracts a premium of 3c / kW.hr (approximately $165 per annum for the average house). A modest incentive of $825 (eg by landowners) would compensate homeowners for the first five years of additional costs.

Electricity demand represents approximately 83% of household emissions in the average Perth house. The use of Natural Power by occupiers at Alkimos Eglinton would therefore significantly reduce the greenhouse profile of the Alkimos Eglinton Project Area. The measure could be built into the Planning Scheme and supported by Planning Policies.

Overall Greenhouse Reductions

The net result of the measures to be adopted will be very significant reductions in the greenhouse profile for Alkimos Eglinton. It is very difficult to quantify the exact greenhouse emission savings but approximate figures are produced in the table below for the housing component of the project.

Table 2 Energy Efficiency Measures at Alkimos Eglinton

Measure	Annual Transport Emissions T CO_2-e	Annual Operational Energy emissions T CO_2-e	Embodied Energy emissions T CO_2-e
Average Perth household	**7**	**6.75**	**48**
Approximate savings from proposed measures			
Integrated rail/ AE-CAT/ bus system	0.7		
Integrated land uses providing for more walk/ cycle use	0.7		
Five star housing		1.1	
Gas boosted solar hot water		1.7	
Grid connected PV (0.6kW)		1.1	
Green power (100% of electrical demand)		5.6	
Embodied energy measures			9
Total savings	1.4	3.9 – 5.6	9
% Reductions	**20%**	**42-83%**	**19%**

2.2.4 Ecosystem Health

Conserve and Enhance Local Biodiversity

» **Conservation of existing significant environmental assets**

As described in the Environmental Assessment Report, Environmental Management Plans will be prepared and implemented to

"achieve the objective of managing the potential impacts of the proposed subdivision, development of infrastructure on the following:

1) land which is reserved as Regional Open Space in the Scheme; and

2) bushland that may be part of an ecological linkage."

The Environmental Assessment report contains principles for protection and management of Vegetation, Regional Open Space, Public Open Space, Biodiversity, Fauna, Foreshore areas, Geoheritage, and Aboriginal Heritage.

The Environmental Management Plan will be the primary vehicle to ensure that protection of conservation assets at Alkimos Eglinton.

» **Biodiversity based landscaping of public and private spaces**

There is an exceptional opportunity at Alkimos Eglinton to consider biodiversity beyond conservation, by developing a landscaping strategy that seeks to create an environment similar in composition and structure to that of the existing vegetation communities (refer EPCAD's Landscape Strategy). The elements of such an approach are:

– the collection of seed from locally indigenous species for propagation of plants to be used in landscaping.
– removed indigenous plant matter, free of weeds, should be mulched and reused as part of the landscaping program to encourage the maintenance of the site' s seed bank and habitat.
– reuse of topsoil in the landscape program from areas of weed-free natural vegetation that will be disturbed by development to take advantage of the seed bank of native vegetation contained in the soil.

» **Encourage community participation in local bush care efforts**

Involvement of the community in protection of biodiversity is an important element of building a sustainable community.

It is proposed to:

– establish a community based bush regeneration program with training for volunteers, tools for loan, provision of tubestock, removal of weeds and seasonal volunteer open and training days.
– implement an education program so that future residents are aware of conservation management issues and their responsibilities.

The City of Wanneroo is participating in a pilot project with the Perth Biodiversity Project to develop a Local Biodiversity Strategy. City of Wanneroo staff have advised that their draft Local Biodiversity Strategy aims to protect biodiversity. The CoW Strategy is an ideal vehicle through which to implement this proposal.

Waste management and resource recovery

» **Construction waste management controls and targets to minimise waste and re-use / recycle residuals.**

Waste minimisation plans will be required under all construction contracts to ensure that the waste recovery targets are met for construction work. The contracts will require waste minimisation measures, the streaming and databasing of residual wastes, and measures to facilitate recycling.

These requirements will apply to both subdivision work and to building works.

» **Recycle organic wastes locally for use in parks and gardens**

Mindarie Regional Council (of which the CoW is a member) is planning to construct and operate a state of the art resource recovery facility at Neerabup Industrial Area. High quality compost will be a product from this facility.

There is an opportunity to use this material to significantly replace fertilisers in both public landscaping and for private gardens, thus recycling nutrients within Alkimos Eglinton and reducing landfill.

Table 3 Priority Sustainability Objectives

Priority Sustainability Categories	A-E Objective	Measures
Community	Promote investment consistent with strategic vision	Marina and tourism associated development at Eglinton with a resort centre and hotel Regional commercial and employment centre at Alkimos
	Advocate provision of communications infrastructure	Communications infrastructure to support home based work
	Encourage Diversity of Housing	Housing sizes that match emerging demography Wide range of housing types
	Ensure Affordable Housing	Affordable housing initiatives for both sale and rent
	Encourage social cohesiveness and civic participation	Indoor and outdoor spaces for Community and Social activity and interaction
	Promote the provision of community facilities and services that meet the needs of the community	Early provision of essential services Community services structured around Alkimos and Eglinton District Centres, Coastal Villages, Neighbourhood Centres/Nodes, "bus-stop" nodes
Water	Promote more efficient use of water	Water efficient fixtures and fittings in homes and other buildings Water efficient irrigation systems Xeriscaping
	Develop integrated water management strategies to increase water efficiency	Water sensitive urban design to replenish superficial aquifer Alternative water sources for irrigation and non-drinking water uses - rainwater - groundwater - recycled wastewater
Energy & Greenhouse	Reduce private transport emissions	Integrated primary and secondary transport network
	Reduce material intensity / embodied energy	Recycled construction and demolition waste in road base and low grade concrete (kerbs, driveways etc) Housing requiring proportion of lightweight materials Concrete utilising low EE cement replacement materials (fly ash and blast furnace slag)
	Reduce operational energy consumption	5 star energy efficient housing Energy efficiency requirements for other buildings
	Increase renewable energy	Greenhouse efficient hot water in homes and other buildings Promote grid connected PV installation in homes Require Green Energy purchase
Ecosystem Health	Conserve and Enhance Local Biodiversity	Conservation of existing significant environmental assets Biodiversity based landscaping of public and private

Priority Sustainability Categories	A-E Objective	Measures
		spaces
	Encourage community participation in local bush care efforts	Community based bush regeneration and protection program
	Encourage sustainable waste management options and improve resource recovery	Construction waste management controls and targets to minimise waste and re-use / recycle residuals. Recycle organic wastes locally for use in parks and gardens

3. Implementation

Implementation Plans have been developed for each of the Priority Objectives. These plans set out the required action at each subsequent stage of development and identify the responsible parties.

3.1 Community Development

Objective C1 Promote investment consistent with strategic vision

Measure:

- Marina and tourism associated development at Eglinton with a resort centre and hotel

Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Identify location of marina and resort development at Eglinton	Landowners
Local Structure Plan	Incorporate marina and resort development in Local Structure Plan and zone accordingly	Landowners, City of Wanneroo, WAPC
Detailed Area Plan (where applicable)	Provide detail of marina and resort development; Determine scale and operation of resort.	Landowners, City of Wanneroo, WAPC
Subdivision Plan	Provide specific development sites for tourist facilities	Landowners, City of Wanneroo, WAPC

Measure:

- Regional commercial and employment centre at Alkimos

Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Identify location and overall scale of regional employment.	Landowners
Local Structure Plan	Incorporate regional employment areas in Local Structure Plan and zone accordingly Determine specific employment creation, attraction and support measures	Landowners, City of Wanneroo, WAPC
Detailed Area Plan (where applicable)	Provide detail of employment areas; incorporate in development guidelines;	Landowners, City of Wanneroo, WAPC
Subdivision Plan	Provide specific development sites for regional employment; Implement specific economic support programs.	Landowners, City of Wanneroo, WAPC

Objective C2 Advocate provision of communications infrastructure

Measure: • Communications infrastructure to support home based work		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Formation of steering committee to guide provision of integrated services infrastructure Broadband network strategy described incorporating: - Ownership issues - Options for telecommunications infrastructure & services models - Design specifications & implementation plans for staged infrastructure & services provision - Selection of suppliers, carriers & service providers - Contracts for supply & service provision	Landowners, City of Wanneroo
Local Structure Plan	As above	
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	As above	

Objective C3 Encourage diversity of housing

Measure: • Housing sizes that match emerging demography		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Continually monitor household formation and work with the housing industry to develop strategies on delivery of housing diversity.	
Local Structure Plan	Ensure planning design accommodates the desired housing diversity strategy.	
Detailed Area Plan (where applicable)	Ensure planning design accommodates the desired housing diversity strategy.	
Subdivision Plan	Ensure planning design accommodates the desired housing diversity strategy.	

Measure: • Wide range of housing types		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Undertake ongoing research and monitoring to develop strategies to inform discussions on provision of housing types.	Landowner, builders.
Local Structure Plan	Ensure the design of plans can accommodate housing diversity strategies.	
Detailed Area Plan (where applicable)	Ensure the design of plans can accommodate housing diversity strategies	
Subdivision Plan	As above	

Objective C4 Ensure affordable housing

Measure: • Affordable housing initiatives for both sale and rent		
Development Stage	*Action*	*Responsibility*
For consideration by LandCorp		

Objective C5 Encourage social cohesiveness and civic participation

Measure: • Indoor and outdoor spaces for Community and Social activity and interaction		
Development Stage	*Action*	*Responsibility*
Local Structure Plan	Design of informal public spaces and 'transitional' spaces (such as 'liveable' front yards) that create opportunities for unplanned social interaction	Landowner in collaboration with CoW
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	As above	

Objective C6 **Promote the provision of community facilities and services that meet the needs of the community.**

Measure:

- Early provision of essential services

Development Stage	*Action*	*Responsibility*
Local Structure Plan	Formation of steering committee to develop strategies for early provision and funding of community facilities and services.	Landowners, City of Wanneroo, relevant Government agencies.
Detailed Area Plan (where applicable)	Ensure plan provides for community facility strategy.	
Subdivision Plan	Ensure plan provides for community facility strategy.	

Measure:

- Community services structured around Alkimos and Eglinton District Centres, Coastal Villages, Neighbourhood Centres/Nodes, “bus-stop” nodes

Development Stage	*Action*	*Responsibility*
Local Structure Plan	Undertake research into the benefits of collocation and develop appropriate strategies and responses.	Landowners, City of Wanneroo, relevant Government agencies.
Detailed Area Plan (where applicable)	Ensure plan can respond to strategy.	
Subdivision Plan	Ensure plan can respond to strategy.	

3.2 Water Cycle Management

Objective WCM1 **Promote more efficient use of water**

Measures:

- Water efficient fixtures and fittings in homes and other buildings
- Water efficient irrigation systems
- Xeriscaping

Development Stage	*Action*	*Responsibility*
Local Structure Plan	Measures described Objectives and performance targets set	Landowners, City of Wanneroo, WAPC
Detailed Area Plan (where applicable)	As above	As above
Subdivision Plan	Requirements explicitly described in Design Guidelines for buildings Designs developed for POS irrigation	Landowners, City of Wanneroo, WAPC City of Wanneroo

Objective WCM2 Develop integrated water management strategies to increase water efficiency

Measure: • Water sensitive urban design to replenish superficial aquifer		
Development Stage	*Action*	*Responsibility*
Local Structure Plan	Drainage strategy described Objectives and performance targets set	Landowners, City of Wanneroo, DoW
Detailed Area Plan (where applicable)	As above	As above
Subdivision Plan	Lot drainage explicitly described in Design Guidelines	Landowners, City of Wanneroo, DoW
	Detailed design of stormwater system incorporating BMPs.	Landowners, City of Wanneroo, DoW

Measure • Alternative water sources for non-drinking water uses		
Development Stage	*Action*	*Responsibility*
IWM Strategy	Full investigation of the IWM options set out in this DSP, and recommendations made for development.	Landowners, DoW, City of Wanneroo, WCorp
Infrastructure Planning	Design of (any regional) alternative water source and primary reticulation network	DoW, WCorp, City of Wanneroo
Local Structure Plan	Measures described Objectives and targets set	Landowners, City of Wanneroo, DoW, WCorp
	Design of (any local) alternative water source and local reticulation network	Landowners, City of Wanneroo, DoW, WCorp
Detailed Area Plan (where applicable)	Design of local reticulation network	As above
Subdivision Plan	Requirements explicitly described in Design Guidelines	Landowners, City of Wanneroo, WAPC

3.3 Energy & Greenhouse

Objective E&G1 Reduce private transport emissions

Measure: • Integrated rail/ AE-CAT/ bus network		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Design of road reserves to provide priority to the AE-CAT, either on its own traffic lanes, or on routes that by-pass expected congestion points.	Land owners/ planners

	Designation of land activities around the AE-CAT and the train stations to maximise the number of people who can walk to a station/ stop.	
Local Structure Plan	Development of the local plans to accommodate the AE-CAT, and maximise walk-on patronage, as discussed above.	Land owners/ planners
Detailed Area Plan (where applicable)	Development of the local plans to accommodate the AE-CAT, and maximise walk-on patronage, as discussed above.	Land owners/ planners
Subdivision Plan	Design AE-CAT stops, inclusive of pedestrian routes, shelter areas, provision for CCTV/ IT systems. Integrate stops within high intensity surrounding land activity.	Land owners/ planners

Objective E&G2 Reduce material intensity / embodied energy

Measure:

- Recycled construction and demolition waste in road base and low grade concrete (kerbs, driveways etc)

Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Recycling study to establish quantities, collection / distribution site, commercial arrangements and other details.	Landowners, CoW, Main Roads.
Local Structure Plan	Identification of assets to incorporate recycled content (eg road base).	Landowners, CoW.
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	Identification of assets to incorporate recycled content (eg driveways) in Design Guidelines.	Landowners, CoW.

Measure:

- Housing requiring proportion of lightweight materials

Development Stage	*Action*	*Responsibility*
Local Structure Plan	Description of objectives and targets	Landowners, CoW.
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	Design Guidelines to incorporate measures to achieve objectives and targets	Landowners, CoW.

Measure: • Concrete utilising low EE cement replacement materials (fly ash and blast furnace slag)		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Development of generic concrete specification clauses for all works.	Landowners, CoW, Main Roads.
Local Structure Plan	Identification of assets to incorporate low EE concrete.	Landowners, CoW, Main Roads.
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	Design Guidelines to require low EE concrete in house slabs.	Landowners, CoW.

Objective E&G3 Reduce Emissions from operation of buildings

Measure: • 5 star energy efficient housing • Energy efficiency requirements for other buildings		
Development Stage	*Action*	*Responsibility*
Local Structure Plan	Energy efficiency objectives and targets set out for residential and other buildings.	Landowners, CoW.
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	Design Guidelines to describe measures to achieve objectives and targets (details will depend on status of WA Basix and the BCA.)	Landowners, CoW.

Objective E&G4 Increase renewable energy

Measure: • Greenhouse efficient hot water in homes and other buildings • Promote grid connected PV installation in homes • Require Green Energy purchase		
Development Stage	*Action*	*Responsibility*
Local Structure Plan	Objectives and targets described	Landowners, CoW.
Detailed Area Plan (where applicable)	As above	
Subdivision Plan	Design Guidelines to describe specific measures (eg gas boosted solar hot water).	Landowners, CoW.

3.4 Ecosystem Health

Objective EH1 Conserve and Enhance Local Biodiversity

Measure: • Conservation of existing significant environmental assets • Management of interface between urban and conservation areas		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	EMP to be developed for infrastructure works	Landowners, City of Wanneroo, WAPC
Local Structure Plan	Management objectives and methods specified. EMPs to be developed for ROS and POS for: Foreshore Reserves, Alkimos and Eglinton ROS, POS as appropriate	As above
Detailed Area Plan (where applicable)	Management objectives and implementation methods specified.	As above
Subdivision Plan	Implementation of environmental management methods and works in accordance with EMP	As above

Measure: • Biodiversity based landscaping of public and private spaces		
Development Stage	*Action*	*Responsibility*
Infrastructure Planning	Use of EMP's to incorporate key biodiversity based landscaping measures	Landowners
Local Structure Plan	As above	As above
Detailed Area Plan (where applicable)	Predominant use of low water use native vegetation in all public realm landscaping	Landowners, CoW
Subdivision Plan	Implementation of environmental management methods and works in accordance with EMP	

Objective EH2 Encourage community participation in local bush care efforts

Measure: • Community based bush regeneration and protection program
The implementation of any community based bush regeneration and protection program will be established during housing occupation

Objective EH3 Encourage sustainable waste management options and improve resource recovery

Measure:

- Construction waste management controls and targets to minimise waste and re-use / recycle residuals

Development Stage	*Action*	*Responsibility*
Local Structure Plan	Description of waste management objectives. Description of streaming and collection of C&DW from sub-division works.	Landowners, CoW.
Detailed Area Plan (where applicable)	As above	Landowners, CoW.
Subdivision Plan	Description of waste minimisation measures and streaming and collection of C&DW in Design Guidelines.	Landowners, CoW.

Measure:

- Recycle organic wastes locally for use in parks and gardens

Development Stage	*Action*	*Responsibility*
Infrastructure planning	Consider logistics of transporting, storing and distributing compost from MRC resource recovery facility	City of Wanneroo
Local Structure Plan	Design in any physical requirements for use of compost in POS	Landowners, CoW
Detailed Area Plan (where applicable)	As above	Landowners, CoW
Subdivision Plan	As above	Landowners, CoW

Attachment A

Integrated Water Management Strategy

Alkimos Eglinton District Structure Plan

Integrated Water Cycle Management Strategy

Contents

Table Index

Figure Index

1. Introduction

1.1 Context

Climate change has contributed to a 10-20 per cent reduction in rainfall in the south west of the State alone over the last 30 years, and a subsequent 40-50 per cent reduction in streamflow, including run-off to public water supply dams, and a reduced recharge of groundwater.

The most recent climate change predictions for Western Australia indicate that the current dry conditions, which extend to many other parts of Australia, are likely to continue. The south west is expected to become increasingly warmer and drier than last century. The increase in temperature will result in further reduced run-off from water catchments, and will lead to increased demand for water by humans, animals and vegetation.

Western Australia's State Water Strategy (Government of WA, 2003) recognises the need for a multi faceted approach to water resource planning, combining the development of new sources with the implementation of new efficiency measures and innovative ways of water re-use. The Strategy calls for strong community, government and industry partnerships to ensure a sustainable water future.

In response to this situation the State Water Strategy (February 2003) includes the following targets:

» Achieve a consumption level of 155 kL / person / year for consumers served by the Integrated Water Supply System by 2012 (consumption at the time was 180 kL / person / year).

» 20 per cent reuse of treated wastewater by 2012.

The Water Corporation is also seeking to achieve water conservation and water use efficiency in order to conserve current scheme water supplies and defer development of new sources. To this end, the Water Corporation has developed a set of Draft *Waterwise Land Development Criteria*, with the aim of supporting and helping to promote developers who adhere to the criteria. The criteria set mandatory measures for achieving water efficiency inside and outside the home, as well as design guidelines for residential gardens. The Water Corporation has also recently developed *Urban Non-potable Water Use: Guidance for Developers and Consultants Considering Non-potable Water Options* (GHD, 2006).

1.2 Purpose of the Integrated Water Cycle Management Strategy (IWMS)

Urban development within the Study Area will lead to a significant demand for water for new residents, to be used in-house and ex-house, as well as for irrigation of public open spaces and commercial/ industrial purposes.

The aim of this document is to provide a framework to guide development at Alkimos Eglinton towards achievement of the State Water Strategy targets in the context of Integrated Water Cycle Management objectives, which are:

» Efficient use of water from all sources for all purposes

» Protection (or reinstatement) of the ecosystem health of receiving waters;

» Protection of human health and amenity;

» Economic efficiency;

» Minimisation of energy consumption and greenhouse gas emissions.

In this context, outlined below are estimates of anticipated water demands due to development in the Alkimos Eglinton area, measures that can be implemented to achieve water conservation and efficiency, options for scheme water substitution and for drainage.

It is acknowledged that strategic planning for location of reticulation and distribution mains for water supply throughout the Alkimos Eglinton area has been undertaken for the District Structure Plan. It is not the intention of this IWMS to replace or substitute this planning, but rather to provide strategic guidance for alternative water supply planning in the Alkimos Eglinton area before more detailed scheme water planning is undertaken.

2. Scheme Water Conservation

2.1 Conceptual Water Balance

The Water Corporation's *Domestic Water Use Study* (Loh and Coghlan, 2003) provides quantifiable indications of water use for single lot residential households (using an average of 3.3 people/household) based on a conventional rate of water use. These quantities are shown in Table 1.

Estimates of household irrigation water consumption presented in the Domestic Water Use Study were derived prior to the introduction of watering restrictions over the summer of 2002-2003 (approximately 251 kL/house/yr). Estimates of the irrigation water consumption after the introduction of the restrictions are approximately 177 kL/house/yr (Australian Academy of Technological Sciences and Engineering 2002).

Under conventional development, there will be a significant increase in the water demand for the Alkimos Eglinton area for in-house and ex-house uses, and also a significant increase in the amount of water that is recharged to groundwater. Identifying these two major differences allows for:

» quantification of scheme water savings to be made through water conservation and efficiency measures in-house and ex-house; and

» an opportunity to reduce scheme water demands through substitution of scheme water for a non-potable water supply.

These two opportunities are described further below.

2.2 Water Conservation and Demand Management

Water Corporation has estimated the likely improvements in water consumption by single lot households from the adoption of waterwise practices. These include water efficient fixtures and fittings within the home, such as taps, showerheads and appliances and waterwise landscaping, such as subsurface irrigation and the use of soil conditioners to reduce watering needs. The same waterwise landscaping measures can be applied to irrigation of public open space (POS).

These quantities are shown in Table 1 to indicate the relative water savings that can be made by adopting waterwise practices.

Table 1 Single lot residential household water use estimates

	Conventional Use		Waterwise Use		
	Daily	Annual	Daily	Annual	% of Conv
	L/house/day	kL/house/yr	L/house/day	kL/house/yr	Use
In-house					
Bath & Shower	171		161		94%
Washing Machine	139		89		64%
Toilet	112		75		67%
Tap	83		69		83%
Other	18		14		80%
	523	191	409	149	78%
Ex-house					
Irrigation	687 (peak)	177	425 (peak)	155	88%
Total Usage	1,210 (peak)	368	833 (peak)	304	83%

The figures in Table 1 indicate that with waterwise measures the potable demand would be reduced to around 300 kL/house/year, which is approximately 100 kL/person/year, 50 kL/person/year less than the State Water Strategy target.

With the addition of a non-potable source for irrigation, the potable demand would be reduced to around 150 kL/house/year, which is approximately 50 kL/person/year. This would be considerably less than the State Water Strategy target of 155 kL/person/year by 2012.

It should be noted that the estimates shown above for domestic irrigation demand are based on conventional landscaping in the Perth metropolitan region, which includes a large proportion of turf compared with garden beds. The domestic irrigation demand could potentially be reduced further if landscaping were designed such that the proportion of turf was minimal.

Adoption of waterwise measures is considered to be a required component of the IWMS and would need to be explicitly addressed in the implementation of Alkimos Eglinton.

2.3 Potential Scheme Water Substitution Options

Substituting scheme water with an alternative source for non-potable uses (i.e. uses that don't require drinking water quality) can make significant savings in scheme water and the associated chemicals and energy required to treat and deliver water to drinking water standard. This is easiest to achieve ex-house (irrigation) than in-house (toilet flushing and cold water inlet to washing machines) in terms of required level of treatment, obtaining regulatory approvals and cost involved.

It is not proposed to substitute scheme water for potable demands within the Alkimos Eglinton development.

Potential supply options for non-potable uses include roof runoff, groundwater, stormwater (runoff from hard surfaces, predominately roads), greywater and wastewater. Substitution using roof runoff and/or groundwater currently occurs by many individuals across the Perth metropolitan region and in regional Western Australia, and is not considered new or particularly difficult options to implement. Indirect reuse of stormwater currently occurs to some extent on the Swan Coastal Plain, through the infiltration of stormwater through sands and subsequent abstraction as groundwater. Direct reuse of stormwater and reuse of wastewater (either directly or indirectly), although currently occurring in some developments in eastern Australia and overseas, have not yet been approved for use in any projects in Western Australia.

GHD (2006) defines key issues for various non-potable source options. The relative difficulty of implementing non-potable water use in the Perth region, as a combination of level of required treatment, availability and costs to implement is summarised in Table 2, and described in more detail below.

Table 2 Relative Ease of Implementation of Non-Potable Water Use Under the Current Regulatory Framework

Water Source	In-house			Domestic Irrigation	Public Open Space Irrigation	Aquifer Recharge
	Hot Water	Toilet Flushing	Washing Machine Cold Water Inlet			
Roof run-off	More effort to implement	Easy to implement	Easy to implement	More effort to implement	More effort to implement	Easy to implement
Shallow groundwater	Significant effort to implement	More effort to implement	More effort to implement	Easy to implement	Easy to implement	Not applicable
Domestic greywater	Difficult to implement	Difficult to implement	Difficult to implement	Significant effort to implement	Significant effort to implement	More effort to implement
Stormwater (urban run-off)	Difficult to implement	Difficult to implement	Difficult to implement	Difficult to implement	Difficult to implement	Easy to implement
Treated wastewater	Difficult to implement	Difficult to implement	Difficult to implement	Significant effort to implement	More effort to implement	Significant effort to implement

Roof Runoff

Rainwater tanks have previously been considered of little value in the Perth environment. However, if rainwater is used to supply in-house requirements rather than irrigation, they are effective in winter. On an annual basis a 3 kL tank (integrated with scheme water) could supply:

» approximately 25% of in-house water requirements if connected to toilets and washing machines (equating to a scheme saving of 43 kL/yr conventional demand, 36 kL/yr waterwise demand); or

» approximately 30% of in-house water requirements if connected to washing machines, toilets and hot water (equating to a scheme saving of 60 kL/yr conventional demand, 52 kL/yr waterwise demand).

This represents 10-14% of total household use under a conventional demand scenario (12-17% waterwise demand). The extension of rainwater to supply hot water systems would require the approval of the Department of Health.

The major potential risk posed by the use of rainwater is the risk to public health of poor water quality. Rainwater quality is generally considered to be of a high standard if regular maintenance and appropriate management of the system is undertaken. Appropriate maintenance and management of rainwater tank systems includes installation of first flush diverters, prevention of access to any vermin or disease vectors, filters to minimise the entry of large particles and leaves, regular desludging to avoid build up of sediments at the base of the tank and regular inspection and maintenance of gutters and downpipes.

With appropriate maintenance and management, it is considered that the rainwater quality would be of a sufficient standard to be used for non-potable in-house use without further treatment.

The use of rainwater tanks is not considered to present a significant risk to the environment and may provide a benefit in the management of stormwater across the development particularly areas with limited infiltration opportunities, by removing or at least detaining roof runoff from lots.

Groundwater

Groundwater abstraction is the easiest and usually most cost effective method of providing an alternative to scheme water for irrigation. It is generally acknowledged that the consumption of groundwater by individual households owning a private bore is greater than for those households irrigating from scheme water, and thus it is considered that encouraging private bore use within the Study Area would not lead to achievement of the water conservation objectives. However, if a centralised system were to be installed, supplying groundwater via a dual reticulation network and with central management, this could be implemented in such a way as to minimise the use of irrigation water and help achieve the water conservation objectives. Such a system is currently planned in Brighton, and is currently being evaluated by the Water Corporation.

Groundwater could also potentially be used as an alternative water supply for non-potable in-house uses. The use of groundwater presents a small risk in terms of water quality. With respect to irrigation, the presence of significant iron concentrations, hardness, alkalinity, nutrients or salinity can impact upon the receiving vegetation and soils and/or contribute to scaling or scour of irrigation pipework. Potential water quality issues of concern for in-house use include the presence of suspended solids and pathogens. If contamination is present in the aquifer, the use of groundwater will pose a risk for both irrigation and in-house uses and may lead to environmental problems due to mobilisation of contaminants.

In locations where the use of superficial groundwater is determined to be feasible for use in principle, site specific investigations would be required to confirm the suitability of the local water supply quantity and quality.

Stormwater (Urban Runoff)

Conventional urban development results in a significant quantity of water being introduced to the local groundwater environment. This local water “surplus” arises from:

» The additional recharge/surface flows associated with drainage of rainwater from hard surfaces (much of which would otherwise be subject to evapo-transpiration); and

» The recharge component of household irrigation.

This “surplus” water will find its way to the superficial aquifer via any natural or manmade surface drainage.

Previous studies have shown that the quantity of surplus water approximately matches the irrigation demand for urban development in the sandy soils in the Perth area. Accordingly it may be possible to supply the irrigation and other non-potable needs from reclaimed stormwater. Using only the surplus will ensure that the post-development flows remains similar to the pre-development flows, resulting in a low risk environmental outcome.

The most efficient option for harvesting stormwater is:

» Infiltration of stormwater to the superficial aquifer at (or close to) source;

» Direct supply of groundwater from the superficial aquifer via a dual reticulation network.

As previously stated, studies would be needed to confirm the suitability of the aquifer to supply non potable demands within the Study Area.

Treated Wastewater

Wastewater recycling within the Study Area would require the construction of tertiary treatment modules at the proposed Alkimos wastewater treatment (which is included in the Water Corporation’s planning for the plant). Recycled water could then be used for non-drinking water uses such as garden and POS irrigation (requiring Class A water treatment), and possibly in-house uses as toilet flushing and clothes washing (likely requiring Class A+ treatment). This latter application would require the approval of the Department of Health.

Recycled water would be conveyed either directly from the wastewater treatment plant to houses or indirectly by recharging superficial or confined aquifers and recovering the water via bores.

<u>Direct Recycling</u>

Separate studies have shown that direct recycling of the total wastewater stream for irrigation and other non-drinking water purposes would require:

» Supplementation in the summer months to meet the required irrigation demand; and

» Conventional discharge in the winter months when there is no irrigation demand.

The use of treated wastewater for non-potable uses presents a medium risk to the environment due to the potential for irrigation or discharge of unsuitable water quality. While the Department of Health's Class A criteria primarily target pathogens, suspended solids and organic material, the criteria does not include potential environmental contaminants such as nutrients or heavy metals. Therefore if wastewater were to be used for non-potable uses in Alkimos Eglinton, the treatment process would need to include removal of nutrients and heavy metals, and quantify the relative risk of any conservative contaminants remaining in the treated wastewater.

If the treated wastewater is used at households for subsurface irrigation, thereby preventing direct contact with the water, the risk to public health is low. Similarly, if irrigation of POS using treated wastewater can be adequately controlled to prevent public access, the risk to public health can be low (assuming that adequate treatment standards are achieved). However, the use of treated wastewater for in-house uses presents a relatively higher risk to public health due to the potential for cross connections of the non-potable supply with the potable supply, potentially providing a pathway for direct consumption of the treated wastewater.

Consideration of direct recycling of treated wastewater for the Study Area would require a full risk assessment as per the Department of Health's HACCP framework.

<u>Indirect Recycling</u>

Indirect recycling by recharging aquifers with treated wastewater, and recovering water from downgradient wells (known as Managed Aquifer Recharge – MAR) is a major potential opportunity in the study area and has been identified as such in the Environmental Protection Authority's (EPA) recent advice (Bulletin 1199 October 2005):

> *The EPA supports in principle the concept of wastewater reuse, and recognises the potential for MAR using treated wastewater to play an important role in the sustainable management of Western Australia's water resources. This is particularly the case given the reduction in rainfall which has occurred in the south west of the State since the mid 1970s, and the large reliance on groundwater resources. There are a number of potential environmental, health and social issues associated with MAR, and these will need to be addressed prior to the implementation of any significant MAR scheme.*

The timeline for any forthcoming approvals for MAR is some time away and thus is unlikely to suit the early stage development timetable for Alkimos Eglinton. However the opportunities for MAR to play a role over the long term are significant.

Treated Greywater

Domestic greywater is potentially available for reuse at both the individual lot scale and collectively at the subdivision scale.

If greywater is to be considered for in-house use, it must meet Class A (Department of Health 2005) standards, for toilet flushing and washing machine use, and potable standards for hot water systems. It is generally considered that greywater reuse for in-house uses would be too costly to consider as a mandatory requirement, and regulatory approvals would be very difficult to obtain due to the requirements for management to ensure adequate maintenance and operation of the systems.

At the individual lot scale, treated greywater is suitable for garden irrigation in accordance with the *Code of Practice for the Reuse of Greywater in Western Australia*. It is generally considered that greywater can only be stored for up to 24 hours at a time without significant impacts on water quality (and subsequent risks to public health). Therefore greywater generated during each day would need to be discharged, either for reuse or for disposal to the sewer network, every 24 hours (especially during winter).

If greywater were to be used for domestic irrigation in single residential houses as described above, it would only be able to meet a proportion of the demand during the summer irrigation period (~10-30 m^2 of garden), and therefore is not a complete solution.

Due to the general inability of the greywater stream to meet irrigation requirements, the costs associated with installing a household system and the potential environmental risk posed by the widespread uptake of household systems, it is not considered appropriate for the IWMS to mandate household greywater systems as a strategic scheme water substitution option.

Individuals may choose to install greywater systems for household irrigation during the development, in which case they will be responsible for adhering to the *Code of Practice for the Reuse of Greywater in Western Australia* and obtaining any necessary approvals.

At the subdivision scale, greywater may be suitable for irrigation of public open space. However this would require a dual reticulation network to collect, treat and distribute the water for reuse and the treated greywater would need to meet Class A standards where there was uncontrolled public access or Class C standards for controlled public access. The system would therefore need to be implemented in the same way as for direct wastewater recycling, with similar risks to the environment and public health.

2.4 Integrated Water Cycle Options for Alkimos Eglinton

The feasibility of implementation of each possible non-potable supply source has been evaluated for the Study Area and the findings are summarised in Table 3. Based on this assessment, three core Integrated Urban Water Management (IWM) options have been developed for supplying potable and non-potable water to the Study Area. The three options are shown in Figures 1 to 3 and summarised in Table 4.

As noted above Managed Aquifer Recharge (MAR) is not an option that can be considered initially and is therefore not included in the options set out below. All options could however accommodate the introduction of MAR for later stages of Alkimos Eglinton.

Table 3 Possible Non-Potable Supply Options for Alkimos Eglinton

Development Area							
Houses / Buildings							
	Kitchen	Bathroom	Laundry	Toilet	HWS	Yard	POS
	Cold water				Hot Water		
	Potable		Non-potable		??	N-P	N-P
In-house							
Drinking	P	P					
Food prep	P						
Bathing		P					
Clothes washing			P				
Hot Water					P		
Toilet flushing				P			
Ex-house							
Irrigation						P	
Public Open Space							
Irrigation							P

POSSIBLE SOURCE	Kitchen	Bathroom	Laundry	Toilet	HWS	Yard	POS
Scheme	P	P	P	P	P	P	x (Ec)
Roof run-off	x (WQ)	x (WQ)	P	P	P	x (Ec)	x (Ec)
Groundwater	x (WQ)	x (WQ)	P	P	P	P	P
Stormwater	x (WQ)	x (WQ)	x (Ec)	x (Ec)	x (Ec)	x (Ec)	x (Ec)
Treated greywater	x (WQ)	x (WQ)	P	P	P	P	P
Treated wastewater	x (WQ)	x (WQ)	P	P	P	P	P

Easy to implement	P	
More effort to implement	P	
Difficult to implement	P	
Not considered feasible	x (WQ)	water quality
	x (Ec)	cost

Table 4 Integrated Water Cycle Management (IWM) Options

OPTIONS	Kitchen	Bathroom	Laundry	Toilet	HWS	Yard	POS
	Cold water				Hot Water	Cold	Cold
	Potable		Non-potable			N-P	N-P
OPTION A							
Scheme	P	P			P		
Roof run-off			P	P	P(Alt)		
Groundwater						P	P
Treated greywater				P(Alt)		P(Alt)	
Treated wastewater							
OPTION B							
Scheme	P	P			P		
Roof run-off							
Groundwater			P	P	P(Alt)	P	P
Treated greywater				P(Alt)		P(Alt)	
Treated wastewater							
OPTION C							
Scheme	P	P			P		
Roof run-off			P(Alt)	P(Alt)			
Groundwater						P	P
Treated greywater							
Treated wastewater			P	P		P	P

All of the options assume that:

- scheme water will be used for potable uses;
- deep sewerage will be used for wastewater conveyance and treatment; and
- a non-potable supply (dual reticulation) will be provided for domestic and POS irrigation, toilet flushing, washing machine use (cold water inlet) and possibly the hot water system (particularly using roof runoff).

It is assumed that all of the options will implement water efficiency and demand management measures in-house and ex-house.

All the alternatives involving the use of non-potable sources inside the house and the use of treated wastewater outside the house would require approval by the Department of Health.

Option A or B would significantly reduce the volume of water reaching the superficial aquifer in comparison with the conventional development scenario, such that the IWM development scenario more closely resembles that of the pre-development situation, thus maintaining water requirements for receiving environments. Under Options A or B the groundwater source would be the superficial aquifer.

Options A or B are both compatible with any eventual MAR scheme in the north west corridor. In essence the treated wastewater recharged to the aquifer would be recovered in the groundwater bores proposed under these options.

Under Option C the predominant non-potable source would be treated wastewater, supplied directly from the Alkimos Wastewater Treatment Plant. However this is only a partial solution as this supply needs to be supplemented in the summer to meet required irrigation demand. It has been assumed here that groundwater would be the supplementary source. Under this scenario the volume of water recharged to groundwater is reduced compared to the conventional development scenario, but is still much greater than under the predevelopment situation. This IWM option therefore results in significant changes to the existing water cycle and leads to a net import of water to the Study Area.

Option C would also only be a viable alternative when flows into the wastewater treatment plant reached a level that would be sufficient to justify the investment in the required treatment infrastructure, and produce sufficient flows to supply the required non-potable demand.

If an MAR scheme is eventually phased into the north west corridor, Option C would be discontinued for new areas, leaving only the initial stages of the Alkimos Eglinton catchment supplied directly with treated wastewater.

Figure 1 Option A

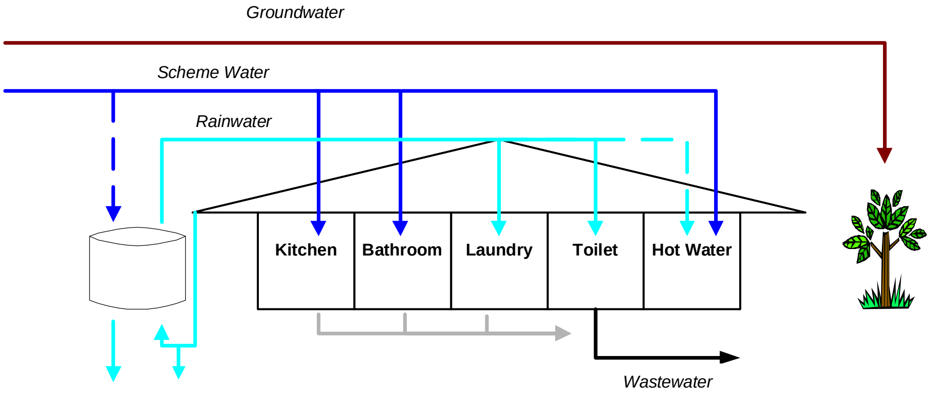


Figure 2 Option B

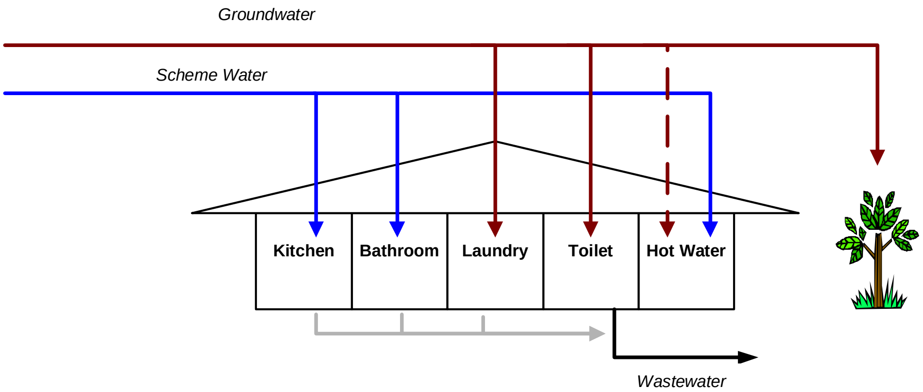
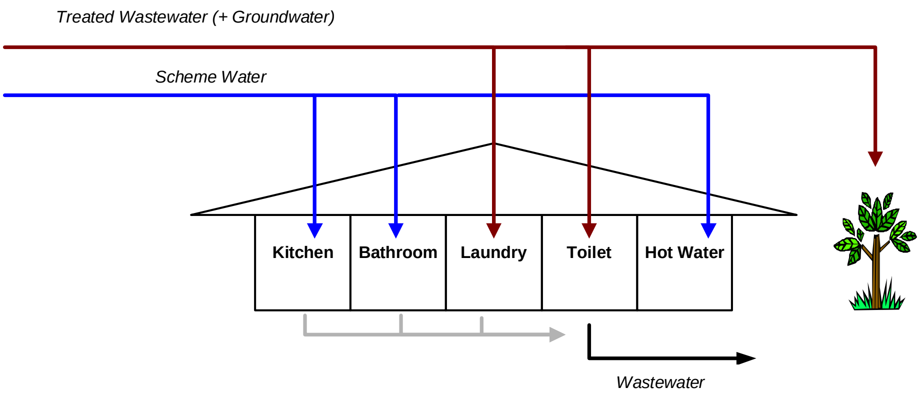


Figure 3 Option C



3. Implementation of IWM at Alkimos Eglinton

The IWM options identified in Section 2 require further analysis, and consultation with a wide range of stakeholders, including the Department of Water, the Water Corporation, the City of Wanneroo, landowners and the community.

It is recommended that this initial study be used as input into a wider Integrated Water Cycle study for the north west corridor. It is recommended that this study:

» Incorporates all existing relevant data and studies that would inform the development of an IWM approach, including environmental, groundwater;

» Further develops the IWM options proposed here;

» Collaboratively develops a suite of social, economic and environmental criteria to guide assessment of the options with a view to achieving the core IWM objectives, ie:

  – Efficient use of water from all sources for all purposes
  – Protection (or reinstatement) of the ecosystem health of receiving waters
  – Protection of human health and amenity
  – Economic efficiency
  – Minimisation of energy consumption and greenhouse gas emissions

» Undertakes the necessary investigation, catchment modelling work and engineering work necessary to complete a full sustainability assessment of the options;

» Engages in the necessary consultation and engagement with stakeholders to ensure transparency and legitimacy;

» Develops a comprehensive IWM strategy for the north west corridor that incorporates the potential for Managed Aquifer Recharge in the future.

Attachment B

Photo Voltaics Business Case

Alkimos Eglinton District Structure Plan

Business Case for Household Grid Connect Solar Power at Alkimos Eglinton

Contents

Table Index

Figure Index

1. Context

The residential photovoltaic (PV) array is a type of distributed solar power generator that can be installed on the rooftops of residential buildings. The power from the rooftop array can be delivered directly to the required output location. By delivering power directly to the point of use, transmission and distribution losses are minimised, therefore increasing overall system efficiency. Alternatively, power produced from the PV array, that is not used in the household, can be fed back into the network and generate revenue for the owner.

Extensive local deployment of this system type reduces, or postpones, the need to increase transmission, base and peak generator system capacities, as demand grows. Rooftop deployment avoids the problem of finding space and support to install solar arrays. PV arrays also utilise an unlimited, renewable energy source, and have no greenhouse gas (GHG) emissions during operation. Therefore they offer an opportunity for reducing household GHG emissions.

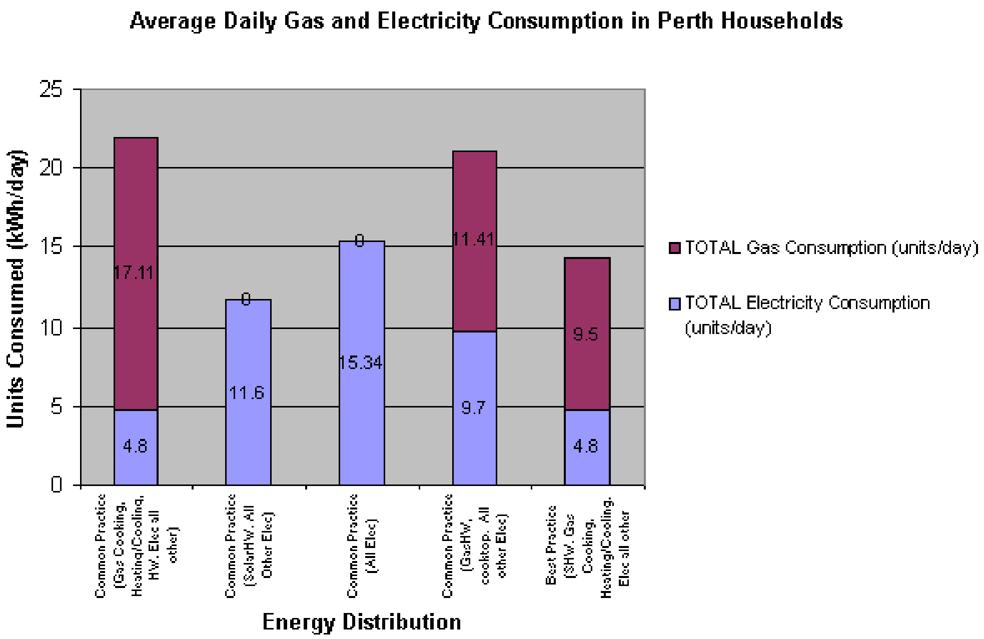
While the more widespread use of PV arrays offers many advantages for generators and society, electricity generated from PV systems is still expensive compared to that from conventional, fossil fuel generation systems, such as coal and gas. While there are very few running and maintenance costs associated with PV arrays once they are installed, they have a relatively large up-front capital cost. This forms a significant barrier to the more widespread implementation of PV arrays by households. In order to overcome this incentives are needed, as well as the articulation of a clear business case for the lifetime (usually 20 years) of the arrays.

The following solar optimisation study aims to identify the level of incentive required to create a business case for householders to purchase grid-connected PV systems.

2. Perth Residential Energy Load Profile

The following load profiles for Perth metropolitan households have been based on extracts from the Office of Energy, the AGO and Case Studies conducted by GHD. According to the State of Environment Report (2006), the average Perth household electricity consumption under common practice, is 15kWh per day. Figure 1 provides average gas and electricity consumption in Perth households, given varying degrees of demand management and use of energy efficient devices within the home. Therefore electricity consumption can range from an average of between about 5 and 15.5 kWh per day.

Figure 1 Average Daily Energy Consumption for Perth Metropolitan Households

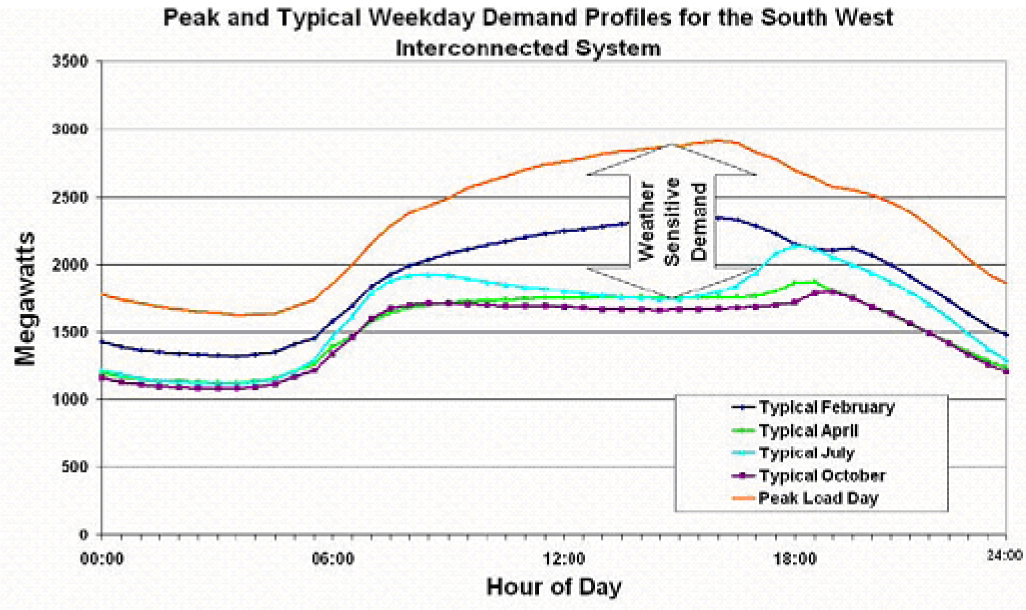


3. South West Interconnected Grid-Connect Peak Power Issues

3.1 South West Interconnected Network Load Profile

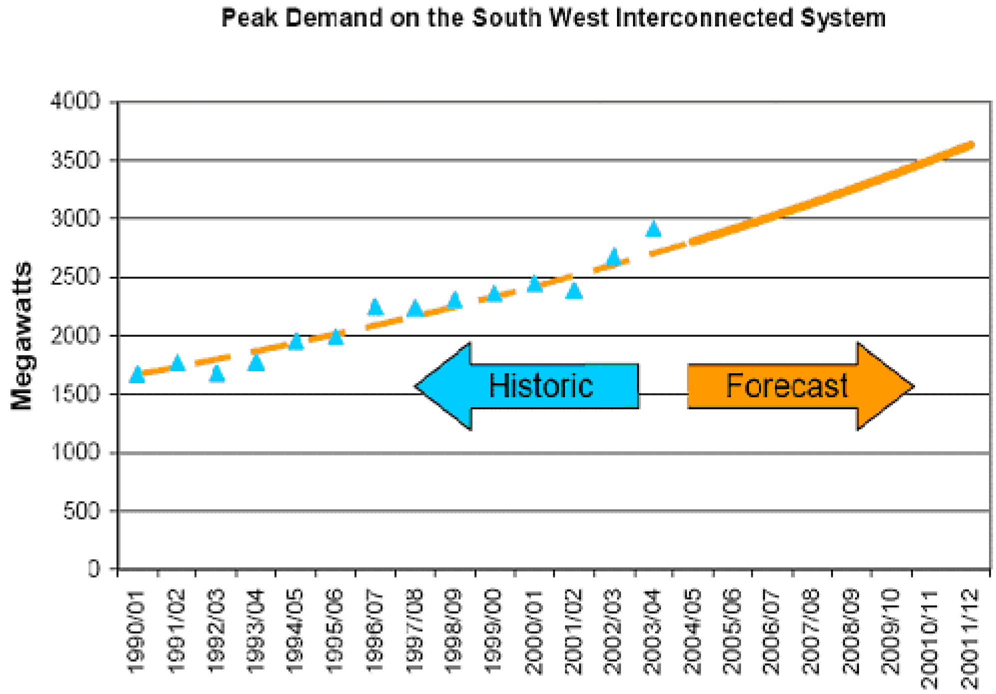
Figure 2 represents overall mixed use weekday power demand on the South West Interconnected Network (SWIN). Peak demand during summer months occurs between 12pm and 6pm, and between 5pm and 7pm during winter months. It should be noted that these seasonal profiles include power demand from household, commercial and industrial processes.

Figure 2 Average Load Profile on the South West Interconnected Network (OOE, 2004)



Peak demand forecasts for the SWIN (Figure 3) show a positive linear relationship between future years and future peak demand growth. The projected peak demand is estimated to rise from 2,800 MW in 2006 to 3,700 MW in 2012. The current SWIN capacity is 3,000 MW, and the forecast peak demand in the next 6 years is more than double the 1990 levels. Growth in demand over the next 6 years is up to 30% of current total peak demand. This will result in a number of issues related to the ability of the SWIN to provide reliable power in future, and require decisions about the installation of new generation and distribution capacity.

Figure 3 Peak Demand on the South West Interconnected System (OOE, 2004)



3.2 Cost Issues Related to Peak Demand and Generation

There are three main cost issues associated with increasing peak demand, given the current capacity of the SWIN:

1. An increase in peak demand up to, and beyond, the generation and transmission capacity of the SWIN can lead to increased instability in the grid supply, increased power dropouts and even blackouts.
2. Peak generation is more expensive than base-load generation.
3. The capital cost of installing new generation capacity that is used for only the short periods of peak demand.

The following table identifies the costs associated with power dropouts to the Power Utility on the SWIN (**http://www.imowa.com.au/**).

Table 1 Costs associated with power dropouts to the power utility on the SWIN

	Low Limit	Deadband			High Limit	Incentive Rate(Portion of transmission revenue)
		Lower bound	Target	Upper bound		
Circuit Availability (%)	97.6	98.1	98.6	99.1	99.6	$269,000 per 0.1% circuit availability
System Minutes Interrupted (meshed network)	4.8	5.8	8.3	10.8	11.8	$134,000 per 0.1 System Minute Interrupted

Although the values for peak- versus base-load generation costs in Western Australia are not readily available it is possible to determine reasonable values for these. Using realistic assumptions about the generation technologies used, and the spot price in a similar system (South Australia) average base- and peak-load costs for Western Australia have been calculated to be ~ $50 MWhr and ~$60 MWh respectively. The South Australian spot market shows however that at times during some peak periods the price can exceed $100 MWhr.

Therefore any measure that can reduce the peak load on the SWIN will result in savings for the electricity generators and retailers.

4. Household Grid-Connect Solar Energy Systems

4.1 Assumptions

A solar optimisation study has been completed based on daily averages for the Perth Metropolitan region, collected from *Condensed Solar Radiation Data Base for Australia; Graham L. Morrison and Alex Litvak, 1999. ; UNSW, Sydney Aus.*

No measured data for the required site at Alkimos/Eglington has been made available, and hence the following cost estimates are based on daily Perth averages. Detailed design with a site-specific daily irradiance profile will be required for accurate system sizing and costing.

4.1.1 Peak Sun Hours

Best Month February 22.2 MWm^{-2} day^{-1} or 6.2 Peak Sun Hours (PSH)

Worst Month July ` 16.0 $MJm^{-2}day^{-1}$ or 4.4 PSH

4.1.2 Temperature Derating

PV manufacturer data specifications on power output are based on module standard temperature of 25ºC. PV modules commonly operate at 20ºC above ambient temperature, which varies considerably from the standard 25ºC. For increased accuracy of power output estimates, calculations need to be based on a temperature derated (drop in module output) PV capacity.

The effect of ambient temperature has been allowed for, as follows:

» February ambient temperature 28ºC

» July ambient temperature 15ºC

We have assumed the solar modules operate at approximately 20ºC above the ambient temperature. Based on manufacturer specifications the drop in module output (temperature derated output) is based on 0.38% per degree Celsius above the standard temperature of 25ºC. This provides the following expected power drop:

» February power drop - 8.74%

» July power drop - 3.8%

Therefore the actual module capacity of a 0.6 kW array would be estimated to be reduced to 548 kW. A summary of the temperature derated module capacities for each array size is contained below in Table 2.

Table 2 Temperature Derated Module Capacity

Best/Worst Month	0.6kW	1kW	1.5kW	2kW	3kW
February	**548W**	**913W**	**1,370W**	**1,826W**	**2,739W**
July	**577W**	**962W**	**1,443W**	**1,924W**	**2,886W**

Table 3 provides a summary of the estimated daily outputs for each array size based on the derated calculations above.

Table 3 Daily Solar Power Output (Temperature Derated)

Best/Worst Month	0.6kW	1kW	1.5kW	2kW	3kW
February (Wh)	3,398	5,661	8,494	11,321	16,982
July (Wh)	2,539	4,233	6,349	8,466	12,698
Average (Wh)	**2,969**	**4,947**	**7,422**	**9,894**	**14,840**

Installation Information

A slope equal to the latitude maximises the annual average solar radiation incident on a surface, and is best for applications seeking the maximum solar output throughout the year. A 50º slope has been the basis of the following analysis that favours output during winter months. Installation of the rooftop panels and connection to the household electricity wiring typically takes less than a day.

Installation commences with laying out each PV panel's rooftop mount. These join together with snap-on connectors to form a rigid platform co-planar with the roof and bolted to the roof using standard roofing screws (www.plug&power.com.au).Each rooftop mount incorporates a simple hinge arrangement that holds its PV panel in place and gives easy access to the inverter beneath. A flying lead from the PV panel plugs into the DC input of inverter to complete the circuit.

The elected electricity utility will require a separate meter to be installed to measure the import and export of electricity. The customer must pay the applicable charges for the import and export meters.

4.2 Design

With large arrays a Maximum Power Point Tracker (MPPT) device is commonly installed to maximise the output from the array. The device seeks to keep the modules in the array at their maximum power point (MPP) for the conditions prevailing at the time.

The difference in power output can be up to 14% in 25ºC conditions. If the ambient temperature were around 48ºC, the difference in power output would be around 6% of the peak power value. However, the cost of a stand-alone MPPT is high and outweighs the possible benefits of greater power output, where a small-scale system is installed. The retail cost of a 1kW stand-alone MPPT is approximately $600. Many inverter units include a MMPT capability, but usually cost more than an inverter only unit. The use of a separate stand-alone MPPT has not been included in this study due to the small-scale of the arrays modelled.

4.3 Photovoltaic Power Output Profile

The average summer power outputs of 0.6 kW, 1 kW, 1.5 kW, 25 kW and 3 kW PV arrays, adjusted for temperature derating, are depicted below in Figure 4 to Figure 8. These power outputs have been estimated based on the best-case sun profile of the Perth Metropolitan region in summer. The data has been extracted from a study conducted by Lawrance and Schaub at Curtin University in 2004, and modified to reflect the highest value for current average residential electricity use of 15 kWhrs a day (State of the Environment Report, 2006).

Figure 4 **Average Perth Summer 0.6kW Photovoltaic Daily Power Output In relation to Average Residential Weekday Summer Load.**

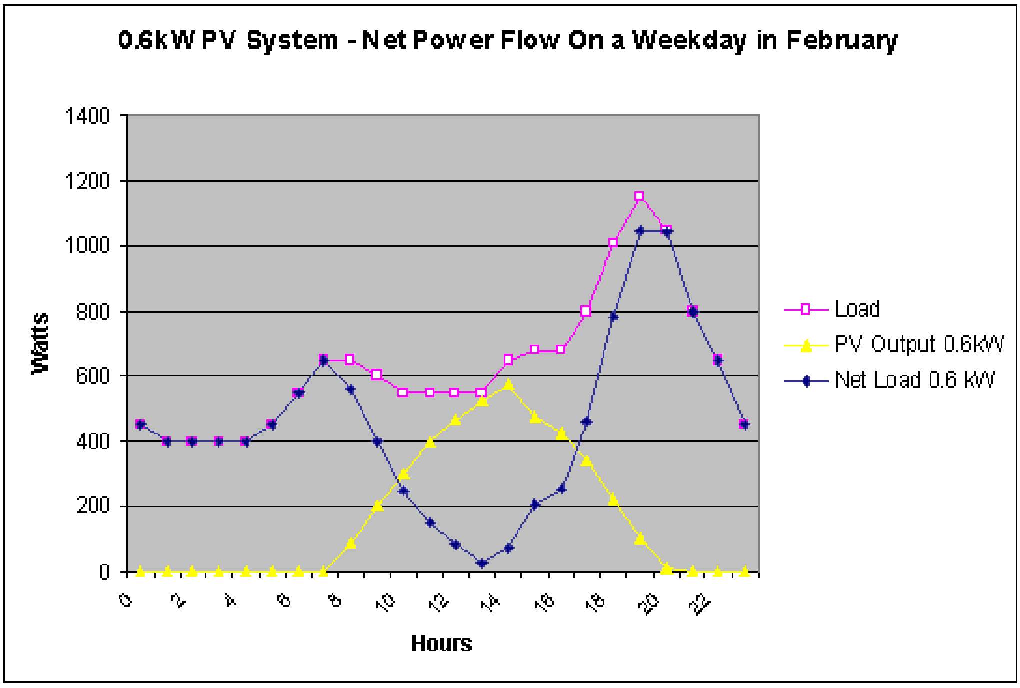


Figure 5 **Average Perth Summer 1kW Photovoltaic Daily Power Output In relation to Average Residential Weekday Summer Load.**

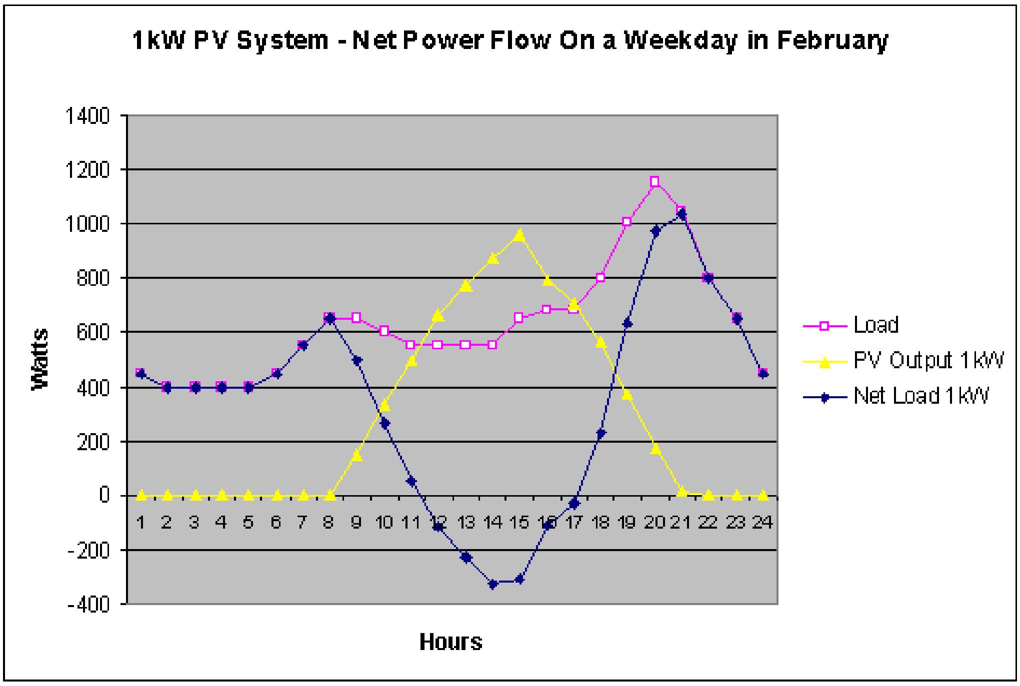


Figure 6 **Average Perth Summer 1.5kW Photovoltaic Daily Power Output In relation to Average Residential Weekday Summer Load.**

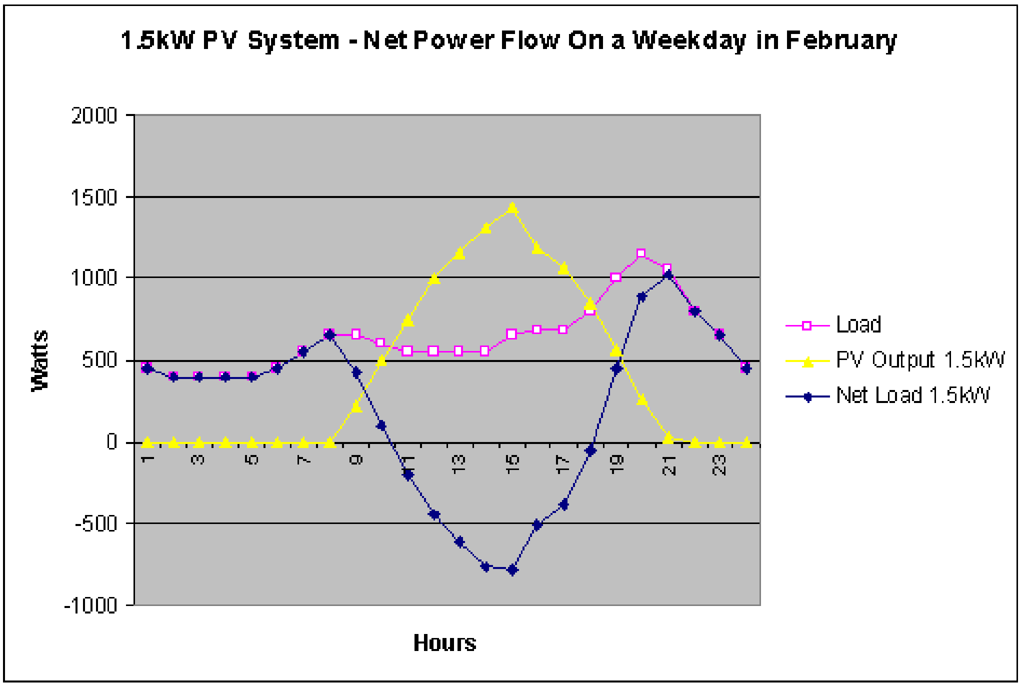


Figure 7 **Average Perth Summer 2kW Photovoltaic Daily Power Output In relation to Average Residential Weekday Summer Load.**

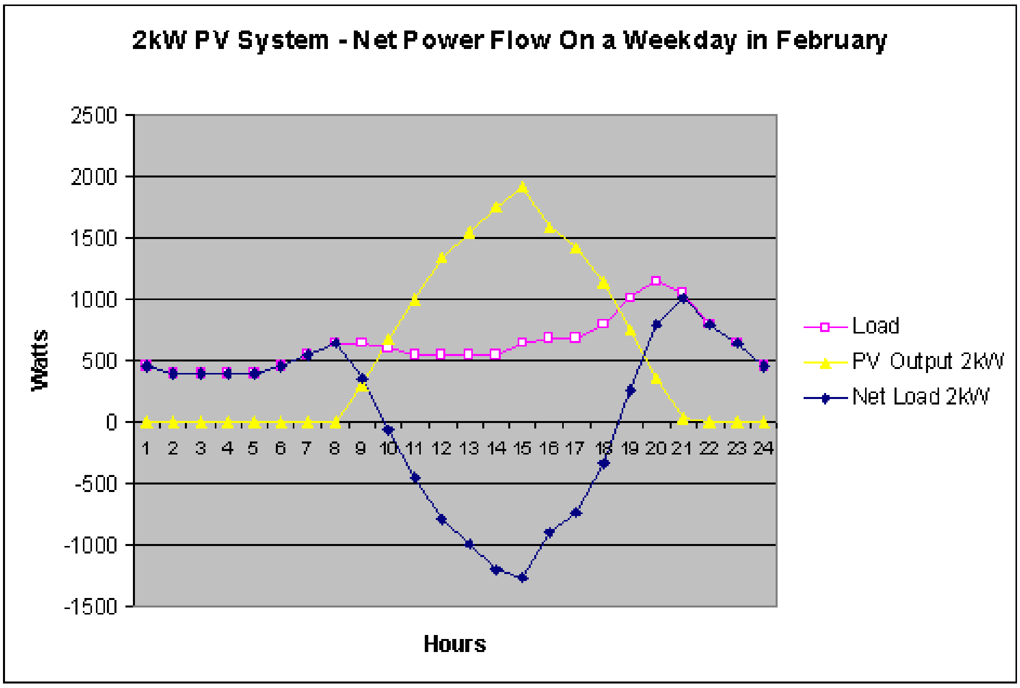
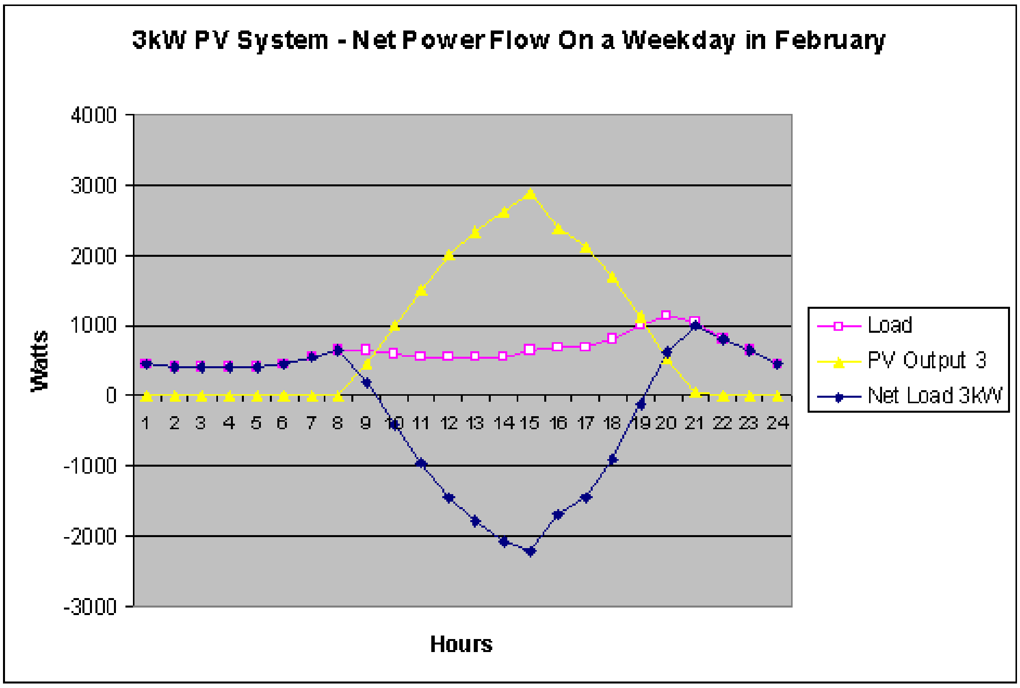


Figure 8 Average Perth Summer 3 kW Photovoltaic Daily Power Output In relation to Average Residential Weekday Summer Load.



Even for a house with the highest average electricity use (15kWhr/day), between 9:30 am and 7 pm more energy is produced from a household 3 kW PV system than is consumed. During this time energy can be exported to the grid network for commercial use. The positive power values of the blue line show the imported power from the grid. The negative values show the exported power into the grid. The electricity flow is based on estimated average household use of 15 kWh per day (State of the Environment Report, 2006). Gas consumption has not been considered for the purpose of this study. For houses with lower electricity consumption more electricity would be exported to the grid.

4.4 PV Potential to Offset Peak Power Network Upgrades

Information provided in Figure 9 has been extracted from a study conducted by the University of New South Wales (Watt M et al., 2004) that illustrates PV power output is at a maximum during peak and shoulder network times. It should be noted that overall network peak times from commercial use are during the day, where residential peak times are late afternoon and early evening.

For summer peaking feeders, the shape of the load curve determines the potential for PV to defer network upgrades. The following figure highlights the load and the load reduced by an appropriately sized PV array for feeders with predominantly residential loads (Watt, M et al., 2004).

Figure 9 Potential PV contribution to NSW residential load during peak demand.

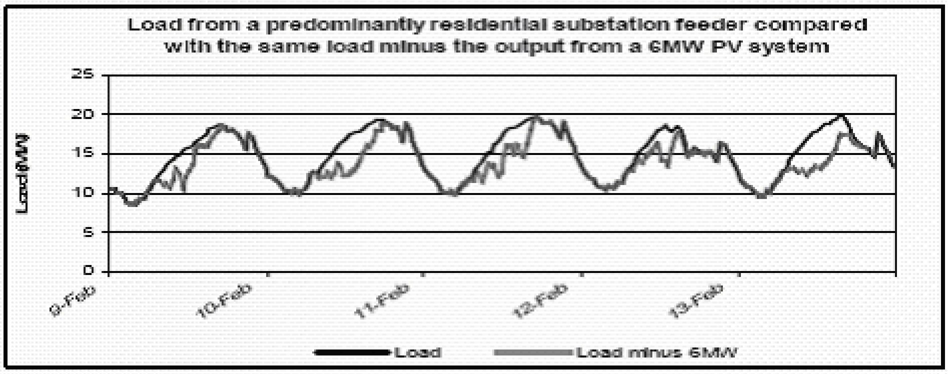
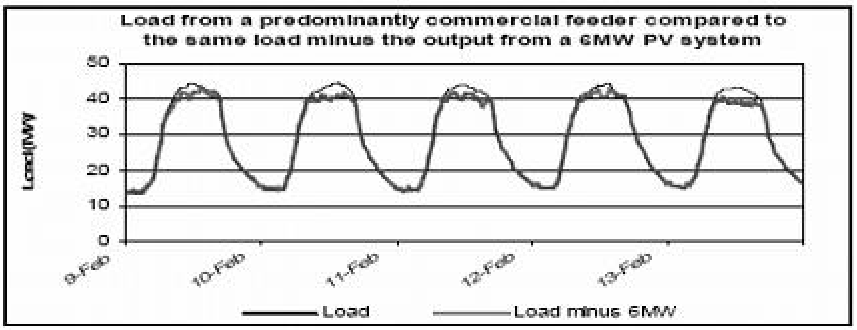


Figure 10 Potential PV Contribution to NSW Commercial Load during periods of peak demand.



The shape of the curve highlights that PV systems can be used to offset commercial peak loads and defer peak power network upgrades.

5. Financial Analysis

5.1 PV Capacity and Output

The PV capacities and outputs used in the financial model are summarised in Table 4 below.

Table 4 PV Capacity and Output

PV kW	0.6	1	1.5	2	3
Inverter	0.46	1	1.5	1.95	2.6
Daily Power Output kWh	2.97	4.95	7.42	9.90	14.84
Annual Power Output kWh	1,084	1,806	2,709	3,611	5,417
Total Power Use (kWh/year)	5,475	5,475	5,475	5,475	5,475
Net Grid Power Use with PV	4,391	3,669	2,766	1,864	58
Annual Greenhouse Gas Savings (kg of CO^2 equiv.)	1,079	1,797	2,697	3,595	5,392

Greenhouse Gas savings have been calculated at 0.995 kg of CO^2 equivalent per kilowatt-hour of power produced by the PV array.

5.2 Capital and Operating Costs

The current capital and operating costs of the PV capacities employed in the study are as follows in Table 5.

Table 5 Standard Solar Domestic Power System (Components and $ Costs)

PV kW	0.6	1	1.5	2	3
PV Cost incl. regulator,cable,framing	6,000	10,000	15,000	20,000	30,000
Inverter Cost	690	1,500	2,250	2,925	3,900
Meter Import/Export	250	250	250	250	250
Installation	900	1,300	1,950	2,450	3,450
Total Capital and Installation Cost	**7,840**	**13,050**	**19,450**	**25,625**	**37,600**
Maintenance Costs %	0.50%	0.50%	0.50%	0.50%	0.50%

5.3 Subsidies

5.3.1 PVRP Rebate Scheme.

The Sustainable Energy Development Office offers a rebate of $4 per Watt for new installed photovoltaic systems up to a maximum of $4,000 for household applications. The minimum new photovoltaic system size is 450W. This rebate has been included in the study for each PV array.

The proposed solar power system is required to be designed and installed by a SEDO accredited system designer and installer before a rebate will be paid. The lifetime of this Program is not guaranteed.

5.3.2 Renewable Energy Certificates

When a solar powered grid connect system is purchased, it can generate Renewable Energy Certificates (RECs) under the Mandatory Renewable Energy Target (MRET), under the Federal Renewable Energy (Electricity) Act 2000.

RECs are electronic certificates that represent:

- 1 MWh of renewable electricity, or
- 1 MWh of electricity displaced by a solar water heater.

For solar grid connect electricity systems installed after 31st July 2005, 15 years of REC's can be created in a single up-front transaction.

The current value for RECs is based on conservative estimates of $20 per Megawatt hour produced each year. The lifetime availability of RECS is not guaranteed.

RECs have not been included in the study due to the minimal impact on the cost savings for householders.

5.3.3 Residential Renewable Energy Buyback Scheme

Residential customers currently have the option of using the power output from their household PV system, and exporting any excess power to the grid under a choice of six tariff arrangements. Full details of pricing structures for all available tariffs can be found on the Synergy Energy website (http://www.synergyenergy.com.au/). The most common tariffs for households connected to the SWIN are summarised below.

A1 Residential Tariff

The A1 Tariff is the standard residential tariff, available to private dwellings and used solely for residential purposes. It charges the same flat rate regardless of when and which time of day electricity is used. Electricity fed back into the grid is priced the same as imported energy under this Tariff.

Table 6 A1 Tariff Charges

A1 Tariff	Cost
Supply charge - cents per day	25.57
Supply charge - cents per day (additional residence*)	19.86

Energy import price - cents per unit	13.94
Energy export price – cents per unit	12.67

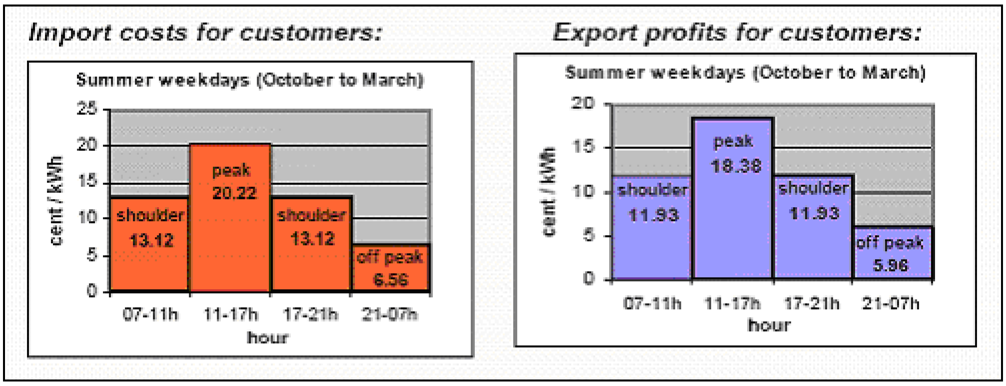
(All prices are inclusive of GST)

* Applies to multiple flats and home units supplied through the main Synergy meter.

Residential Smart Tariff

Residents have the option of importing and exporting power during peak and shoulder rates under the following price structure.

Figure 11 Residential Smart Tariff



5.4 Net Present Value Analysis

A Net Present Value analysis was prepared for the range of PV arrays. A summary of the assumptions used and the results of the analysis are included in the sections below.

5.4.1 Assumptions

The following assumptions were used during the analysis:

» Real costs and revenues are calculated at 2006 prices.

» Inflation is calculated at 3% per annum.

» Cashflows are discounted at 8% to the base year of 2007.

» PVRP Rebates are provided at $4 per watt, with a maximum of $4,000 per household.

» Grid cost savings are calculated at $0.14 per kilowatt hour.

» Maintenance costs are minor and calculated at 0.5% of capital costs per annum. This is expected to cover the minimal maintenance and cleaning costs associated with PV installations.

» Standard PV installations have a lifespan of 20 years and the NPV was calculated over this timeframe.

» Inverters will need to be replaced after 10 years of operation.

» Import and export tariffs are both the same at 13.94 c/kW.hr[1].

5.4.2 NPV Analysis Results

The NPV analysis revealed the following incentive required to achieve a positive NPV within 20 years for each householder for each option.

Table 7 Net Present Value Analysis

PV (kW)	0.6	1	1.5	2	3
Annual Power Output (kWh)	1,084	1,806	2,709	3,611	5,417
% Electricity Savings	20%	33%	49%	66%	99%
Capital ($)	7,840	13,050	19,450	25,625	37,600
Incentive to achieve positive NPV ($)	4,381	7,503	13,120	18,452	28,482
Rebate ($)	2,400	4,000	4,000	4,000	4,000
Net Capital Cost ($)	1,059	1,547	2,330	3,173	5,118
Annual Maintenance Costs ($)	39	65	97	128	188
Energy Savings ($)	152	253	379	506	758
Annual GHG Savings (kg CO2-e)	1,079	1,797	2,697	3,595	5,392
Net Annual Savings ($)	113	188	282	377	570

This analysis reveals that with an incentive to householders the PV array is a viable option that also reduces substantial GHG emissions. If Greenhouse Gas emissions are charged at $20 per tonne of CO_2 equivalent the incentive required would be slightly reduced as follows:

Table 8 Incentive required with GHG credits

PV (kW)	0.6	1	1.5	2	3
Incentive to achieve positive NPV ($)	4,096	7,027	12,406	17,501	27,056

[1] This is a simplification as at present export tariffs are some 10% lower than import tariffs – see Table 6.

5.4.3 Analysis of Emerging Technology

More recent innovations in PV design suggest that capital costs could be reduced by up to 30% for a 3 kW array resulting in a more cost effective application. The lifespan of these recent innovative arrays is not yet known, so for the purpose of the study an operating life of ten years has been assumed, at which time the components are fully replaced.

The technology is also not yet eligible for the PVRP rebate scheme however the rebate has been included for the first year of purchase in the following NPV calculations, which cover a twenty-year period.

Table 9 Net Present Value – Emerging Technology

PV (kW)	1	3
Annual Power Output (kWh)	2,000*	6,000*
% Electricity Savings	37%	100%
Capital ($)	9,166	26,250
Incentive to achieve positive NPV ($)	35	8,078
Rebate ($)	4,000	4,000
Net Capital Cost ($)	5,131	14,172
Annual Maintenance Costs ($)	23	66
Energy Savings ($)	280	767
Net Annual Savings ($)	257	700

* The specifications of the technology chosen for the analysis do not indicate a derating for temperature.

5.4.4 Analysis of Benefits from Installation in the Whole Development

If each of the 23,000 households in Alkimos-Eglinton were fitted with a PV system then this would constitute a significant benefit, especially as the majority of the generation would be during peak time. Table 10 shows the Annual greenhouse gas and peak generation cost savings from having each household in Alkimos-Eglinton fitted with a PV system of different sizes.

Table 10 Greenhouse Savings from Alkimos Eglinton wide PV take-up

PV (kW)	0.6	1	1.5	2	3
Annual Power Output (GWh)	24.9	41.5	62.3	83.1	124.5
Annual GHG Savings (tonnes CO2-e)	24,817	41,331	61,985	82,639	123,970
Net Annual Savings for generator due to Peak-load reduction[#] ($)	1,495,920	2,492,280	3,738,420	4,983,180	7,471,140

based on peak generation cost of $60 MWhr

6. Conclusions

PV can make a useful contribution to summer electricity loads, although the value to electricity networks and retailers is dependent on actual feeder load patterns and on electricity prices. Further analysis is needed at specific feeder level and solar zone in order to assess the actual PV potential value over summer. PV output correlates well with loads on feeders with a high proportion of commercial load, indicating a strong case for PV use in commercial buildings in Australia.

For residential loads, the peak is typically in mid to late afternoon. In areas with high air conditioner penetration, the peak load is significantly higher on hot days and can remain high up to 6 or 7 pm. The value of PV for peak load reduction is dependent on the load pattern of individual feeders to which they are connected. The large scale use of PV can increase the reliability of power supply and meet peak load growth if appropriately placed and operated on the grid. It would also result in significant reductions in greenhouse gas emissions.

Capital costs are still high for PV arrays, however the study has shown that if an incentive is supplied to householders at the time of purchase a positive or nil NPV over the expected 20-year life of the array is possible. This includes the savings made on grid power costs and further cost reductions could be achieved with the introduction of Greenhouse Gas emission charges, or extension of the MRET program. Recent innovations in PV technology are expected to increase the value of installations and reduce the capital costs.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	W. Grace C. Leigh J. Stewart	C Leigh		W. Grace		
2	W. Grace C. Leigh J. Stewart	W. Grace	*W Grace*	W. Grace	*W Grace*	29 Sept 2006