Renewable Energy Scoping Study

13 January 2011

Southern Sydney Regional Organisation of Councils

Ashfield Bankstown Botany Bay Burwood Canada Bay Canterbury
City of Sydney Hurstville Kogarah Leichhardt Marrickville Randwick
Rockdale Sutherland Shire Waverley Woollahra

SSROC, PO Box 536, Hurstville NSW 2220 13 January 2011

Table of Contents

1 Introduction

This document is the report of a high-level investigation into the issues surrounding the establishment of renewable energy sources for stationary energy in the southern Sydney region. It has been produced by the ROC secretariat for the ROC in order to define the scope of a feasibility study into increasing the use of renewable energy and to estimate the cost of such a study.

1.1 Background

The SSROC Sustainability Committee resolved at its April 2010 meeting that SSROC should conduct a high-level investigation into options for renewable energy technology and business models (such as community-owned wind turbines) in the southern Sydney region. The resolution was subsequently adopted by the ROC Ordinary Meeting in June.

1.2 Objectives

Many forces are currently driving interest in renewable energy sources, including the need to reduce greenhouse gas emissions, expected big increases in the price of power over the next few years, and energy security.

The major outcomes of increasing the use of renewable sources of energy within the region are:

- Reducing the greenhouse gas emissions attributable to energy consumption in the region, helping to mitigate global warming potential;
- Facilitating the move away from oil consumption in anticipation of declining supply following Peak Oil;
- Protection against the rising costs of electricity and fuel by establishing an alternative supply.

The objectives of this Renewable Energy Scoping Study are to:

1. Examine the roles that SSROC could have in reducing greenhouse gas emissions and improving energy security through the use of renewable energy, and
2. Recommend a way to progress the initiative.

1.3 Structure of This Paper

This analysis is extensive and has generated a great many options and issues. It also necessarily includes background information and examples. Following this introductory section 1, are:

- Section 2 considers the objectives of SSROC in relation to renewable energy;
- Section 3 outlines some of the renewable energy technologies that could be deployed in the region;
- Section 4 identifies some of the business models that could be suitable for the financing and operation of a regional initiative;
- Section 5 highlights some of the major issues relating to the possible role of SSROC and local government in the deployment of renewable energy technologies in the region;
- Section 6 focuses on possible next steps for further consideration;
- Appendix A provides some background information on technologies that exploit renewable energy sources;
- Appendix B lists the documents referred to throughout the paper.

2 SSROC Role in Renewable Energy

Before any decision on renewable and lower-carbon energy options the ROC will need to resolve what the region aims to achieve in order to maximise outcomes from any future investment. The ROC needs to decide how ambitious to be, since the range of possibilities to some degree independent of the technology and business model, although obviously influenced by factors such price and carbon intensity.

In order to make this decision, it is necessary to decide and clearly articulate its objectives. The range of possible objectives would cover:

- Reducing regional carbon emissions – such as major action aimed at direct reduction in emissions by becoming a generator of power from renewable sources;
- Reducing councils' own carbon emissions – such as by generating sufficient power from renewable sources to enable councils to achieve the regional carbon reduction target of 20 per cent below 1997 levels (SSROC, 2003);
- Influencing others by demonstrating that energy can be generated cost-effectively from renewable sources

To date, most councils have worked towards reducing their own carbon emissions and towards influencing, and raising the level of awareness in, their communities. Taking a regional approach opens up more possibilities, such as that combining resources to take a single, larger-scale action collectively, or of developing a region-wide program of local interventions.

The starting point for the development either program, however, has to be the agreement and clear articulation of the objectives. A program would then be developed to achieve the objective(s).

Case Study - Objectives: The City of Boroondara, Victoria

In initiating the installation of a combination of cogeneration, solar power and energy efficiencies, the City of Boroondara in Victoria sought to achieve:

1. A reduction in its own demand for energy, and hence a reduction in cost;
2. A reduction in its greenhouse gas emissions of 1,200 tonnes p.a. (7 per cent of council's emissions);
3. A high profile demonstration of sustainable and innovative technology for residents.

It also identified several further benefits that would be achieved:

- the capacity to trial cogeneration for possible future deployment at other council sites,
- contribution to the council KPI of "healthy, safe and inclusive community" since the installation of cogeneration at the community pool and recreation precinct would encourage greater recreation use, and
- contribution to the council KPI of "sustainable built and natural environments" since it would contribute to a more sustainable place, as well as encouraging behaviour-change.

This paper aims to inform the ROC's decision as to what it intends to achieve through its involvement in renewable energy sources by examining a range of different technologies at different scales of operation and under different business models. It aims to set out a range of possibilities to help the ROC and its Committees to envisage possiblities for the region.

Once SSROC's objective is clearly articulated and agreed, SSROC secretariat will be able to develop a delivery program, and to define a scope of works and seek fully costed tenders from suitably qualified renewable energy advisers.

3 Technology Options

This section identifies the technologies that appear to be most relevant to the southern Sydney region. Which technology is eventually deployed will depend upon a combination of feasibility, cost and benefit relative to the objective that SSROC seeks to achieve. All options could also be supported by a range of lobbying activities aimed at removing barriers and changing conditions that are outside of direct control or even sphere of influence. The various options are all compatible with different models for funding and operations.

Appendix 1, Renewable Energy Technologies, summarises the results of the literature review examining a wide range of possibilities. The range is potentially very wide, and the particular options presented have been singled out on the basis of the following criteria:

- Proven technology that has been demonstrated in a relevant setting
- Social and environmental impacts (other than reductions in greenhouse emissions)
- Fit with the regulatory and economic context.

The technologies considered are:

- Wind energy
- Solar energy
- Ocean energy
- Cogeneration/trigeneration
- Energy efficiency

However, all options can be implemented at different scales, and some at very widely different scales. So this paper presents a range of options by means of case studies that demonstrate the potential at different levels of investment and in response to different objectives. SSROC has endeavoured to identify case studies from a wide range of locations, where a local government has played a significant role.

	Large	Regional	Council	Locality
1. Wind energy	Thanet Offshore Wind Far	Hepburn Wind Park City of Toronto Exhibition Place	The Strand Wind Project, Townsville Tocco da Casuaria council wind turbines	No case study yet identified
2. Solar energy	Solar Energy Generating System, California Sanlucar la Mayor, Spain	Wilpena Pound Resort Singleton Solar Farm Kogarah Town Square	Sutherland Shire Council Administration Building Rigby House, Coffs Harbour	Warrnambool City Council Solar Bulk Buy Hobart City Council hot water and heat pump rebate
3. Ocean energy	Aguçadoura Wave Farm, Portugal	N/a	N/a	N/a
4. Cogeneration/trigeneration	N/a	Borough of Woking, UK City of Sydney	Annette Kellerman Aquatic Centre, Marrickville	N/a
5. Energy efficiency	N/a	The ClimateCam Billboard, Newcastle	Newcastle City Council ECO*STAR	Many initiatives in SSROC

An overview of each option is provided in the remainder of this section.

3.1 Wind Energy

3.1.1 Large Wind Energy

Major wind farms are capital-intensive initially, but the energy source is free, so on-going operational cost is relatively low. As with any wind installation, the site is critical: it needs good wind and must be close to the grid in order to minimise transmission losses. In the southern Sydney area, an off-shore installation could be more suitable than any site on land, in which case water depth would also be a consideration.

Case Study – Large Wind: Thanet Wind Farm

Thanet Wind Farm is a British commercial venture 11 kilometres off the cost of Kent in south-east England. It extends over 35 square kilometres in water of 20-25 metres depth, with 500 metres between turbines and 800 metres between rows.

It was project-financed under Thanet Offshore Wind Ltd, which was owned by a hedge fund, which used a £150 million (GBP) mezzanine loan arranged by Investec. Originally established by Warwick Energy Ltd, which continued to manage the construction and operation (Oil Voice, 2007). The complexity of the project is reflected in the many contractors involved (see 4C Offshore, 2010). In 2008 Thanet Offshore Wind Ltd was sold again, to the Swedish energy company Vattenfall. Vattenfall CEO Oyetein Loseth commented that the project would not have been possible without the "British Government's active support and its commitment to renewable energy".

The wind farm has created 21 permanent jobs, with more opportunities to follow.

3.1.2 Regional Wind Energy

Wind power can be harnessed on a smaller, but still regionally significant, scale by means of smaller wind farms or large individual turbines.

Case Study – Regional Wind: Hepburn Wind Park

The Hepburn Wind Park planned for an area 10 kilometres south of Daylesford in Victoria will consist of two 2 MW turbines, generating sufficient power for 2,300 homes: sufficient for Daylesford and Hepburn Springs.

Hepburn has been conceived largely in response to climate change and the increasing demand for low carbon electricity. It is community-owned, based on a cooperative model with local residents offered minimum parcels at $100 while others are offered a minimum of $1,000. The idea originated with the Hepburn Renewable Energy Association (now the Sustainable Hepburn Association Renewing the Earth (SHARE 2010)), a not-for-profit, non-political association run community volunteers. Hepburn Community Wind Park Cooperative Ltd (which trades as Hepburn Wind) will own and operate the wind farm. Its shareholders are members of the cooperative, and it is managed by an elected Board of Directors.

The company has retained control of the project, having let a construction contract to REPower Systems. The project has grants from the Renewable Energy Support Fund of $975,000 towards development costs and the Regional Infrastructure Development Fund for $750,000 towards grid connection. It has bank financing of $3.1 million and more than $8.25 million invested by its 1340 members. At the time of writing, the project is close to reaching its capital investment target (Hepburn Wind, 2010).

The scalability of wind power installations means that there are suitable technology options at each level of the matrix being considered. Sub-regional or LGA-level solutions could consist of a single, large, high-visibility turbine that could promote the concept of renewable energy, or one or more less high profile turbines to contribute power to a particular site such as an aquatic centre or Council Chambers.

Case Study – Regional Wind: City of Toronto Exhibition Place Turbine

The City of Toronto in Ontario, Canada, has more than 4.6 million residents, and its Exhibition Place Turbine on the shore of Lake Ontario was North America's first urban wind turbine. North Toronto Green Community created the Toronto Renewable Energy Cooperative (TREC) specifically to develop a city turbine, and partnered with Toronto Hydro Energy Service Inc. in an equal joint venture. Windshare was established by TREC to own and manage their share.

A 750 kW turbine was installed in December 2002 and became operational in January 2003, generating around 1000 MWh of electricity to the main grid. The turbine was installed before the Ontario Power Authority (OPA) introduced a feed-in tariff in 2006.

Windshare expects to yield a dividend of between 4 and 8 per cent over the 20-year life of the turbine. The turbine cost approximately $17 million CDN (CanWEA, 2004). Development was locally sourced, as was around half the equipment. The turbine itself was imported from The Netherlands. The project is thought to have been pivotal in the establishment of further cooperatives, the growth of the industry in general in Canada, and the establishment of more business ventures by the original participants. A poll by Toronto Hydro found that 69 per cent of people surveyed saw it as a positive addition to the skyline. It has also been educational, with more that 250,000 people visiting the associated display in the first year.

3.1.3 Council Wind Energy

An individual council could establish a wind turbine as a source of power as a demonstrator or as a combination of the two. Should several councils wish to do so, SSROC could for example, conduct a joint procurements of the expertise to locate turbines in each LGA, and of the turbines themselves.

Randwick City Council is currently trialling the effectiveness of a wind turbine under its Sustaining Our City program. Its aim is to test the application of wind power in Randwick with a view to reducing greenhouse gas emissions from council operations. A small scale wind turbine is running at the Randwick Community Centre. Council installed the wind turbine earlier this year as part of the sustainability retrofit of the Randwick Community Centre and Council is proposing to install a small scale wind turbine at Maroubra beach and another in Heffron Park, Maroubra adjacent to the car park at Des Renford Aquatic Centre. (RaCC, 2007.)

Case Study – Council Wind: The Strand Wind Project, Townsville

The Strand Wind Project in Townsville, Queensland, is primarily educational. It stands on the popular Strand in central Townsville, and has an interpretation system that the public can use to view weather information and power output data. Schools can download data. Power is fed into the grid, but its purpose is to demonstrate renewable energy in a public place and to support education and tourism.

The project is part of the Townsville City Council's Sustainable Townsville Program. The whole project, including interpretation, cost $65,000. It was funded by TCC in partnership with EPA Sustainable Industries and Ergon Energy, the mains grid operator for far-north Queensland.

Case Study – Council Wind: Tocco da Casauria, Italy

The local town government of Tocco da Casauria earns around €170,000 ($233,000 AUD) by selling its electricity, and the money goes back to the community in projects and the community no longer pays local taxes. The electricity is generated by four wind turbines, located in a natural wind tunnel between two mountain ranges. The town has just 2,700 inhabitants. (Reuters, 2010.)

3.1.4 Local Wind Energy

SSROC has not located any robust statistics for small-scale wind energy use. However, it appears that there is significant take-up, with some vendors claiming large sales volumes.

The Research Institute for Sustainable Energy (RISE 2010) reports that the small wind turbine industry in Australia has just one fully commercial SWT manufacturer and two others in the final stages of commercialising their product but it also notes signs of "dramatic" growth with some 12 manufacturers at the early stages of establishment. In a survey of the WA SWT industry, funded by the Western Australian Local Government Association (WALGA) and carried out over the period December 2008 and March 2009, 3 local designers/manufacturers of SWTs were identified: both manufacturers and designers were interested in the grid-connected residential market, but interestingly saw their immediate market as local government and local businesses. The main reason was the lack of uniform SWT system planning regulations across the 141 different local councils in WA, and perceived difficulties the politics of SWTs in residential areas. Growing interest of manufacturers in the urban market was reflected by the fact that the focus of all three interviewed local designer/manufacturers was on developing vertical axis SWTs for specific urban situations. (RISE 2010.) (SSROC has as yet been unable to identify any comparable research for NSW.)

3.2 Solar Power

3.2.1 Large-Scale Solar Power

The largest operational solar installations are located in the USA and Spain, although Australia has the best solar resource of any developed country. Initial capital costs are high, and location is important, requiring space and sunlight. The largetst, the Solar Energy Generating System (SEGS) in the Mojave Desert in California is made made up on nine power plants with a total of 354 MW installed capacity, with an average gross solar output of 75 MW. The turbines also operate at night by burning natural gas. The operator claims that this powers 232,500 homes. All the power generated is bought by Southern California Edison. (SEGS, undated.) It is a commercial operation.

Spain's Sanlucar la Mayor power station is the world's most powerful solar power tower. When complete in 2013 it will produce 300 MW, equivalent to the needs of the city of Seville (ENS, 2007). The whole project requires an investment of €1.2 billion, partly funded by the European Union. This type of development is planned for north-west Victoria by Solar Systems at a cost of $420 million, with $75 million federal government funding from the Low Emissions Technology Demonstration Fund, and $50 million from the Victorian government. The remainder will be privately funded. (Solar Systems, 2006.)

All the large installations appear to be commercial operations, with varying levels of public funding from higher levels of government.

With major capital costs and no obvious location in which to accommodate any significant solar power station, SSROC suggests that there is no large solar opportunity within the region. Major solar projects proposed for NSW are all in areas outside metropolitan Sydney, and include Buronga (50,000 MW) and Dubbo (50 MW).

3.2.2 Regional Solar Power

There are several solar power stations supplying electricity to a group of buildings or a smaller community, including those at Wilpena Pound Resort in South Australia, and at Singleton in NSW. Both are power-station style developments, in the sense that there is a large ground-mounted installation on a single are of land. While unlikely to be feasible within the southern Sydney region, a large solar far is envisaged for the Mosman-SE-NSW Solar Farm (see Business Models, below).

Case Study: Regional Solar/Diesel Power – Wilpena Pound Resort

Wilpena Pound Resort is powered by an off-grid solar electricity system, constructed in 1998, owned and operated by AGL Energy. The system cost $2.5 million (AUD), and delivers power 24-hours a day using a combination of 1250 solar modules each with a capacity of 80kW, 400kW of battery storage, an inverter and three diesel generators (AGL, 2010). It is controlled by a computer system that enables the power station to operate unattended, with remote monitoring and control.

The solar component of the power station provides up to 40 per cent of the resort's power. During the daytime, with good sunshine, the solar cells will meet the resort's demand. For cloudy periods, the batteries or diesel generators or both can be used to supplement the solar power. At night, the most efficient diesel generator combination is switched on to meet the load and any excess solar energy stored in the batteries is used.

The project was originally funded by the South Australian government and the Electricity Trust of SA (the then government-owned utility). A key driver for the installation of the local system was the need to minimise the impact on the surrounding environment, which is a major tourist attraction. It also aimed to demonstrate a stand-alone community-sized PV-based power system. Having a local source of power prevent the visual pollution of power lines and the excavation work that would have been necessary to extend the grid. (Wilpena, 2010.)

Case Study: Regional Solar Power – Singleton

Singleton Solar Farm was set up in 1997-98 on 2.75 hectares as a grid-connected 400 kWp array with multiple 4 kW inverters. It produces 500,000 kWh p.a. and supplies 6,000 PureEnergy customers. It was funded by EnergyAustralia, via contributions from PureEnergy (i.e. GreenPower) customers, the Sustainable Energy Development Authority (SEDA), Singleton Shire Council. (UNSW, 2005.)

The solar farm is estimated to eliminate the need to produce 550 tonnes of CO_2-e each year via traditional means of electricity production. (Singleton Tourism, 2010.)

Solar PV in urban environments is more commonly roof-mounted. Examples of installations at this larger scale include the Building-Integrated PV (BiPV) in Newington (the former Olympic Village), in Coffs Harbour, and in Kogarah Town Square.

Case Study: Regional Solar Power – Kogarah Town Square

Kogarah Town Square development includes 1459 solar cells rated 161kWp, integrated into the fabric of the building, generating 153MWh p.a. and saving an estimated 143 tonnes CO_2-e annually compared to coal power generation. This approach increases efficiency in power generation at the demand point while reducing inefficiencies through transmission loss, and the displacement of traditional building materials effectively reduced the overall construction costs. The objectives were to:

- construct the largest BIPV installation on a medium density development in Australia that incorporates a range of complementary energy efficiency features that effectively demonstrates the practical application of this technology with mainstream urban renewal projects to the general public and the development industry;
- support and hasten the development of BIPV technology in the more user/builder friendly and cost effective product which maintains roof/building integrity; and
- provide an opportunity to systematically document and record the lessons learnt from the process and to develop generic training material/programs for professionals, trades people and the educational sector.

The project originated in Kogarah Council's master plan for Kogarah Urban Village in 1997, which aimed to realise Council's vision of "a viable and sustainable future, in partnership with our community". Kogarah Town Square was an integral part of the plan. Council developed a partnership with a range of different organisations to address the many facets of this major urban renewal project, but among them were the:

- Department of Environment and Heritage Australian Greenhouse Office, which contributed $1M from the, for the installation of BIPV;
- Sustainable Energy Development Authority, which proved $200K for installation of BIPV and energy efficient appliances and fittings.

(Kogarah, 2010.)

3.2.3 Council Solar Power

The scalability of solar power allows possibilities at all levels of the matrix, and councils have adopted solar technology for use in their own operations across Australia. There are numerous examples within southern Sydney already, include Sutherland Shire Council's $60,000 9.8kW installation, and Marrickville Council's installation at the Annette Kellerman Aquatic Centre.

Case Study: Council Solar Power – Sutherland Shire Council

Sutherland Shire Council has reduced its power consumption and its contribution to greenhouse gas emissions by installing solar panels on the Council Administration building at Eton Street Sutherland. The electric solar system is rated 9.8 kW and cost $60,000 to install. It is expected to save 16,500 kilograms of CO_2-e each year

The new system was funded by the NSW Department of Environment Climate Change and Water through its Waste and Sustainability Improvement Program and supplied by SolarSwitch of Caringbah. The Australian-made panels and will have a large display screen attached in the council's main foyer showing how much solar energy is being generated, the total amount of power produced since the system was installed, the weight of greenhouse gases being saved and the greenhouse equivalent in driven kilometres. The power generated is fed into the grid through a bidirectional Smart Meter, and will offset the Council Administration Building's overall power use.

Case Study: Rigby House Solar Panel Project, Coffs Harbour

Coffs Harbour City Council was awarded a grant from the Department of Environment, Climate Change and Water under the Climate Change Fund: Public Facilities Program in November 2008. As part of this grant Council installed a photovoltaic (PV) solar power system on the Rigby House rooftop that generates approximately 175 MWh per annum and supply green energy to the building, up to approximately 30% of the building's daily power requirements. This public building houses several tenants including the Regional Art Gallery and City Centre Library, Council offices, Centrelink offices and a Café. At the time of installation in 2010, it was the largest regional network connected PV array in New South Wales.

The installation covers a rooftop area of 1200m^2 with a PV array of 650 panels generating 136.5 kW, at a capital cost of $808,500 (AUD). Combined with retrofitted lighting efficiency measures throughout the centre, annual cost savings are estimated at $30,000 in avoided electricity costs, and annual CO_2-e savings at 175 tonnes. The facility is owned and managed by Coffs Harbour City Council, which has applied to the Australian Government's Office of the Renewable Energy Regulator to create renewable energy certificates (RECs) as an accredited power station, which will generate a revenue stream of an estimated $6,500 p.a. from the sale of these RECs.

A display in the foyer of Rigby House permits visitors to see how much power (kW) is currently being generated, and the greenhouse emissions that have been avoided since the system was commissioned.

(Coffs, 2010.)

3.2.4 Local Solar Power

Solar hot water and Photovoltaic (PV) are perhaps the most familiar renewable energy technology at the local level. Individual households are increasingly deploying solar hot water and PV in their own properties, motivated by energy efficiency, by the NSW government's gross feed-in tariff, and by a desire to reduce their own carbon emissions.

Some councils have facilitated this uptake by:

- bulk purchase of solar panels (Brimbank, 2010) such as Brimbank Council and Manningham and Port Phillip councils jointly

- solar and heat pump hot water rebate (Hobart, 2010)
- providing information to residents about obtaining rebates.

Case Study: Local Solar Power – Warrnambool City Council Solar Bulk Buy

Warrnambool City Council partnered with a local business to run a solar bulk buy as part of its Solar Program, following local community interest in successful Melbourne programs. Council determined the best system and business to deliver the solar bulk buy and appointed a single local supplier.

The bulk buy will comprise the purchase and installation of solar PV systems to produce electricity and for sale back to the grid, via a streamlined process. Residents and businesses throughout South West Victoria can participate. Price packages start from $3,000, with savings of $500 should 150 participants take part. Approximately 400 people attended community information sessions. It is expected that the solar bulk buy will generate considerable savings in energy bills and reduce greenhouse gas emission for residents and businesses taking part.

Case Study: Local Solar Power – Hobart City Council Solar Hot Water and Heat Pump Rebate

Hobart City Council has a Solar and Heat Pump Hot Water Rebate Scheme, whereby ratepayers can get $500 to install a solar or heat pump hot water system at home. A solar or heat pump water heater can provide 50 to 90 per cent of a household's hot water requirements. The rebate is a one-off payment of $500 per household for Hobart ratepayers who have purchased and installed a suitable system at a rateable property to replace an electric system, and who are eligible for at least 20 Renewable Energy Certificates (REC's) at the time and place of installation. With over 360 applications approved, the cost to council was $79,000 and $108,000 in 2008/09 and 2009/10 respectively (Hobart, 2009 and 2010b).

Hobart also offers rebates for energy-efficient new developments (100 per cent rebate of basic planning fee), and up to $300 to landlords installing ceiling insulation.

3.3 Trigeneration

The Institute of Sustainable Futures (ISF 2009b), examined options for meeting the shortfall in projected energy generation, and found that a coal-fired power station with additional open-cycle gas turbines was an expensive and high-polluting solution. The comparison was made against combined open-cycle and combined-cycle gas turbines, cogeneration and demand-side response, energy efficiency and demand-side response, and combined distributed energy (cogeneration, energy efficiency, and demand-side response). The ISF found a distributed energy solution would be significantly cheaper as well as lower greenhouse emissions.

If the objective of the initiative were to achieve reductions in greenhouse gas emissions, then trigeneration would appear to be an option worth consideration, especially as is it could utilise renewable sources of energy in the longer term.

3.3.1 Large-Scale Trigeneration

Cogeneration is not generally a large-scale source of power, by its decentralised nature. No large-scale application has been identified, and it is not examined as an option at this stage.

3.3.2 Regional Trigeneration

Cogeneration and trigeneration are typically installed at a particular site to provide power to that site. However, they can also deliver surplus power to neighbouring sites, and can be distributed across an area in multiple applications in order to generate power for a wider area.

Case Study: Borough of Woking, UK

Woking's joint venture, Thameswey Ltd (see the case study in the Business Models section), actions include phase one of the town centre private wire CHP/absorption cooling district energy system. The system provides 130% of the electricity required by 5 buildings in the town centre, the surplus – at least 30% of the requirement – is exported over public wires to sheltered-housing residents and other local authority buildings. (Woking, 2001.)

The town has reduced its greenhouse gas emissions by 77.5 per cent from 1990 to 2004, with conventional power replaced with 81 private-wire decentralised cogeneration and trigeneration energy systems. (Ecolibrium, 2009.)

In a later development, the trigeneration town-centre site is switched of at midnight, but nightclubs continue to operate heat-fired absorption cooling from thermal storage from electricity generation earlier in the day by leisure complexes. The leisure complexes use more thermal energy to maintain thermal energy and humidity balance, but used relatively little electricity (Jones 2009).

An Advanced Building Energy Management System:

- controlled and monitored each building's heating, cooling and electricity,
- read each generating station's electricity and gas meters
- read the consumer's heating, cooling and electricity meters
- measured temperature, wind speed and outside light levels at Civic Offices, enabling
- smart control of electrical and thermal energy.

The Sydney City's recently published *Draft Energy Master Plan - Trigeneration* (CoS 2010) puts forward a decentralised energy model based on the widespread deployment of trigeneration capacity. Combined with a range of other plans within the framework of Sustainable Sydney 2030, it aims for the city to be off coal-fired electricity by 2030. The document puts forward a case for the priority development of the four most energy- and carbon-intense zones into Low Carbon Infrastructure Zones. These would supply low-carbon electricity and zero-carbon thermal energy for hot water, heating and cooling. Further low-carbon solutions for areas outside these are to be developed in the future. Some buildings in the city already have trigeneration facilities generating power for use within the building (such as Star City casino): the City of Sydney's plan would move the city's trigeneration capability to another level of sophistication by connecting multiple buildings to the supply.

The following is an extract of the key features of the proposition:

"… if implemented, a decentralised energy network could:

"1. connect 65% of all commercial floor space, 50% of all retail floor space and 30% of all residential floor space within the City of Sydney LGA to low carbon electricity and zero carbon heating and cooling

"2. reduce greenhouse gas emissions within Low Carbon Infrastructure Zones by 39% to 56% below 2006 levels by 2030

"3. reduce greenhouse gas emissions across the entire City of Sydney by 18% to 26% below 2006 levels by 2030

"4. provide lower cost CO_2 abatement than solar, wind, hydro, or coal or gas fired power station carbon capture and storage

"5. provide the city with an energy solution that is transformative, future proof and will provide an energy infrastructure that other green infrastructure can take advantage of."

3.3.3 Council Trigeneration

Cogeneration is already in use in Marrickville and Sutherland Shire Councils.

Case Study: Council Trigeneration - Annette Kellerman Aquatic Centre

"The new Annette Kellerman Aquatic Centre is one of the most ecologically sustainable aquatic centres in Australia, after the recent installation of the cogeneration unit. AKAC is the first aquatic centre in Australia to have a cogeneration unit connected to the local electricity supply grid with any surplus energy generated to be supplied back to the grid. The cogeneration unit has the capacity to produce 350 kilowatts of electricity.

"In addition to the energy saving technology of the cogeneration unit an array of 160 photovoltaic solar panels has been installed on the roof of the Centre. The solar panels provide 30 kilowatts of additional power, giving Marrickville Council an enormous solar generation capacity.

"Other sustainable features include automatic roof vents for natural ventilation controlled by a weather station, special daylight controls, high capacity insulation and double-glazing, high quality water treatment systems and substantial rain water collection tanks."

Marrickville Council 2010

3.3.4 Local Trigeneration

SSROC has not as yet been able to identify any small-scale tri- or cogeneration examples or case studies. The technology appears to have potential, but as yet be unproven, at the small scale of a single home or small business.

3.4 Wave Power

Review of the wave and tidal power technologies has demonstrated that they are not yet proven, and so these are not considered further in this paper.

Case Study: Wave Power – Not There Yet

The Aguçadoura Wave Farm was an attempt at a commercial wave farm, located 5 km (3 mi) offshore north of Oporto in Portugal. It was designed to use three wave energy converters to convert the motion of the ocean surface waves into electricity, totalling to 2.25MW in total installed capacity. The farm was officially opened in September 2008 by the Portuguese Minister of Economy, and was intended to generate clean electricity for more than 1,000 family homes. The wave farm was shut down two months after the official opening in November 2008. (Guardian 2008.)

The following article appeared in the CleanTech Group News on 17 March 2009

“The €9 million Aguçadoura wave-power project in Portugal has been taken off line indefinitely after a series of technical and financial setbacks. … But in mid-November, all three [converters] were removed from the water because of leaks in the buoyancy tanks that required replacement, according to the International Herald Tribune. Other technical problems followed, and the energy-conversion units are now sitting idle in Leixões harbor near the city of Porto, the paper reports.

Once the technical problems were solved, Pelamis couldn't get the financial backing to relaunch the units. Because of the global economic crunch, backer Babcock & Brown began selling off assets to pay down debt and refused to put more money in the project."

3.5 Energy Efficiency

Energy efficiency is not a renewable energy option since it involves making better use of the existing power supply. However, with energy consumption accounting for some two-thirds of national carbon emissions (PMTGEE 2010), energy efficiency will probably be a part of any strategy, particularly if the objective to be achieved is the reduction of carbon emissions by councils. Measures to improve energy efficiency are scalable, and a great many efforts have already been undertaken in the area at the level of the individual council and locally. Climate Works Australia has identified twelve measures to reduce buildings sector emissions, which would result in emissions reduction of 28 $MtCO_2$-e in 2020, (28 per cent reduction on business-as-usual emissions).

The Report of the Prime Minister's Task Group on Energy Efficiency (PMTGEE 2010) identifies a range of possibilities for local government covering facilitation and awareness-raising as well as direct interventions and funding opportunities. However, these are as yet only possibilities for consideration and not government policy.

3.5.1 Large Scale Energy Efficiency

Energy efficiency measures by definition relate to the consumption of power, and so at the largest scale are likely to comprise an aggregation of regional or local measures (at least insofar as councils' powers might permit). Therefore this option is not considered further.

3.5.2 Regional Scale Energy Efficiency

Larger-scale opportunities extending beyond LGA boundaries into and across the region might include future development of charging stations for electric cars, or incorporating a pathway to zero-emission buildings into council development controls, for example. Both are candidates for future Commonwealth Government policy (PMTGEE 2010). Improvements to the efficiency of street lighting, as targeted under the SSROC Street-Lighting Improvement Program (SLIP) represent an important regional energy efficiency measure.

Case Study: Regional Scale Energy Efficiency – The ClimateCam billboard

Newcastle City Council claims that its ClimateCam billboard is the world's first City Power Meter. Visible to the public from one of Newcastle's main squares, Wheeler Place, it displays the amount of electricity the city of Newcastle has consumed in the past hour. The whole Newcastle City LGA has been broken up into geographical zones which are fed by 15 zone electrical substations, and readings are taken each hour from all of them. Graphs for each zone, accessible on the City's website, show hourly electricity consumption in megawatts per hour, along with historical monthly and annual consumption data. These readings are aggregated to provide total electricity consumption in megawatts per hour for the whole city. Historical monthly and annual data for the City is also recorded, along with greenhouse gas emissions from electricity.

While not of itself improving energy efficiency, ClimateCam does enable council to measure its LGA's energy consumption, and so to monitor any changes. This is a critical part of being able to judge the effectiveness of interventions, and to respond to unexpected changes. It is considered to be a good tool for engaging with the community, particularly schools.

Newcastle is continuing its regional initiative with a market-segmented approach whereby specific initiatives target businesses, schools and other education institutions, residential and council operations. Its Financial Loss Control and EcoStar Programs have been successful in Newcastle and are being taken up by other councils. Newcastle will be the site of Australia's first commercial smart grid, having won the Federal Government's $100 million Smart Grid Smart City bid (see www.newcastle.nsw.gov.au).

3.5.3 Council-Scale Energy Efficiency

Note that this option is already covered to some extent the SSROC Energy Cost Control project. At the time of writing, this project, which targets immediate and medium-term cost savings and controls, is gathering data from which to draw a profile of initiatives completed or under way across the region. This information will be used to identify opportunities that other member councils may wish to replicate individually, and opportunities for regional actions such as joint contract arrangements.

Case Study: Council-Scale Energy Efficiency – Newcastle City Council ECO*STAR

Newcastle City Council has achieved a 39% ($400,000 pa) reduction in energy consumption compared to 1995 levels, despite the addition of facilities such as the Fred Ash office building and the Wallsend Library, together with the provision of heating for the Lambton Pool. Its ECO*STAR program is aimed at improving the environmental performance of park, beach and pool amenity blocks by cutting water and energy wastage. It has also been expanded to make it accessible to other organisations, such as schools, which can achieve a star rating by taking similar efficiency measures.

3.5.4 Local Energy Efficiencies

Again, this is an area where councils are generally already very active, providing information and facilitating household and small business energy efficiency opportunities.

4 Business Model Options

There are many different models under which most projects could be financed and operated, and SSROC's research has provided a variety of examples. Like the technology options, the most appropriate is likely to relate to the objective to be achieved, but the extent to which councils are willing to invest in the project will be a key deciding factor whether expressed in dollars or time.

This section again presents a range of different models for funding and operations. The different models are not necessarily mutually exclusive, and may not be relevant to all the different technology options.

4.1 Enabling and Facilitating Services

Perhaps the current most common form of local government participation in the renewable energy market is by enabling and facilitating the access of others, often by providing information about technologies (such as solar panel installations) or about grants and rebates. Many Councils, including SSROC members, actively promote State and Federal Government initiatives by providing information about schemes that offer subsidies, rebates or loans to their local communities and on their websites.

Other examples of this type of business model include creating access to renewable energy through decentralised power generation, supporting suppliers of services, negotiating special rates for residents, or paying a premium for GreenPower. Some of these are easy and relatively cheap to provide, while others are less so: but most eliminate the need for significant capital investment.

4.1.1 Support to Suitable Businesses

Under this business model councils support the development of the renewable energy sector, often with the benefit of being able to offer a service to residents and/or local businesses at a favourable rate. Council could offer support to businesses willing to invest in project in their locality, perhaps under a project finance model, a common approach for long-term financing of major industrial projects based on projected cash-flows for the project.

Case Study: Facilitation – Thanet District Council

Thanet District Council supported the development of the Thanet Offshore Windfarm, and continue to support the development of the new London Array, as part of their efforts to revitalise the LGA's ports. The exact nature of the support appears to be changing governance arrangements to enable commercial diversification of the port area, supporting development, and commercial agreements for the use of port facilities. As a result, up to 100 employment opportunities related to turbine maintenance have been created in some of the most deprived areas of the LGA, as well as construction work during the development phase. (www.thanet.gov.uk)

4.1.2 Support to Residents

Woollahra Municipal Council waived the fees for Development Applications that are solely for PV systems and/or solar hot water systems in March 2009 (WMC 2010), reducing the overall cost of the investment for residents.

4.1.3 Negotiating Discounts

Councils' could also take the form of identifying a service or product that meets a specific set of criteria in relation to renewable energy (or more general sustainability), making a special arrangement with the provider of the service/product, then endorsing and facilitating and the provider's service offering to its community. A range of services and products could be put together into a broad program designed to achieve council's objectives.

Case Study: Facilitation – Brisbane City Council's Ezygreen

Brisbane City Council offers a range of energy-saving options under its Ezygreen program. It is a partnership between Council, the Government of Queensland, and a number of businesses. By September 2010 30,000 homes had signed up to the program. Among the options available are:

Service	Partner
20 per cent GreenPower at no extra cost	AGL
Free EarthSmart powerboards	Crest
Discounts on energy-efficient appliances	The Good Guys
Discounts on electric bikes	Nope Electric Bikes and Scooters
Discounts on hot water systems	AGL, Ingenero
Discounts on solar power systems	Ingenero
4.75% discount on personal loan rate for relevant purchases	NAB

4.1.4 Overcome the Capital Investment Barrier

Councils could seek to increase the uptake of renewable energy options by its local communities by overcoming the serious barrier that the up-front capital investment represents for many people (see key issues below).

Case Study: Facilitation – SolarCity

In San Francisco SolarCity is a commercial operation that leases solar panels. The business model eliminates the need for an up-front capital investment in solar panels for household electricity generation. The company installs the system and provides the electricity at no cost to the customer, charging them instead for the leasing of the solar panels (Mims, 2009). They also offer to identify and claim any relevant government rebates on the customer's behalf, crediting their account at the outset so that the customer does not have to wait for the rebate (SolarCity, 2010). The company claims that the leasing rate is less, per kilowatt-hour, than they would pay for electricity from the grid (Mims, 2009).

Case Study: Facilitation – Power Purchasing Agreement

Under a Power Purchasing Agreement (PPA) the customer (i.e. the consumer of the power) signs an agreement to purchase power with a supplier who installs and management the system at no charge to the customer. The customer agrees to pay a fixed price for a number of years. The major advantage of the system is the elimination of the up-front capital cost for the consumer.

In a further refinement, the supplier sells the PPA to an investor, who can claim any rebates etc., but also pays the supplier for the development, maintenance and monitoring of the system.

The price set is a key consideration in this business model. In Australia examples PPAs that SSROC has identified have all been for large-scale installations such as the 206 MW Collgar wind farm in Western Australia (Wind Power Monthly, 2010).

Case Study – Council Enabling Services – The Local Government Association of South Australia

The LGA of South Australia has set up a trial Solar Councils Community Program whereby its residents and businesses can buy solar panels at a 10 per cent discount from its supplier. ZEN Home Energy Systems was appointed after a selection process which considered the product offered, technical capability, customer service, relevant experience, OH&S and financial stability. Thirteen councils are participating in the program (Solar Councils, 2010). The supplier contributes $100 - $200 for every unit installed into a Renewable Energy Research Fund, which is managed by the LGA and used to investigate further options to cut carbon emissions in the area. The program was trialled first in Victor Harbour and eight other regional councils. In Victor Harbour 800 homes took up the offer, resulting an estimated 1,170 tonnes CO_2-e saved each year, and electricity cost savings to residents of $250,000 p.a. The thirteen metropolitan councils of the southern Adelaide area began their year-long trial in mid-2010.

4.1.5 GreenPower

GreenPower is another form of facilitation, whereby a council can contribute to funding investment in renewable energy development by paying a premium price for its electricity. Although the power is purchased from an electricity retailer, GreenPower is in addition to their target for energy from renewable sources under the Commonwealth Government's Renewable Energy Target legislation.

Case Study: Facilitation – GreenPower

GreenPower is a government accreditation program for renewable energy. When a customer signs up for GreenPower, their energy provider undertakes to purchase energy generated from renewable sources on their behalf. The program organises independent auditing of energy retailers' sales and purchases to verify energy providers' claims in this regard.

Member Councils can purchase GreenPower under SSROC's electricity supply contract with Momentum, which is sourced from the Mount Millar Wind Farm. In addition, Momentum is part of the Hydro Tasmania group of companies, which is Australia's leading renewable energy company generating almost half of Australia's renewable energy from water and wind.

(Hydro Tasmania's hydro-electric generation capabilities were build before 1997, and are therefore not eligible to form part of the GreenPower offering: power generated by these sources is included in their "traditional" energy sources.)

4.1.6 Enabling Direct Access to Decentralised Energy

Where local power generation from renewable (or lower-carbon) sources is undertaken and surplus power is available, it could be stored in batteries for use later, or it could be sold to grid (typically at the energy retailer's wholesale price). Alternatively, the power could be privately transmitted to another, neighbouring site: either another site occupied by the generator, or a third party entirely.

Case Study: Facilitation – Enabling Direct Access to Decentralised Energy by the City of Sydney

The City of Sydney proposes to operate its decentralised trigeneration operations in a similar way to the model set up by Woking and enhanced by London, whereby buildings in a locality are enabled to access energy from decentralised generating facilities that exploit either lower-carbon or renewable sources.

Decentralised energy projects will be designed to trade electricity with each other over a virtual private network, using monitoring and control systems and meters to provide a smart grid. Implementation will necessarily be modular with each trigeneration project designed with future capacity and interconnectivity in mind. City of Sydney recognises that it will need to continue to work with Energy Australia to identify and resolve regulatory and other issues (Jones, 2010).

4.2 Government Rebates and Subsidies

A range of subsidies and rebates are available under various conditions as State and Federal Governments attempt to influence the growth of the renewables industry and carbon emissions. Governments can also reduce or withdraw these same interventions in response to changing circumstances, policies or economics – as recently witnessed when the NSW feed-in tariff was reduced from 60c to 20c per kWh. This risk does need to be taken into account in developing any business case.

Case Study: Government Rebates – Wyong City Council

Wyong City Councils installed solar panels on three public facilities with the intention of selling excess electricity back to the grid. Energy Australia, however, has declined Wyong's plan on the grounds that Council is not a small retail customer and therefore not eligible under the Solar Bonus Scheme. (Express Advocate, 2010.)

4.3 Community-Ownership

Community-owned power generation facilities are typically cooperative arrangements, whereby local people are able to buy shares in a particular venture. In a further refinement, the cooperative venture might be more open, perhaps with local participants given a preferential share price. The model is generally initiated, driven and operated by and/or on behalf of a local community. The cooperative may also be a for-profit.

Case Study: Community-Ownership – Windshare

Windshare is a for-profit cooperative based in Toronto, Canada. It develops locally-owned projects to the scale that the community requires for its size and other characteristics. Its mission is to demonstrate leadership and action (see windshare.ca/about/about_windshare.html). In 1999 the Toronto Renewable Energy Corporation (TREC) used a grant to study sites for a wind turbine, which identified the highly visible site of Exhibition Place as suitable. A community outreach program resulted in 427 members investing $2,000 (CDN) each within four months, raising over $800,000 (CDN) capital.

Windshare is progressing to its next project, the 10MW Lakewind Power Project. Each member of the cooperative has one vote, irrespective of the level of their investment, and they receive an annual dividend payment for the power that their turbine produces. The power is fed into the power grid. The Ontario Power Authority (OPA) offers a feed-in tariff, and a contract under the new Green Energy Act is expected in 2010. Investment in the Lakewind project will be used for capital and will entitle the member to cooperative ownership of the Exhibition Place turbine. There are several membership types: individual, joint, institutional and gift.

As noted in earlier sections, several technologies are not suited to the urban environment where development density precludes the allocation of large open spaces to a renewable energy power station. However a Mosman community group, the Mosman chapter of Clean Energy for Eternity, is working with the Bega chapter to set up the South East Solar Farm.

Case Study: Community-Ownership – Clean Energy for Eternity

Clean Energy for Eternity (CEFE) is a climate change group that started in the Bega Valley on the far south coast of New South Wales. A community meeting chaired by the local mayor committed to a target of a 50% reduction in community energy consumption and 50% renewable share of energy production by 2020. Six months later the Bega community had a widely endorsed action plan for achieving its target.

Mosman is the first city based CEFE chapter and represents a shared commitment between the city and the bush to tackle climate change. Both groups are not-for-profit and staffed entirely by volunteers, and aim to show the way forward in dealing with the climate change issue. Their solution lies in individual action, local community initiatives and getting policy changes and a suitable incentive framework introduced at the state and national political level. In Mosman the group looks forward to working together with Council through its Sustainability Panel.

Adapted from www.mosman.nsw.gov.au/events/710/CEFE

CEFE plans a 1-2MW community solar farm into being in the Bega Valley building on a perceived natural synergy between "the city and the bush" in Australia when it comes to community power: urban communities being generally more wealthy but short on space, while rural communities have abundant land but often need investment to help manage the dual pressures of changing rainfall patterns and increasingly competitive global markets for agriculture. This project is a practical partnership between the Bega and Mosman chapters of CEFE.

A feasibility study for the solar farm was conducted with a $100,000 grant from the Federal government's Green Precincts Program, to assess the most effective technology, design and business case and to provide a replicable model for other interested communities. The project currently appears to be on hold, although it has commitments of $650,000 for panels at Eurobodalla's water plant and $350,000 from Mosman for panels on its various buildings, with the possibility of that $1 million being matched by the Department of Environment, Water, Heritage and the Arts (DEWHA).

The team reassembled. We looked for local government and commercial partners. In the end was prepared to commit and Mosman $350,000 for panels on its various buildings plus the Balmoral water project. That was enough to match the federal government $1 million. CEFE awaits a decision.

Adapted from: CEFE website http://austcom.org.au/780.html 25 November 2010

4.4 Build, Own, Operate

The concept of councils building, owning and operating their own power-generating infrastructure raises the immediate question of funding for the necessary investment. At the smaller end of the scale councils can fund their own projects, and can seek public funding under a range of different government programs.

In the USA, municipal financing for clean energy projects addresses the barriers of the up-front cost of investment, and reluctance to invest if the owner might sell their property before they received the full benefit of the installation. It does this by providing finance to residents and commercial property-owners that enable them to spread the cost over time, and for any property-buyer in future to take on the outstanding debt.

Case Study: Municipal Financing – Berkeley FIRST

Under the City of Berkeley FIRST (Financing Initiative for Renewable and Solar Technology) finance is available for the installation of electric and thermal solar systems and for energy efficiency improvements. The recipient of the finance repays the loan over a 20-year period, while the municipality places a lien on their property. If the property is sold before the end of the 20 years, the new owner pays the remainder due. The interest component of the finance is tax-deductible.

The program has initially been in high demand with the $1.5 million (USD) available for the pilot being claimed within 10 minutes of applications being accepted on 5 November 2008.

(Fuller, Portis and Kammen 2009.)

Many US States have laws that permit local governments to finance improvements through special assessments collected through their property tax system. The City of Boulder passed Measure 1A in November 2008 to allow it to issue up to $40 million (USD) in special assessment bonds to finance clean energy improvements (Fuller, Portis and Kammen 2009).

Fuller, Portis and Kammen (2009) compared clean energy municipal funding in terms of its NPV against other financing options (such as mortgage re-financing, a personal loan, and cash up-front). They found that municipal funding had advantages relating to tax deductibility, lower transaction costs, and the transfer of outstanding repayments to the new owner. They also found that the improvements alone already made financial sense, but that the financial case would improve further with a carbon price factored in, particularly when combined with declining solar costs.

SSROC has been unable to identify any comparable models of funding in local government in Australia.

4.5 Energy Services Company

The ISF (ISF 2009b) notes that there are significant barriers to the effective implementation of a decentralised solution, and that the "economic and environmental benefits will not be realised unless there is deliberate and effective policy reform in NSW". These barriers are relevant since any renewable-energy technology deployed in southern Sydney would have to operate within or alongside the existing NSW stationary energy infrastructure. The City of Sydney's plans for implementing trigeneration include addressing these barriers (Jones, 2010) and cites the example of how similar barriers presented by the comparable UK regulatory regime were overcome.

Case Study – Energy Internet: Borough of Woking (UK)

Woking Borough Council established Thameswey Ltd as a wholly-owned energy and environmental services company in 1999 to act a contractor to Council to invest in combined heat and power plant, to sell heat and power in an environmentally friendly way with a view to improving the environment within the LGA. It delivered its first station in Woking town centre in March 2001, which supplies electricity by private wire to 9 public venues such as hotels and entertainment centres, as well as to the Museum and Civic Offices. Over the public electricity network it supplies other council sites and residential properties. The company also undertakes projects outside the borough, the profits of which can be use to the benefit of residents. (Woking, 2007.)

The UK's regulatory regime is, like NSW, premised upon a centralised energy source. When Council established its public-private joint venture ESCO, Thameswey Energy Ltd, it made an enabling agreement with EDF Energy (SEEBoard at the time) regarding operation of the regional distribution network. The agreement brought together 81 decentralised sites into a common local trading system balancing their electricity imports and exports. Local trading was managed using the same data collection system as for the centralised system, but permitting both generation (export) and supply (import) at the same meter (Jones 2009).

4.6 Public-Private Joint Venture

The Borough of Woking Council set up its ESCO to enable it to implement large-scale district energy CHP with mainly private finance. It formed the wholly owned company, Thameswey Ltd., in order to enter into public-private joint ventures to deliver a range of environmental and energy strategies and targets. Thameswey Energy Ltd was subsequently established under a joint venture with Danish green energy company, ESCO International A/S. This enabled them to escape UK capital controls on local government ventures, with Council's shareholding capital at less than 20 per cent and funded by its Energy Efficiency Recycled Fund, and the Danish company owning 81% of the private company.

The noise barrier at the Tullamarine-Calder Interchange, which generates power by solar panels which are integral to its function, was built by Going Solar for the Tullamarine-Calder Interchange Alliance, a partnership of Parsons-Brinkerhoff, Baulderstone and VicRoads.

4.7 Energy Performance Contract

Under an Energy Performance Contract (EPC), a company is engaged to improve the energy efficiency of a facility with guaranteed energy savings paying for the capital invested. The company implements the changes and guarantees the savings over a specified period. Such as arrangement addresses the concerns, typically of property managers, of limited maintenance budget coupled with ageing infrastructure in a situation where the actual spend on energy is not high enough for any reduction to justify a significant capital investment. At least one SSROC member council is currently considering this business model to improve its energy efficiency.

Case Study: Energy Performance Contract – Hornsby Shire Council

Hornsby Shire Council has over 160 sites with either metered energy or water supplies. The Energy Performance Contract (EPC) included lighting upgrades in the administration building, council chambers, works depot and libraries. This included upgrading lighting to high efficiency tri-phosphor lamps or compact fluorescents. In the administration building, electronic ballasts (147 units) were fitted to lights on perimeter zones to maximise available daylight. Over 200 smart occupancy sensors were installed throughout offices, libraries and the works depot. Power Factor Correction equipment was installed at the main switchboards of a number of sites. This equipment ensures that the Council only pays for the energy it uses. Programmable time-clocks were installed to ensure air conditioning is only on when required. Split systems were tuned to improve performance and reduce energy use in warmer weather.

There is a 15 year payback period, and the system will provide council with a detailed account of energy and water consumption across the sites. Energy use will be analysed using regression analysis tools, normalising for variables such as weather, so that a true representation of system savings can be generated.

The EPC forms part of Council's Greenhouse Gas Reduction Strategy. By the year 2010, this strategy aims to reduce Council's greenhouse gas emissions by 20 per cent or 717 tonnes of greenhouse gas emissions per annum.

5 Key Issues

5.1 Culture Change

Allan Jones, (formerly of Woking (see case study above) and London, now at City of the Sydney, recommends that Australia can learn from London and Woking to move beyond a silo approach when it comes to tackling climate change and reducing emissions, stating that "You get far higher levels of efficiency – and greater reductions in CO_2 emissions – when you combine the community together." (Ecolibrium, 2009.) He advocates taking a more holistic approach, whereby small co- and trigeneration systems in individual buildings are not considered only in isolation within that building, but as part of a bigger master plan to reduce emissions, covering energy, water, transport and waste. With cities responsible for 75 per cent of global emissions, a city-wide approach seems to be an appropriate response: but Jones also points out that this implies holistic changes to mindsets, philosophy, and how we operate (Ecolibrium, 2009).

Within SSROC member councils there has been a shift in attitudes towards greater energy efficiency, often driven by the increasing cost of electricity and fuel as well as the need to achieve carbon emissions reductions. Further attitude-change is required to increase the actual reductions in emissions beyond what has already been achieved, and to extend the drive to a broad LGA- and region-wide thrust, beyond the current local and incremental initiatives.

5.2 Carbon Economy

The term "Carbon Economy" is used in this paper (and other SSROC documents) as a broad label for the wide range of issues that it implies, covering the economic implications of activities related to: carbon emission mitigation and adaptation, global warming/climate change, and carbon trading and taxes.

The uncertainty around how greenhouse gas emissions should be factored into the Australian economy means that it is very difficult to develop robust financial business cases for any undertaking that would be affected by the change. The issue is often raised in relation to Emissions-Intensive Trade-Exposed (EITE) industries and Australian power generators, but it also extends into any renewable energy project. This is because it is impossible to reliably account for any environmental cost of electricity generation in conventional financial models. Australia's existing carbon-related policies include the Renewable Energy Target, State-based feed-in tariffs, the NSW Greenhouse Gas Reduction Scheme, the Queensland Gas Scheme and a range of other initiatives that involve competitive bids for grant funding such as Solar Flagships and Renewables Australia. A decision on the introduction of a carbon price (whether through an emissions trading scheme, a carbon tax, or some other mechanism) remains an issue for the future.

But the present debate around the issue of carbon pricing signals that it will be necessary to incorporate this cost in future plans. At Cancun in December 2010, 192 nations agreed to "anchor" their emissions pledges: this does not appear to be any form of obligation, but may add a little more pressure to honour those pledges than previously existed. Neither was an overall target set, binding or otherwise. This extra pressure may be considered by the Australian government to be sufficient to justify increasing our national target beyond its current 5 per cent by 2020, especially since the USA, China and India are among the signatories to the Cancun Agreement.

For the foreseeable future it will be difficult to develop a robust business case for a renewable energy venture that takes environmental costs of carbon emissions into account. However, depending upon the project undertaken, it is possible that the business case could be financially sound.

5.2.1 Enhanced Renewable Energy Target (RET)

The Australian Government's enhanced Renewable Energy Target will come into effect from 1 January 2011, splitting the target into the Small-scale Renewable Energy Scheme and the Large-scale Renewable Energy Target (LRET). Small-scale generation units will be eligible to create small-scale Renewable Energy Credits

(RECs) under the SRES, and will not count towards the LRET. The RET enhances the 2001 Mandatory Renewable Energy Target (MRET).

The objective of the scheme is to encourage the generation of additional electricity from renewable sources by creating a market for it. It does this by requiring (mainly) electricity wholesalers to source a percentage of their energy from renewable sources. The percentage increases over the years until it reaches 20 per cent in 2020.

Aiming only at additional electricity generation, the scheme does not directly target the transition from traditional sources such as coal, and it does not directly target the reduction of greenhouse gas emissions. It is intended to stimulate investment in and deployment of renewable electricity, and to be phased out in the decade after 2020. The scheme was designed to be complementary to an emissions trading scheme and to the development of carbon capture and storage technologies.

The fastest growing form of electricity generation in the world today is wind energy, accounting for 1.5 per cent of Australia's electricity generation . In western Europe it is already cost-competitive with other forms of electricity. Being such a mature technology compared to other renewables (except hydro-electricity), its further development in Australia is perhaps the most likely of the technologies considered in this paper to be boosted by the RET.

5.2.2 Carbon Pricing

The identified need for a carbon price has arisen from the need to address climate change, which has dramatically accelerated in the industrial era and is almost certainly caused by our emissions of greenhouse gases. Imposing a price on these emissions would have the effect of discouraging them. This could be done by taxing emissions or by creating a market in which emissions can be traded but, according to the Government's adviser Professor Garnaut, the trading scheme would be the more cost-effective of these two models. Other possible interventions include direct regulation, energy efficiency measures, and new technologies such as carbon capture and storage.

The Carbon Pollution Reduction Scheme, which was proposed as Australia's emissions trading scheme, has been shelved. No replacement has yet been put forward, but the formal debate about the best mechanism has started with the first meeting of the Multi-Party Climate Change Committee (MPCCC) on 10 November 2010. Professor Garnaut has been asked to update his 2008 report (Garnaut, 2008), considering

- international developments on climate change mitigation efforts;
- developments in climate change science, and understanding of climate change impacts;
- previous proposals to develop a carbon price in Australia, and the ensuing public debate;
- domestic and international emissions trends;
- changes in low emissions technology costs and availability;
- the potential for abatement within the land sector; and
- developments in the Australian electricity market.

A series of papers are to be prepared and published, and the report is due on 31 May 2011. (Garnaut, 2010.)

So, although the Government remains committed to a carbon price, the actual price and the mechanism(s) used to impose it are unlikely to known before late 2011 at the earliest.

In relation to any SSROC renewable energy initiative, the development of a conventional financial case for a renewable energy project would be affected by the absence of a carbon price. That does not necessarily mean that a positive case could not be made, and benefits that would be intangible in traditional financial models (such as a lessening of global warming potential) might still lend weight to the project's justification.

5.2.3 National Energy Market

The inflexible pricing of the National Energy Market (NEM) is reflected in very little variation on the flat price model throughout Australia (IPART 2002, and TEC 2010). This mitigates particularly against trigeneration, which could exploit the cost variations that would normally be associated with rising and falling demand e.g. during the course of a day.

More generally, the model is a traditional one in which it is in the suppliers' interests to sell a much as possible at the highest price they can achieve. With the price regulated, the drive to sell a much as possible is even stronger. Energy efficiency measures directly conflict with this principle market driver, and further distort the market. The Prime Minister's Energy Efficiency Task Group (DoCCEE, 2010b) identified the NEM as a key factor in the drive to improve the nation's energy efficiency, recommending several significant reforms:

- improve generator efficiency and reduce network losses
- improve the balance of demand-side options and new network infrastructure in the NEM
- reduce remaining barriers to energy efficiency and demand-side options in the NEM
- improve the focus on energy efficiency in the NEM.

The concerns of the taskforce highlight the flaws in the current NEM, and presage the challenges that significant reductions in demand for electricity would present. Without major reform, the stakeholders in NEM are likely to fight to retain the current model, which favours centralised generation and distribution, and to resist demand-reduction and decentralisation efforts.

5.3 International Perspectives

The Climate Institute's report (Vivid, 2010) estimates that Australia's carbon-related policies have an overall effective carbon prices of $1.68 (USD) per tonne CO_2 (measured at purchasing power parity rates). This compares with carbon prices of $29 (USD) in Britain, $14 (USD) in China and $5 (USD) in USA[1].

Many countries around the world have targets related to energy efficiency, including:

- 27 European Union (EU) countries have agreed to reduce energy consumption by 20 per cent by 2020
- China is on track to meet its target of a 20 per cent improvement on its 2005 energy intensity by 2010, and 40-45 per cent by 2050
- Russia is targeting a 40 per cent reduction in 2005 energy intensity by 2020
- Asia-Pacific Economic Cooperation members (including Australia) aim to reduce energy intensity by at least 25 per cent of 2005 levels by 2030.

Many developed countries have, or are considering, market-based measures to help reduce their carbon emissions:

- The EU emissions trading scheme (ETS) was established in 2005 and covers around half of Europe's emissions from 27 member and 3 non-member countries;
- New Zealand's trading scheme started with forestry in 2008 and was extended to stationary energy, transport, liquid fossil fuels and industrial processes from July 2010;
- South Korea is trialling an ETS, and plans to begin full trading in 2012;
- Japan is considering a set of "global warming countermeasures" including an ETS, a carbon tax and feed-in tariff;

---

[1] Vivid Economics (Vivid, 2010) estimates are based on:
- Britain's participation in the European trading scheme and various domestic measures,
- China's replacement or upgrade of high-emitting power stations, energy performance standards for emissions-intensive industries, vehicle emission standards, clean energy incentives and spending on renewable energy
- the USA's federal subsidies to clean energy sources and state renewable energy targets.

- Denmark, the Netherlands, Norway, Sweden and Switzerland all have carbon taxies in place, some since the early 1990s.

5.4 Governance and Regulatory Framework

Some of the major external influences on the role of local government in the deployment of renewable energy technologies are:

- The Local Government Act 1993
- NSW electricity regulation
- National Electricity Market regulation.

5.4.1 The Local Government Act

The role of local government in NSW is set out in the Local Government Act 1993 , but it does not precisely describe exactly what functions local government should perform. Rather, it sets out a charter, describing it as "a set of principles that are to guide a council in the carrying out of its functions. A council may add other principles not inconsistent with those …". It goes on to require councils to provide services and facilities for the community and to exercise community leadership, to conserve the environment and promote the principles of ecological sustainability (see box D1).

Box D1 Local Government Charter (1) A council has the following charter:
• to provide directly or on behalf of other levels of government, after due consultation, adequate, equitable and appropriate services and facilities for the community and to ensure that those services and facilities are managed efficiently and effectively
• to exercise community leadership
• to exercise its functions in a manner that is consistent with and actively promotes the principles of multiculturalism
• to promote and to provide and plan for the needs of children
• to properly manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of ecologically sustainable development
• to have regard to the long term and cumulative effects of its decisions
• to bear in mind that it is the custodian and trustee of public assets and to effectively plan for, account for and manage the assets for which it is responsible
• to engage in long-term strategic planning on behalf of the local community
• to exercise its functions in a manner that is consistent with and promotes social justice principles of equity, access, participation and rights
• to facilitate the involvement of councillors, members of the public, users of facilities and services and council staff in the development, improvement and co-ordination of local government
• to raise funds for local purposes by the fair imposition of rates, charges and fees, by income earned from investments and, when appropriate, by borrowings and grants
• to keep the local community and the State government (and through it, the wider community) informed about its activities
• to ensure that, in the exercise of its regulatory functions, it acts consistently and without bias, particularly where an activity of the council is affected
• to be a responsible employer.
(2) A council, in the exercise of its functions, must pursue its charter but nothing in the charter or this section gives rise to, or can be taken into account in, any civil cause of action.

Local Government Act 1993
Chapter 3 What is a council's charter?

SSROC has not at this stage taken any legal advice on the role of local government in the generation and supply of electricity. However, it appears that Local Government in NSW currently has no direct mandate to generate or supply electricity either for its own use or for its local community. However, given the level of concern in the community generally with issues relating to climate change and greenhouse gas emissions, local governments taking on a role in the generation of electricity from renewable sources could be construed as efficient and effective provision of services, consistent with and promoting the principles of ecologically sustainable development.

IPART, in its review of local government revenue frameworks (IPART 2009), noted that "The Act imposes few limitations on what services local government can provide. Rather, its intention is to provide councils with the flexibility to provide services in response to the changing needs of their communities".

5.4.2 NSW Electricity Regulation

The regulatory regime in NSW was designed for centralised energy and does not currently address the issue of private transmission. At present, privately generated electricity (such as that generated by households with solar PV systems) is sold to the grid and effectively added to the "pool" of electricity for sale by the retailer. However, if councils aimed for a larger electricity generating capacity and to become independent of electricity retailers then the issue of how to share their electricity between sites would be likely to arise. This is the situation that City of Sydney will encounter as it generates electricity for multiple sites from trigenerations plants (Jones, 2010).

In his analysis of the barriers to trigeneration, Jones (Jones, 2009) acknowledges some difficulty in NSW in relation to large-scale application, which results from a regulatory framework designed for centralised energy. However, he points out that similar regulation exists in the UK, and was overcome by class exemptions and private wire networks (Woking) and later by licence modification to permit virtual private wire over public wires (London).

5.5 Market Imperfections

The National Electricity Market (NEM) is a wholesale market for electricity supply in Queensland, New South Wales, Victoria, South Australia, The Australian Capital Territory and Tasmania. It began operation in December 1998 as part of a program of reform to Australia's electricity supply industry, which aimed to increase competition in the industry and provide greater choice for end-use electricity consumers. However, the imperfections in the market prevent it operating at its model best, creating the need for market regulation by the Australian Energy Market Commission (AEMC) and the Australian Energy Regulator (AER) (AEMO 2010).

The Total Environment Centre (TEC 2010) sums up these issues concisely as "… a market to *sell electricity*. This is in sharp contrast to a market that aims to save electricity."

Furthermore, the terms of reference of the Australian Energy Market Operator (AEMO) do not include any social or environmental responsibilities, being purely focused on economics and ensuring supply[2], which actively precludes it from preferring any fuel source on the basis of environmental considerations such as carbon emissions. The Total Environment Centre (TEC 2009) highlights the declining priority given to environmental considerations since the early 1990s.

Specific continuing market failures (ISF 2009b) include:

- Culture and attitude – reinforcing the perception that the centralised carbon-based model that has delivered electricity successfully for years must therefore continue to be successful and to grow in future, as well as a general reluctance to change.
- Imperfect information – electricity consumers are often unable to identify what drives their overall electricity consumption and so cannot change their behaviours effectively. Domestic users often cannot tell which appliances use most power, or how much power is consumed by equipment on "standby". Many industrial users have had to invest in more sophisticated electricity management and monitoring systems in order to exploit energy efficiency opportunities. Without such information, consumers cannot make the demand decisions that economic models assume.
- Split incentives – for example, in the situation where a landlord pays the electricity bill for multiple tenants, the individual tenant has little incentive to reduce consumption.
- Payback gap – where the time to recover the cost of an investment is deemed to be too long, e.g. the up-front cost of a solar installation might be prohibitively high to someone on a low income, no matter how

[2] See, for example, AEMO 2010.

good the pay-back over three years. In the case of organisations, making a capital investment which requires an extended approvals process may be perceived as too much effort compared with simply authorising the payment the quarterly power bill.

- Prices do not reflect all costs – a persistent policy of keeping prices low at the expense of investment in infrastructure renewal, and the failure to cost the environmental impacts of power generation.
- Regulatory failure – regulation, that has developed premised upon a system that is becoming inadequate, needs to be adjusted or replaced in order to accommodate new alternatives and enhancements.

These are all imperfections that often distort markets to a greater or lesser degree, and all are increasingly distorting the NEM. The City of Sydney's planned decentralised energy system would largely by-pass the NEM by generating its power locally and ultimately sharing electricity across its sites by using only the local distribution network (and not the transmission network). An enabling agreement with Energy Australian is proposed. (Jones, 2010.)

5.6 Community Participation

Centralised energy generation and supply has become the norm throughout the developed world, and its availability on demand is generally unquestioned, even considered to be basic right. Our dependence upon electricity and oil is so deeply entrenched that our society is threatened by the suggestion that our supply systems might change. Like any major change, the deployment of renewable sources of power and ideas such as decentralisation will be met with resistance and scepticism by many people. Community participation is critical to raising awareness of problems and solutions, to breaking down barriers to change, and to building engagement in and support for change.

At the level of individual projects, participation of the community is often considered to be a major element in renewable energy projects, since active engagement with real community actions can result in proposals being more acceptable and often more effective. There is a perception among some sectors of Australian society that the technologies for exploiting renewable energy sources are new and unproven, and that reliance upon them would be risky. The Institute for Sustainable Futures (ISF, 2009a) identifies the lack of local precedents as a barrier to the implementation of trigeneration.

While some protests are probably deliberately disingenuous in order to protect vested interests, and other probably just misinformed, there are undoubtedly also some newer technologies that are less well proven than others. The result is that suspicion, reluctance to take a perceived risk, and a general disinclination to change all combine with a lot of varied information to create confusion.

Case Study: Community Participation – The Macarthur Hawkesdale Wind Farm Community Engagement Committee

The Macarthur Hawkesdale Wind Farm Community Engagement Committee was established in 2009 as an advisory committee to the Moyne Shire Council. Community Engagement Committees (CECs) are an important component of Moyne Shire Council's community engagement strategy for major projects with three others currently in operation.

A newsletter will be produced by the Council following each meeting, and distributed throughout the Macarthur and Hawkesdale districts. So that the community is more informed about the project, the newsletters will contain information of interest from the CEC meetings, including progress reports from proponent and construction company representatives. The newsletters will also be available on the Moyne Shire Council's website.

Case Study: Attitudes to the Proposed Tempe Wind Farm

Some negative perceptions were highlighted by the proposed Tempe wind farm in Marrickville LGA, where the local paper reported a Councillor saying that Tempe residents "already felt bombarded by the M5 expansion, the airport, and IKEA. She was unsure that the benefits would outweigh the cost to council of a wind farm." (Inner West Courier, 2010.)

The major implication of this issue for any renewable energy initiative in the region is that at least two levels of community involvement are needed:

- A general awareness, to provide information, enable understanding and promote well-informed and active decision-making.
- Active participation in projects with participants – council and community – committed to finding a solution to the problem of LGA carbon emissions.

Councils generally put resources into general awareness, with information available on web-sites and in printed form, as well as through many community events. Councils also understand the need for community participation in specific projects, and manage such processes very well: however, they are very resource-intensive activities. Increasing the number or scale of initiatives executed which require extensive community participation would necessitate a commensurate increase in the resources allocated. Many councils would find such an expansion difficult to absorb.

5.7 Program Development

The City of Sydney, in its plan to become carbon neutral, adopted a range of different approaches, including several described in this document. It achieved carbon neutral status in 2008, purchasing carbon offsets for unavoidable emissions. The City's approach highlights the multiplicity of combinations that can be considered.

Case Study – Program Development: City of Sydney

The City of Sydney has developed a broad portfolio of programs in order to achieve its Sustainable Sydney 2030 targets of 70% reduction in CO_2 emissions and 330 MW_e from trigeneration delivering 70% of the City's electricity by 2030 (CoS, 2010a), but the program also covers awareness-raising initiatives and the promotion and demonstration of new technologies. The programs include:

- Changes to the composition of the vehicle fleet, including hybrid-powered trucks,
- Acquisition of electric vehicles
- Implementation of public roadside electric vehicle charging stations
- Push-bike fleet for staff
- Go-get hybrid fleet
- Driver education
- Car-share schemes and car-share-only parking spaces
- Cycle paths
- Locally produced electricity, including master-planning for CCHP, renewable energy and energy from waste disposal
- Purchase of Greenpower for street-lighting
- Installation of energy-efficient lighting (starting with a sustainable lighting trial).

Like the Zero Carbon Australia Stationary Energy Plan published by Beyond Zero and the University of Melbourne Energy Research Institute, the broad range of the City's portfolio of activities signals the need for a range of solutions to be adopted under a long-term strategic plan, if a significant impact on carbon emissions and energy security is to be made.

Clearly there is no single solution to the issue of carbon emissions: councils are all developing their own responses and watching those of the State and Federal Governments. Whether a regional program is required, or a simply one (or more) regional actions in response to councils' individual needs will be driven by the ROC's objective(s) for its renewable energy initiative. Options range from simple individual procurement contracts to large multi-council investments. Any regional program should be designed to deliver the ROC's stated objective(s) in renewable energy.

5.8 Grid Access

Accessibility of the grid limits the physical location of power generating plant, since transmission losses over distances make many location unviable. Local power generation where the generator is connected directly to the consumer's network, (such a solar panels connected directly to a home) eliminates entirely the need for grid access.

Larger decentralised energy requires use of the grid to share electricity between sites, while retaining the ownership of it. The Energy Internet, a network of grids analogous to the internet, could also be used in this context. The concept was described in 2004 (Economist, 2004) and reiterated by the UK's House of Lords (HoL, 2004) after visiting Woking.

The major implication of this issue for any regional initiative depends upon the overarching plan: if access to the grid is a requirement, then the ROC will need to work with the relevant stakeholders as quickly as possible, since some issues will undoubtedly take time to resolve. SSROC could also offer its support to the City of Sydney, which has already initiated the dialogue.

6 Conclusions

The first step in moving the region towards any renewable energy project is to decide and clearly articulate what the region aims to achieve: to create a shared understanding what will be achieved when the renewable energy has been completed. This "vision" will then combine with the range of drivers for change to provide a target, which a program can be designed to achieve.

6.1 Articulate the Vision and Objectives

In 2003, the SSROC Regional Greenhouse Plan stated:

> "A reduction in greenhouse gas concentrations will be achieved by implementing effective, practical actions within the SSROC region. A united Council approach to greenhouse gas reduction not only brings efficiencies and benefits with the sharing of resources and expertise, but also means we can tackle cross boundary issues like transport.
>
> "Our Goal is: to reduce greenhouse gas emissions by 20% across the region by 2010.
>
> "Our Commitment:
>
> "Councils are taking the greenhouse issue seriously, and are demonstrating leadership on this issue with a commitment to reduce the greenhouse emissions from their council areas by at least 20% of the 1997 level by 2010. They are developing innovative projects to reduce greenhouse emissions both from their operations and across the community. Participating Councils have joined the international greenhouse reduction program Cities for Climate Protection (CCP) to help them achieve this goal. The Regional Greenhouse Plan (RGP) complements and expands on the Local Action Plans developed by Councils under CCP.
>
> "Ten member Councils of SSROC are participating in the RGP covering more than one million people and a third of the Sydney metropolitan area. Participating councils include: Botany Bay, Canterbury, Hurstville, Kogarah, Marrickville, Rockdale, South Sydney, Sutherland Shire, Waverley, Woollahra. We are the biggest region in the world working together to reduce greenhouse gas emissions.
>
> "The Plan builds on SSROC's pioneering document A Greenhouse Strategy for the Southern Sydney Region (1992) that demonstrated the important role local government could play in reducing greenhouse gas emissions, providing a regional response to the issue as well as outlining local actions."
>
> (SSROC 2003)

Since 2003, councils have found that achieving reductions in carbon emissions is not easy, and that the task of quantifying and tracking emissions is a necessary and challenging prerequisite. The CCP Program has ceased following the withdrawal of its funding. The international and national background to the issues of global warming and carbon reduction has changed, scientific understanding has improved, and the economic implications of internalising the costs of carbon pollution are beginning to be understood.

SSROC needs to re-state such a commitment and aim, updated for our current understanding of the issues.

6.2 Develop a Program to Achieve the Objectives

A program to achieve the vision would include a range of projects, which would be executed over different timeframes and by different means. The program could be designed by the ROC secretariat to balance the realisation of benefits against the level of investment required and the level of risk acceptable to SSROC. It would be under-pinned by a resource plan and communications strategy. Individual projects could be executed by consultants where specialist expertise is required, or by council resources, each project being subject to approval by participating councils.

The following examples are intended to provide some suggestions as to objectives and projects that could be initiated in response to them. (Note that, as previously observed, a range of coordinated projects and initiatives would actually be required in most cases.):

Example 1:

Objective: energy consumption is the major contributor to the greenhouse emissions from all southern Sydney LGAs, and SSROC aims to reduce the region's emissions through a consolidated drive towards reducing consumption.

Project: SSROC should develop a Regional Energy Master Plan that will set out the long-term path to implement significant reductions in emissions by lowering overall fossil-fuel consumption.

Example 2:

Objective: the consumption of fossil-fuels is unsustainable, and SSROC aims to increase the proportion of its power from renewable sources, ultimately to 100 per cent.

Project: Investigate the feasibility of council operating as a power generator by investing in major renewable energy facility

Example 3:

Objective: to preserve our environment and resources for future generations, consumption of fossil-fuels needs to be reduced and energy generated from renewable sources needs to increase; so SSROC wishes to demonstrate its support for renewable energy and the associated industry, and to promote renewable energy to the community and businesses in the region.

Project: Set up a prominent demonstrator wind-turbine within the region for educational and awareness-raising purposes

Example 4:

Objective: communities should be able to reduce their demand for centralised carbon-based system of power generation, by installing their own power-generating facilities; so SSROC proposes to enable communities to do so by facilitating the access of residents and local businesses to appropriate technologies.

Project: Set up a preferred supplier arrangement for energy performance contracts for councils, enable individuals and local businesses to buy solar PV panels and small wind turbines at pre-negotiated prices, or for the supply of trigeneration services and equipment, establish affordable financing arrangements for lower-income residents.

Example 5:

Objective: SSROC seeks to influence higher levels of government to introduce market-based instruments aimed at reducing our carbon emissions.

Project: Lobbying for related reforms, such as the introduction of a carbon price, the reform of the NEM and the accelerated roll-out of smart meters.

6.3 Next Steps

The SSROC secretariat recommends that the Sustainability Program Committee agree the objective for the renewables initiative and a broad outline of the outcome that is required. The recommendation will then be put to the ROC. With the approval of the ROC, the secretariat will then develop a program outline, identifying resource requirements (funding, capabilities and staffing) for General Managers to progress.

Appendix A Technology Options

The following sections provide a brief introduction into each of the current major renewable energy technologies. They have been written based on a review of literature by the SSROC secretariat, who are not specialists in the field, and should be regarded only as a non-technical introduction intended only for this purpose. Technical feasibility and initial design of any proposed installation would be the subject of the next phase of the program if the ROC decides to progress the opportunity any further.

A.1 Wind Power

According to the Clean Energy Council (CEC 2010), the total operating wind capacity at the end of 2009 was 1712 megawatts (MW) – a 31 percent rise on 2008, equivalent to approximately 4,284 GWh of electricity annually. In March 2010 one new wind farm had been commissioned and the total operating capacity stood at 1769 MW (approximately generating 5,000 GWh of electricity annually).

Small-scale wind turbines are generally considered to be those that have a rated capacity of less than 10kW. These turbines can also be connected to the grid, but more commonly are used to generate electricity as part of a Remote Area Power Supply (RAPS) system in regions where the grid is unavailable. However recent models of small turbines appear to be more suited to urban settings, with less noise than earlier models.

The possibilities for wind power range from large wind farms to individual residential turbines.

A.1.1 Prerequisites

Australia has very good wind resources, particularly in western, south-western, southern and south-eastern coastal regions, extending inland by hundreds of kilometres. However, the suitability of exact locations for wind turbines needs careful analysis of prevailing wind conditions: locating a suitable site requires regional wind-speed mapping using actual speed measurement and atmospheric data to identify a likely area, then area mapping to identify local variations, and finally siting studies to determine the optimal sites for individual turbines using input from long term sensors installed on the site (GA 2010). Other considerations for siting wind turbines include proximity to transmission lines, access to land, transport access, local development zoning and development guidelines, and proximity to markets.

The UK and Denmark make the most use of this technology, with the top ten installations. There are currently no plans for such development in Australia (GA 2010).

Wind turbines are relatively simple to build and commission: however feasibility studies, siting and approvals processes can take some time. A Department of Planning Discussion Paper (NSW DoP 2010) published in April 2010 put forward a streamlined approvals process for small wind turbines, whereby a complying development could be approved within 10 days. This would cover pole-mounted wind turbines with a total combined capacity of less than 10 kW in residential zones or 60 kW in industrial and rural zones. Heights would be limited to 15 and 25 metres in residential and industrial zones respectively, and there would be strict noise limits on turbines near residential dwellings.

Small or micro turbines still require appropriate siting where they appropriately exposed to wind – typically 10 kph before they begin generation electricity – and where other conditions are also met, such as positioning in relation to flight paths, environmental impacts, distance from residential development and distance from the grid. The structure itself needs to be assessed, positioned well in order to avoid turbulence, and to have vibration dampeners (RISE 2010). They need to be connected to a suitable inverter or battery and battery charger. According to RISE (2010) they are most suited to exposed terrain and/or large distances to neighbouring properties e.g. rural blocks and industrial estates.

A.1.2 Maturity of Technology

Wind energy is a proven and mature technology with low operating costs. Both the size of turbines and wind farms have increased, with farms of more than 100 MW combined capacity now common and substantially larger wind farms proposed.

Geoscience Australia reports that in 2007–08, Australia's wind energy use represented only 0.2 per cent of total primary energy consumption and 1.5 per cent of total electricity generation, but notes that wind energy is the fastest growing energy source in Australia with an average annual growth of 69.5 per cent since 1999–00. The report states that in October 2009, there were 85 wind farms in Australia with a combined installed capacity of 1.7 GW. These power stations are mainly located in South Australia (48 per cent), Victoria (23 per cent) and Western Australia (12 per cent), with a further 11.3 GW of wind energy capacity proposed for development in Australia.

According to the Global Wind Energy Council 2009 report, china accounted for a third of the 31 per cent increase in globally-added wind capacity. At the end of 2009 it had an installed capacity of almost 26,000 MW, putting it slightly ahead of Germany and behind only the USA. In 2008 it increased its production of small-scale turbines to 80,000.

Wind farm development – the clustering of multiple turbines to generate significant power – has escalated in recent years. The largest development currently planned in Australia is in Victoria, and has been permitted to generate up to 420 MW from 140 3MW turbines, which is sufficient power for some 220,000 homes, abating 1.7 Mt of carbon emissions annually.

The Capital Wind Farm at Bungendore near Canberra has a capacity of 140.7 MW and an estimated production of 450 MW p.q. from 67 2.1MW turbines.

An example offshore wind farm is Thanet off south-east England, currently the largest such installation with a capacity of 300 MW. It cost approximately £780 GBP and is expected to operate at around 35-40 per cent of capacity. Its 100 Vestas V90 turbines will operate at wind speeds of 13 to 90 kilometres per hour. (Global Energy 2010.)

The Strand wind turbine in Townsville is a Ropatec WindRotor WRE.060, a vertical axis turbine 8.6 metres high, the 4.5 metre rotors mounted on a 4-metre tower. The rotors are 3.3 meters across, and the capacity is 6kW and it generates around 16kWh per day which is estimated to be sufficient to power an average home in Townsville (TCC, 2010).

Small wind turbines of the type used in rural areas are a mature technology, and many have been operation for some years. Residential-style wind turbines are relatively new, and SSROC has as yet been unable to locate any detailed analysis that demonstrates their effectiveness. RISE (2010) identifies an increasing trend towards Small Wind Turbines (SWT) in built-up areas, particularly in Europe, with Urban Wind Turbines (UWTs) on commercial and residential buildings as well as in school grounds. Turbines can be ground-based mounted on poles or they can be mounted on buildings, and are typically less than 6kW.

Building-mounted wind turbines currently tend to be vertical-axis wind turbines (VAWTs), which do not have to yaw to track the wind, and which have lower rotation speeds so less noise and vibration. However they are also less efficient than horizontal-axis wind turbines (HAWTs). Building-integrated wind turbines, which speed air flow into the turbines by using the shape of the building, are still at the concept/prototype stage. (RISE, 2010.)

RISE (2010) concludes that "Initial optimism ("microwind turbines for every home!") on UWTs has been tempered by results of demonstrations e.g. Warwick Wind Trials ("may make a tangible contribution on suitable sites")" and further that "… UWTs are immature technology at this stage - plenty of scope for technological innovation to adapt SWTs to the built environment. Use of more mature technology e.g. large commercial scale turbines within city limits may provide a valid alternative."

At the smallest end of wind power scale are individual turbines suitable for domestic or small business use. The smallest might generate 50W and be connected directly to a fridge, for example. Those for residential use are about 2.1 to 7.5 metres in diameter, with a generating capacity of 300W to 10kW. There is still debate about the siting of such turbines, with some arguing that roof-top generators are feasible, others that the turbine needs to be at least 9 metres higher than anything within 500 metres. For example, one 12 volt 200W turbine claims to have sold more than 100,000 units in 120 countries, and suggests that it could power a washing machine, fridge or television (SouthWest Windpower, 2010).

A.1.3 Infrastructure Requirements

According to Geoscience Australia (GA 2010), grid constraints, whether lack of capacity or simply availability, may limit further growth of wind energy in some areas with good wind resources (particularly South Australia), so upgrades and extensions to the current grid may be needed to accommodate significant further wind energy development. Elsewhere, current grid infrastructure should be adequate for the levels of wind energy penetration projected for 2030: grid infrastructure is generally able to accommodate only 10 to 20 per cent wind energy due to power quality issues, capacity constraints and grid management techniques (GA 2010). Most wind farm developments in Australia have been within 30 kilometres of the grid; costs and transmission losses have a significant effect on cost-efficiency the further from the grid power is generated.

The variable nature of wind effectively limits the potential penetration of wind energy, but according to Geoscience Australia is not likely to be reached in the next 20 years. The limit could be extended by better wind-forecasting (allowing the grid to react to projected changes in wind conditions), demand management (shedding or adding load to match wind conditions) and even the addition of storage nodes to the grid (moving excess wind energy to higher demand periods).

Exploiting wind energy effectively will require better grid management than is currently available, in order to cope with the intermittent and variable nature of wind energy which causes electricity generation to fluctuate with the prevailing weather conditions, season and time of day. This will necessitate increasing grid capacity as well as accurate and timely wind forecasting (GA 2010). The Australian Government is trialling smart grid technology, automated electricity systems that are able to automatically respond to changes in supply from renewables and fluctuations in electricity demand, which will facilitate the useability of wind energy. There is also a possibility that interconnecting wind farms could enable a better contribution to baseload power (Archer and Jacobson, 2007).

A.1.4 Environmental and Social Impacts

The operation of wind turbines produces no greenhouse gas emissions, and emissions involved in sourcing the materials and constructing the turbines are low compared with electricity generation from other sources (GA 2010). One study in Taiwan indicated a pay-back period for energy input of 1.3 months (Lee and Tzeng 2008).

Other impacts include threats to birds and bats and the noise generated by large turbines. According to RISE (2010), the urban environment has increased air turbulence that may lead to noise and turbine fatigue, the latter could also be a safety hazard in an urban environment. Building-mounted and building-integrated turbines might transmit vibrations to the building (RISE 2010).

While the National Health and Medical Research Council has stated that there is no evidence of any impacts on human health, there is not full wide acceptance that there are no impacts, as recent media coverage has highlighted.[3]

A.1.5 Economic Viability

Geoscience Australia reports that wind turbine manufacturing output is currently doubling every three years, and that there is also a shift from European and United States' production to lower-cost manufacturing centres in India and China. Both trends are likely to lower turbine costs.

The set-up phase of wind turbine project costs is relatively capital-intensive, with around 70 to 80 per cent of the total investment required for the turbines and grid integration infrastructure. Whereas variable costs are relatively low comprising mainly maintenance costs.

[3] For example, see *Residents reject wind farm health findings,* by Kellie Lazzaro, July 5, 2010 ABC News and *You don't need a weatherman to know which way the wind blows* by Adam Morton July 3, 2010 The Age.

Currently installed wind farms illustrate the significant economies of scale that can be achieved in this sector. At the end of 2008, small wind farms (less than 10 MW capacity) comprised 70 per cent of operating wind farms in Australia but accounted for less than 2 per cent of Australia's wind energy capacity. This compares with large wind farms (greater than 100 MW capacity), which comprised 6 per cent of operating wind farms but accounted for around 38 per cent of Australia's wind generating capacity. The majority of wind energy capacity in Australia is from medium-sized wind farms (10–100 MW capacity), at around 60 per cent. The economies of scale are reflected in the lower cost per kwh of the larger wind farms. (GA 2010)

The viability of large installations has presented a barrier in the past, with high initial capital cost and uncertainty about supply contracts. However, both elements are being reduced with falling turbine costs and increasing demand for renewable energy.

In order to be eligible under the SRES, a "small" wind turbine is up to 10kW capacity, must be installed at an eligible premises (such as houses, apartments and shops), must be new and the only unit at the site (DoCCEE 2010). The cost of a wind turbine varies with its generating capacity, but is expected to fall with a trend towards mass production in India and China. Urban Wind Turbines of under 10kW are cheap compared with the cost of PV for small and residential systems to install, but they have moving parts and do require regular maintenance at additional cost over their lifetime. According to RISE (2010), the urban environment has increased air turbulence that may lead to turbine fatigue, and the energy produced may be small compared to the cost of the turbine over its life-time.

A.2 Solar Power

Solar power is generated from sunshine by either solar thermal or solar photovoltaic (PV). Solar thermal generates heat energy directly by heating air, water or another fluid and is typically used for hot water, space heating or generating electricity using steam-driven turbines. Solar thermal electricity and concentrating solar thermal with storage is usually for large-scale power generation. Solar power is extremely scalable with individual small panels commonplace, domestic roof-top panels increasingly common, and major power stations generating up to 50 MW in commercial operations overseas.

Solar PV converts sunlight in electricity using photovoltaic panels, often installed on rooftops or integrated into building designs. They can also be scaled up to megawatt-scale power plants, but in Australia, most solar energy production is off-grid and residential installations. Since the electricity from this type of system has to be used as it is produced i.e. during the hours of sunlight, it is best used for displacing grid electricity and is not suitable for base-load generation. However, the correlation between the peak-generating hours and peak daytime demand means that solar has the potential to meet the peak demand which could lessen the need for upgrades to existing coal-fired supplies. Beyond Zero Emissions speculates that small-scale local PV could become so prevalent that it might reduce demand for baseload electricity during sunlight hours to almost zero: this in turn would increase the value of centralised solar thermal power with storage for baseload power (BZE 2010).

Concentrating solar thermal (CST) and photovoltaic (CPV) technologies have also been developed to enable power generation over extended periods making it suitable for baseload generation. This technology is a key component of the Zero Carbon Australia 2020 Stationary Energy Plan (ZCA, 2010). A system of power towers is proposed with CST power towers, heliostat mirror fields and molten salt storage. This type of power plant has been in full commercial operation in Spain's Andasol plant since 2008.

A.2.1 Prerequisites

Geoscience Australia (GA 2010) describes Australia as having a vast and largely untapped resource in its solar energy, with a highest average solar radiation per square metre of any continent, including areas with access to the grid. Large-scale solar power plants require around 2 hectares of land per MW, which needs to be flat for some types of plant (GA 2010). In Australia, the highest solar radiation areas are in the north-west and towards the centre of the continent, and suitable sites have also been identified in other areas including central and north-west NSW.

Solar radiation throughout the Sydney metropolitan area theoretically represents an excellent renewable energy source. In practice each installation has to be designed individually to take account of shadowing as well as many of the usual development considerations such as visual amenity and heritage issues.

A.2.2 Maturity of Technology

In 2007/08 solar energy use represented 0.1 per cent of Australia's total energy consumption, with solar thermal water heating the main form of solar energy use (GA 2010), although electricity generation is projected to increase from 0.1 TWh in 2007/08 to 4TWh in 2029/30 (ABARE 2009a). Smaller solar PV applications, such as those on residential roof-tops, are well proven technology best suited to displacing the requirement for grid electricity. Spikes in demand for electricity often occur during hot weather and sometimes cause brown/blackouts, which could be avoided by using residential-scale solar PV for air-conditioning demand at such times (BZE 2010).

Installations of solar PV, both connected to the grid and off-grid, have been rising since the 1990s, with more than 145 MW installed when the Clean Energy Council wrote its 2009 report (CEC, 2009). Both solar thermal and solar PV technologies are well proven, with the largest users of thermal being China (180 PJ), the USA (62 PJ) and Israel (31 PJ) and the largest users of grid-connected solar PV (i.e. not including off-grid PV installations) being Germany (3.1 TWh), the USA (0.7 TWh) and Spain (0.5 TWh). (GA 2010.)

In Australia, the Government's Solar Flagships Program is partly funding some major large solar plants, particularly the 4 MW Liddell solar thermal concentrator owned by Ausra/Macquarie Generation (CEC, 2009).

A.2.3 Infrastructure Requirements

The infrastructure requirements of small and roof-top PV arrays are simply a suitable mounting surface and sunshine. An inverter is required to convert the current to AC for direct use within a house. Solar thermal heating uses either an array of small tubes in a flat plate or evacuated tubes to directly heat water, and require just a surface mounting and requisite plumbing. Standalone systems require batteries for power storage to be effective when the sun is not shining or the power is not immediately required. A meter and grid connection is necessary if surplus electricity is to be exported.

While many are mounted on rooves, solar panels have been built into the noise barrier on the Tullamarine Freeway by the Tullamarine-Calder Interchange Alliance. The 500-metre length of wall functions to reduce noise by deflecting sound away from neighbouring houses as a result of glass density. It also generates up to 24 kW of power, which is fed into the grid to offset the energy used by the street-lighting and the CCTV system.

A.2.4 Environmental and Social Impacts

Solar cell modules contain toxic substances which could be released if the modules were destroyed, for example in a fire. There are visual impacts from solar cells which need to be taken into account, as well as the issue of over-shadowing, particularly when neighbouring developments create a shadow problem after installation.

A.2.5 Economic Viability

For electricity generation, initial capital cost of installations is relatively high in Australia, with small-scale solar PV arrays suited to off-grid and remote use, and other applications currently largely dependent on government or research funding.

Solar thermal hot water systems for domestic use are most widely. The largest cost is also initial installation.

Once installed, the cost of fuel (sunlight) is zero. However, there is an additional cost for replacement of the inverter (which converts the direct current to alternate current) approximately every ten years.

In NSW, customers generating electricity with an annual electricity consumption less than 160 megawatt hours (MWh) under the Solar Bonus Scheme would qualify for 20 cents per kWh gross feed-in tariff. This would cover households (which consume approximately 7.6 MWh per annum on average), as well as some small businesses, schools and community organisations (NSW DII 2010a). However, SSROC member councils would not typically fall within that group of small retail customers.

A.3 Ocean Power

Ocean power is broadly divided into two major types: mechanical energy from the movement of tides and waves, and thermal energy from the heat of the sun.

- Tidal power generation (GA 2010) – tides result from the gravitational attraction of the Earth-Moon-Sun system acting on the Earth's oceans, and are like waves that occur over a long time period combined with horizontal currents. Tidal energy can be captured by means of barrages, which usually allow water to enter a tidal basin and then to drain through a turbine, or stream generators, free-standing turbines that exploit the horizontal currents.
- Wave power generation (GA 2010) – waves are caused by winds on the ocean surface, with the height influenced by wind speed, duration, distance as well as the depth and topography of the ocean floor. Storms can generate both local waves and long-distance swells. Wave energy can be harnessed in a variety of ways, and a number of trials are under way to identify the most efficient technology.
- Ocean thermal power generation exploits the difference in temperature between the cooler deep water and the surface water that has been heated by the sun.

A.3.1 Prerequisites

Wave and tidal energy is obviously abundant on the coast, and tides especially are very predictable. Some parts of the south coast are subject to some of the largest and most persistent wave energy levels in the world. Different technologies operate most effectively in different conditions, and so need to be matched to the prevailing tides and wave conditions. Barrage systems require tide ranges of more than 4 metres, which effectively limits the potential of existing systems to northern Australia. Tidal turbines also have the greatest potential on the northern half of the Australian continental shelf and Bass Strait. Geoscience Australia notes the greatest wave power potential exists on the continental shelf of Western Australia, South Australia, Victoria and Tasmania.

A.3.2 Maturity of Technology

The current market for ocean energy is small (0.003% of world electricity generation), with only Canada and France making commercial use of this source of energy in 2009, and a new plant near Seoul due to start production in 2010 (GA 2010). There is a wave power facility operating at Port Kembla in NSW with an installed capacity of 0.5 MW, owned by OceanLinx Ltd. (CEC 2009).

The International Energy Authority projects growth in the ocean power sector, but with a forecast market share of 0.038% by 2030, clearly sees the sector remaining small compared with the major renewables.

White and Hearps (BZE 2010) see wave energy technology as emergent, "as yet have not overcome all technical hurdles not have they been demonstrated at scale". Wave energy's potential seems to be signficant and reliable enough for baseload power eventually, with favourable sites from Exmouth in the north-west all round the southern coast to Brisbane in the east (Carnegie and WWF, undated). But as yet it is still, relatively, in the early stages of development.

A.3.3 Infrastructure Requirements

A.3.4 Environmental and Social Impacts

Barrages and associated lagoons can have environmental impacts.

A.3.5 Economic Viability

Initial capital costs of installations are relatively high.

A.4 Cogeneration and Trigeneration

Whilst not a generally yet employing a renewable energy source, cogeneration and trigeneration are frequently presented in this context in the media and in studies of carbon-reduction technologies. If the purpose of any power-generating initiative by the ROC is agreed to be the achievement of real reductions in emissions, then the analysis would appear to be incomplete without this alternative given the technology options available today. Being decentralised in nature, this option would also be suitable for any program aimed at improving energy security. Furthermore it would appear that renewable source of energy could be used to power such plants in the future.

Cogeneration, also known as Combined Heat and Power (CHP) is the process of power generation, usually from natural gas, by means of small plants located close to customers, where both heat and electricity are used. Energy efficiency can be more than 70 per cent better than power from the grid (CEC 2010b). It can also reduce the amount of infrastructure required to transport electricity (i.e. poles and wires). Cogeneration plant can also use other fuel sources such as solar collectors, biomass and geothermal (DEKB, 2010), and potentially the renewable gases derived from waste (Jones, 2009).

However, in 2007-08 the Australian energy industry generated most (80.8%) of its electricity using coal, with only 13.2% derived from gas and 5.8% from renewables, mainly hydroelectricity (CEC 2009). The greenhouse emissions from the coal process are higher than those from natural gas, so switching to electricity generated from gas would significantly reduce the greenhouse emissions from electricity consumed.

Trigeneration is a related technology, which uses surplus heat for both heating and, via absorption chillers, for cooling. It is also known a Combined Cooling, Heating and Power (CCHP).

At a small scale, micro trigeneration can provide CCHP for local business or residential use, although the technology is not yet in widespread use. The University of Newcastle (in England) has developed a micro-trigeneration system that incorporates an energy storage system, enabling the supply of electricity, heating, and cooling to a home when it is required (InTech 2008). However, SSROC has been unable to locate any information indicating the system is in production on a commercial basis, or that it has yet been installed in any homes.

A.4.1 Prerequisites

To operation CHP or CCHP requires a fuel source, and in the short-term least this is likely to mean connection to a natural gas supply, which could be very expensive if improvements for adequate volume and pressure are also required (ISF 2009a).

The suitability of a site for cogeneration or trigeneration depends on the ability of the site to use the heat generated by the plant: so suitability has to be assessed on a site-by-site basis. In northern Europe heat is utilised for site heating, but such use may not be justified the warmer Sydney area. However, trigeneration technology may well be suited to many sites.

To operate at a larger scale, trigeneration/cogeneration requires access to wire networks for electricity distribution (as opposed to access to the national grid for sale to an electricity retailer).

A.4.2 Maturity

Both cogeneration and trigeneration are well proven technologies with applications relatively common in Europe and increasingly in Australia. Installed CHP capacity in the USA was reported to be 82GWe in 2006 (WADE, 2006). In NSW to date CCHP installations have been small-scale for standalone buildings, and not large-scale for groups of buildings (Jones 2010).

A.4.3 Infrastructure Requirements

An adequate supply of suitable fuel is required, which is why such systems typically run on natural gas in Australia, with its much lower carbon emissions than a comparable supply of electricity. For a large-scale installation to power a group of buildings or a zone, high electrical efficiency plant is required, while low electrical efficiency plant would be adequate for demonstration projects (Jones, 2010).

CHP software is required to run the equipment, thermal storage capacity is necessary to allow heating/cooling to continue after the plant is shut down, and some kind of back-up capability would probably be required for continuity during periods of maintenance, upgrade or unexpected interruption.

A.4.4 Environmental and Social Impacts

The Inter-American Development Bank found no serious environmental or social impacts resulting from a cogeneration installation in Monterey, Mexico in 2000 (IADB, 2000). It found construction impacts equivalent to any medium-scale development, such as dust, noise and vehicle emissions, and carbon emissions from burning natural gas relatively low compared with using grid power. Trigeneration does result in emissions of nitrous oxides, carbon monoxide and unburnt hydrocarbons on-site, and may be subject to the PoEO Act depending upon the size of the plant (ISF, 2009a).

A.4.5 Economic Viability

The financial case for trigeneration may be premised on the avoided cost of retail electricity and the income from the sale of surplus electricity. However electricity sold back to the grid attracts only the wholesale price which is 40 to 60 per cent lower than the retail price (ISF, 2009a). One option to compensate is to supply electricity to tenants or neighbouring properties under regulatory exemptions, but this involves creating a new business function in which the building owner may not wish to engage.

Alternatively, ISF (ISF, 2009) suggests that trigeneration facilities might be paid for their contribution to lowering peak network demand and so reducing the need for electricity infrastructure to deliver power from distant centralised power stations.

Installation of a private wire network, duplicating the local electrical distribution system, would avoid the problem, but add a further layer of cost and, being a duplicate system, would be economically inefficient (ISF 2009). Virtual private wire networks offer a more viable economic proposition, as established in London, UK, and the principle underlying the City of Sydney's plan for decentralised energy (Jones, 2010).

ISF reports that the financial case for trigeneration is "attractive in many cases" but notes that it can be critically dependent upon the price of gas (ISF, 2009a), and on whether or not environmental and efficiency benefits are captured to present a true business case.

A.5 Energy Efficiency

Energy efficiency is not a renewable technology but is included in this paper because any transition to renewable energy will take time and councils will not be able to cease their consumption of power in the interim and are unlikely to be able to afford to buy off-sets equivalent to all their emissions. SSROC is conducting another project, the Energy Cost Control project, to progress energy efficiencies in the interim.

A.5.1 Prerequisites

Energy efficiency measures can be applied to any energy user: there are no other prerequisites. Energy consumption is currently projected to increase by 2 per cent per annum for the next 20 years.

A.5.2 Maturity

There are many different interventions for improving energy efficiency, and many are well proven, having been implemented in a wide variety of settings. Insulation, is a key measure in homes, and is installed in about 61 per cent of homes, mostly in the roof only. Ceiling and roof insulation is estimated to save up to 45 per cent on the energy used for heating and cooling (CEC 2009). Other examples include the use of energy-efficient light globes, with 58 per cent of dwellings in Australia using them in at least one room (CEC 2009).

A.5.3 Infrastructure Requirements

Energy efficiency applies only where energy infrastructure is already in place. There are generally no additional requirements. Smart meters can often be a component an improvement program: they do not deliver improvements since they are only measuring instruments, but they provide the consumer with information about their consumption that enables them to make efficiency improvements.

A.5.4 Environmental and Social Impacts

Recent difficulties with the installation of insulation under seem to have been caused by poor installation techniques.

A.5.5 Economic Viability

The economics of energy efficiency are well demonstrated, and payback period are usually relatively short since they involve reduction in consumption and hence lower costs.

Costs are relatively low when compared with some of the larger project investments required for changing energy source.

Organisations would usually commence energy efficiency initiatives with an energy audit to identify the areas where the greatest potential for savings exists so that returns are maximised.

A.6 Other Renewables

Other forms of renewable energy have been eliminated from further consideration in this scoping study. The selection is consistent with that of Zero Carbon Australia 2020 Plan (BZE 2010), which states that “Wind, solar photovoltaics and concentrating solar thermal with storage are commercially proven, scaleable solutions that together can ensure reliable, 24-hour renewable energy supply.”

It is possible than one or more might re-emerge during the feasibility study, but at this point they are thought to be unlikely to be relevant to the regional context.

- Hydro-electricity – Australia has a well-established hydro-electricity industry, but it is considered to be almost fully mature with little scope further potential (ATSE 2009). Hydro-electric power, especially the Snowy Mountains Scheme, is the source of most electricity generation from renewable sources today (ABARE 2009b) with 88 per cent share in NSW (NSW DII 2010b). Its share of energy generation declined between 1999/00 and 2007/08 by 4.2 per cent largely due to drought: its dependence on the availability of water (relatively low rainfall, high temperatures and high rates of evaporation) is a constraint on its further development. There is still potential for small-scale develop, which is suited to systems that use the natural flow of a river or waterfall (rather than a dam) for mainly rural use, although the price ($ per MW) is relatively high. (GA 2010)
- Geothermal energy – although Australia has good prospects for harnessing geothermal energy, most projects are currently at either proof-of-concept or early commercial demonstration stage. It is a proven technology, effectively used in areas of high volcanic activity such as Iceland, where it is the source of 30 per cent of power. However, the commercial viability of geothermal energy in Australia is not yet proven, and there are high up-front capital investment costs. Government grants appear not to favour geothermal developments, with $153 million invested in the development of two "hot rock" energy plants, and some $50m in drilling assistance, compared with a predicted $20 billion in wind investment, and a total of $4bn in promised to carbon capture and storage and large-scale solar (The Australian, 2010)[4]. Most of the likely sites are located in areas of Australia that would require additional transmission infrastructure, and which implies potentially high rates of transmission loss, further threatening its commercial viability. Geoscience Australia anticipates that geothermal energy is unlikely to be in full production before 2030 (GA 2010). SSROC concludes that it is very unlikely that the region could effectively engage with this form of power generation.
- Bioenergy – the major existing source of renewable energy (i.e. in generating both heat and electricity) mainly from bagasse (sugar cane residue used in cogeneration plants in sugar refineries), wood waste, and landfill and sewage gas capture. Councils already exploit bioenergy to some extent by means of the

[4] The Australian March 08, 2010

landfill gas capture from their waste disposal arrangements, although most landfills generate only sufficient power for their own operational use. Sydney Water has begun exploiting methane from sewage treatment plants by means of cogeneration (Sydney Water 2010). There is significant and user-used resource available in Australia, such as crop residues, and this form of renewable energy is expected to increase by 60 per cent by 2029/30 (GA 2010). While there is an opportunity to support the agricultural industry by growing crops for this purpose, it must be balanced against competing with food crops. SSROC cannot currently identify any further opportunity to exploit this technology in the region.

Appendix B References

ABARE, 2009a, (The Australian Bureau of Agricultural and Resource Economics), *Australian Energy Statistics*, Canberra, August 2009.

ABARE, 2009b, *Energy in Australia 2008*, for the Australian Government Department of Resources, Energy and Tourism, Canberra, February 2009.

AEMO 2010, The Australian Energy Market Operator, *An Introduction to Australia's National Energy Market,* July 2010.

AGL 2010, AGL, *AGL Earth Power Generation Portfolio,* available: http://www.agk.com.au/earth/#/map accessed: 19/11/10

Allan P, Darlinson L and Gibbs D 2006, *Are Councils Sustainable? Final Report: Findings and Recommendations, Independent Inquiry into the Financial Sustainability of NSW Local Government (The Allan Report)*, Local Government and Shires Associations, Sydney, May 2006

AMC 2010, Ashfield Municipal Council, *Green Loans Program*, available: www.ashfield.nsw.gov.au/pages/green_loans_program.html accessed: 15/11/10

ATSE, 2009 The Australian Academy of Technological Sciences and Engineering, *The Hidden Costs Of Electricity: Externalities of Power Generation in Australia*, March 2009

BZE Beyond Zero Emissions and The University of Melbourne, *Australian Sustainable Energy - Zero Carbon Australia - Stationary Energy Plan*, Melbourne Energy Institute, University of Melbourne, July 2010 available: http://beyondzeroemissions.org/ accessed: 16/7/10

Clean Energy Council, 2009, *Clean Energy Australia 2009*, available: http://www.cleanenergycouncil.org.au/cec/resourcecentre/reports.html accessed: 12/7/10

Clean Energy Council, 2010, *Clean Energy Fact Sheet – All about Wind Energy*, available: http://www.cleanenergycouncil.org.au/cec/resourcecentre/factsheets.html accessed: 12/7/10

Climate Works 2010, *Low Carbon Growth Plan for Australia,*March 2010 available: http://www.climateworksaustralia.com/Low%20Carbon%20Growth%20Plan.pdf accessed: 23/11/0

Coffs 2010, Coffs Harbour City Council, *Rigby House Solar Power Project*, available: http://www.coffsharbour.nsw.gov.au/www/html/5228-rigby-house-solar-power-project.asp?intLocationID=5228 accessed: 5/11/10

CoS 2010, City of Sydney, *City Of Sydney Decentralised Energy Master Plan —Trigeneration, 2010–2030*, prepared by Kinesis Consortium for The City of Sydney, available: http://www.cityofsydney.nsw.gov.au/Council/OnExhibition/CityofSydney.asp accessed: 13/12/10

DoCCEE 2010a, Department of Climate Change and Energy Efficiency, *Small scale renewable energy systems under the RET scheme*, available: http://www.climatechange.gov.au/government/initiatives/renewable-target/need-ret/solar-ret.aspx accessed: 12/7/10

DoCCEE 2010b, Department of Climate Change and Energy Efficiency, *Report Of The Prime Minister's Task Group On Energy Efficiency,* Canberra, 2010

Ecolibrium 2009, *Showing by Doing,* Mattew Dillion, Ecolibrium, March 2009

EIA 2009 (Energy Information Administration of the United States) International Energy Outlook 2009, Washington DC in Geocience Australia 2010.

Fuller MG, Portis SC and Kammen DM 2009, *Toward a Low-Carbon Economy. Municipal Financing for Energy Efficiency and Solar Power*, Environment Magazine Volume 51, Issue 1, January/February 2009, Taylor and Francis, Philadephia.

Garnaut, 2008, *The Garnaut Climate Change Review Final Report,* 2008 Cambridge University Press

Garnaut, 2010, *The Garnaut Climate Change Review Update 2011, Terms of Reference* available: http://www.garnautreview.org.au/update-2011/terms-of-reference.html accessed: 18/11/10

Geosciences Australia, 2010, *Australian Energy Resource Assessment*, by Geoscience Australia and the Australian Bureau of Agriculture and Resource Economics (ABARE) for the Commonwealth Department of Resources, Energy and Tourism, Canberra.

Guardian 2008, The Guardian (UK newspaper), *Making waves: UK firm harnesses power of the sea ... in Portugal*, 25 September 2008, available: http://www.guardian.co.uk/technology/2008/sep/25/greentech.alternativeenergy accessed: 24/11/10

Hobart 2009, Hobart City Council, *Annual Report 2008/09*, available: http://www.hobartcity.com.au accessed: 19/11/10

Hobart 2010b, Hobart City Council, *Annual Report 2009/10*, available: http://www.hobartcity.com.au accessed: 19/11/10

Inner West Courier 2010, *Wind Farm Deadline for Marrickville Council*, by Marie Sansom, Inner West Courier, 2 February 2010 available: http://inner-west-courier.whereilive.com.au/news/story/wind-farm-deadline/ accessed: 9/11/10

InTech 2008, *A New Green Way To Power A Home*, 4 December 2008 available: http://www.isa.org/InTechTemplate.cfm?Section=Industry_News&template=/ContentManagement/ContentDisplay.cfm&ContentID=72902 accessed: 13/12/10.

IPART 2002 Independent Pricing and Regulatory Tribunal of NSW, *Inquiry into the role of Demand Management and other options in the provision of energy services*, October 2002, available: http://www.ipart.nsw.gov.au/electricity/documents/InquiryintoRoleofDemandManagementandOtherOptions-FinalReport.pdf accessed: 30/9/10

IPART 2009 Independent Pricing and Regulatory Tribunal of NSW, *Revenue Framework for Local Government – Other Industries – Final Report*, December 2009, available:http://www.ipart.nsw.gov.au/investigation_content.asp?industry=5&sector=15&inquiry=167&doctype=7&doccategory=1&docgroup=1 accessed: 14 July 2010

ISF 2009a, Dunstan C, Langham E and Daly J, *Barriers to Trigeneration in Sydney: Working Group Discussion Paper and Action Plan,* prepared by the Institute for Sustainable Futures, UTS for the City of Sydney, October 2009 available: www.cityofsydney.nsw.gov.au accessed: 6/9/10

ISF 2009b, Rutovitz J and Dunstan C, *Meeting NSW Electricity Needs in a Carbon Constrained World: Lowering Costs and Emissions with Distributed Energy,* (prepared as part of Project 4 of the CSIRO Intelligent Grid Research program by the Institute for Sustainable Futures, University of Technology Sydney).

Jones 2009, Allan Jones, Chief Development officer, Energy and Climate Change, City of Sydney Council, *City of Sydney Property Portfolio Decentralised Energy Strategic Direction,* 19 November 2009 (in Jones, 2010) available: www.cityofsydney.nsw.gov.au accessed: 6/9/10

Jones 2010, Allan Jones, Chief Development officer, Energy and Climate Change, City of Sydney Council, *Removal of the Barriers to Trigeneration,* 2 March 2010 available: www.cityofsydney.nsw.gov.au accessed: 6/9/10

Kogarah 2010, Kogarah City Council, *Kogarah Town Square Redevelopment Factsheet – Energy*, available: http://www.kogarah.nsw.gov.au/resources/documents/Town_Square_Fact_Sheets_ENERGY1.pdf accessed: 19/11/10.

Local Government Act 1993, available: http://www.legislation.nsw.gov.au/scanview/inforce/s/1/?TITLE=%22Local%20Government%20Act%201993%20No%2030%22&nohits=y accessed: 12 July 2010

Mims, C 2009 *The No-Money-Down Solar Plan,* Scientific American, 00368733, Dec2009, Vol. 301, Issue 6

NSW DII 2010a, Department of Industry and Investment, 2010a, *NSW Solar Bonus Scheme - frequently asked questions*, available: http://www.industry.nsw.gov.au/energy/sustainable/renewable/solar/solar-scheme/faq#Eligibility accessed: 20/7/10

NSW DII 2010b, Department of Industry and Investment, 2010b, *Sources of renewable electricity generation in NSW*, available: www.http://www.industry.nsw.gov.au/energy/sustainable/renewable , accessed: 12/7/10

NSW DoP 2010a, NSW Department of Planning, *Discussion Paper On Planning For Renewable Energy Generation – Small Wind Turbines* (consultation draft), April 2010, available: http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=yHOCF-baJXs%3D&tabid=394&language=en-AU

NSW DoP 2010b, NSW Department of Planning, *Discussion Paper On Planning For Renewable Energy Generation – Solar Power* (consultation draft), April 2010, available: http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=yHOCF-baJXs%3D&tabid=394&language=en-AU

RaCC 2007, Randwick City Council *Trialling of Wind Turbines on Council Buildings*, Mayor's Minute 113/2007, 29 October 2007.

RISE 2010, Research Institute for Sustainable Energy, Murdoch University, *Small Wind Turbines in the Built Environment*, available: http://www.rise.org.au/research/NSWTC/install.html accessed: 13/12/10

SSROC 2003, Southern Sydney Regional Organisation of Councils, *SSROC Regional Greenhouse Gas Reduction Plan*, available: www.ssroc.nsw.gov.au/publications accessed: 18/11/10

Sydney Water, 2010, *Sydney Water Renewable Energy*, available: http://www.sydneywater.com.au/Majorprojects/RenewableEnergy.cfm accessed: 9 July 2010

TEC 2009, Total Environment Centre Inc, *Role of the NEM in responding to climate change policies,* by McLennan Magasanik Associates, available: www.tec.org.au accessed 1/10/10.

TEC 2010, Total Environment Centre Inc, *Demand Management and Energy Policy Development: A Case Study of New South Wales. A Review and Proposals for the Future.* Available: www.tec.org.au accessed: 30 /9/10.

The Australian March 08, 2010, *Geothermal to play role in nation's future energy mix* by Giles Parksinon

UNSW 2005, *Best Practice Guidelines for Solar Power Building Projects in Australia*, University of NSW Faculty Of The Built Environment, Centre for a Sustainable Built Environment, 2005 available: http://www.re-systems.ee.unsw.edu.au/documents/BiPV%20Best%20Practice%20guidelines.pdf accessed: 19/11/10

Vivid 2010, Vivid Economics, *The Implicit Price of Carbon in the Electricity Sector of Six Major Economies,* prepared for The Carbon Institute, October 2010

Wilpena 2010, Wilpena Pound Resort website available: http://www.wilpenapound.com.au/community-environment/ accessed: 19/11/10

Woking 2001, Woking Borough Council, *Woking Borough Council's Thameswey Joint Venture Project,* April 2001, available: www.woking.gov.uk, accessed: 1/11/10

Woking 2007, Woking Borough Council, *Thameswey Limited and Thameswey Energy Limited*, March 2007, available: www.woking.gov.au, accessed: 24/11/10

Yuh-Ming Lee and Yun-Ern Tzeng, *Development and Life-Cycle Inventory Analysis of Wind Energy in Taiwan,* Journal of Energy Engineering, American Society of Civil Engineers, Jun2008, Vol. 134 Issue 2, p53-57.